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Original Research Paper

Anatomy

ANATOMIC VARIATIONS IN THE MIDDLE CEREBRAL ARTERY IN HUMAN CADAVERS

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ABSTRACT

INTRODUCTION: Middle cerebral artery (MCAis the largest branch among all the branches of internal carotid artery,abnormal development of which in the embryonic period can lead to developmental anomalies of the cerebral arteries. The present study was aimed to describe the anatomical variations in the MCA in the formalin preserved brains of human cadavers.

METHODOLOGY: This study was conducted in the Department of Anatomy, Mahatama Gandhi Mission Medical College, Aurangabad in which 50 formalin preserved specimens of brain were dissected. We carefully dissected the MCA on either side from its origin to its termination and its course was traced through the lateral cerebral fissure. We carefully and delicately separated the arterial networks of the Circle of Willis along with the MCA of both sides and using a verniercaliper the dimensions of the MCA were measured.

RESULTS: In all specimens, MCA originated from the internal carotid artery, and it ran towards the posterior end of the lateral sulcus of the cerebral hemispheres lateral to the optic chiasma. The length ranged from 11.3 to 26.2 mm, with mean length being 18.9 and 17.6 mm in the right and left side respectively. Diameter of the MCA ranged from 2.5 cm to 4.8 cm, with mean diameter being 3.12 and 3.24 cm in the right and left side respectively. Symmetric branching of MCA was seen in 22 specimens and rest had asymmetric branching.

CONCLUSIONS: Awareness about the anatomical variations in the morphometric measurements and branching patterns of MCA are essential from the clinical viewpoint. Since these variations are rare, multi-centric studies with larger sample size are required in future.

KEYWORDS : Anatomy, branching patterns, middle cerebral artery, origin

INTRODUCTION

Phylogenetically, middle cerebral artery (MCA) is the youngest intracranial artery. Its evolution is related to the development of cerebrum. MCA is formed by the cortical vessels appear on the lateral aspects of hemispheres before infolding and deepening of hemispheres occurs.[1]It is the largest branch among all the branches of internal carotid artery, which runs in the lateral cerebral fissure then posterosuperiorly on the insula. A number of small branches are given off in the interpeduncularfossa which are grouped as medial and lateral striate arteries, which supply lentiform nucleus, caudate nucleus, and internal capsule. Abnormal development in the embryonic period, can lead to developmental anomalies of the cerebral arteries. Due to the high prevalence of intracranial aneurysms and the mortality associated with symptomatic cases, anatomical variations of the MCA carry special clinical importance. Prior knowledge of such variations makes surgical and endovascular planning easier and to anticipate any intra-operative emergency.The present study was aimed to describe the anatomical variations in the MCA in the formalin preserved brains of human cadavers.

METHODOLOGY

This study was conducted in the Department of Anatomy, Mahatama Gandhi Mission Medical College, Aurangabad in which 50 formalin preserved specimens of brain were dissected. We excluded those brains which had gross morphological abnormalities or variations. The study was approved by the institutional ethics committee.Age or cause of death of the cadavers from which brains were removed were not known to us.The Circle of Willis was exposed by carefully removing the arachnoid mater in the interpenduncular fossa.Internal carotid arterywas identified at the lateral angle of the Circle of Willis and dissected to find out its terminal branches which are middle cerebral artery (MCA) and anterior cerebral artery (ACA). We carefully dissected the MCA on either side from its origin to its termination and its course was traced through the lateral cerebral fissure. The branches arising from MCA were dissected carefully and branching pattern of MCA was noted. We carefully and delicately separated the arterial networks of the Circle of Willis along with the MCA of both sides and pasted on the black plastic sheets for a better observation. Using a verniercaliper (discrimination up to 0.01 mm) the dimensions of the MCA were measured. Using a proforma, the origin, course and morphometric measurements were noted and tabulated.

RESULTS

In all specimens, MCA originated from the internal carotid artery, arising in the interpenduncular fossa at the lateral angle of the Circle of Willis. None of the specimens had accessory MCA, double MCA or aneurysm. In all the specimens, MCA ran towards the posterior end of the lateral sulcus of the cerebral hemispheres lateral to the optic chiasma (Table 1). Morphometric data of MCA was measured and tabulated in table 2. Length of the MCA as measured from its origin to its termination from the main stem. The length ranged from 11.3 to 26.2 mm. Mean length of MCA was 18.9 and 17.6 mm in the right and left side respectively. Diameter of the MCA ranged from 2.5 cm to 4.8 cm. Mean diameter of the MCA was 3.12 and 3.24 cm in the right and left side respectively. Symmetry of the MCA branching was observed as well. Symmetric branching of MCA was seen in 22 specimens and rest had asymmetric branching.

DISCUSSION

In the present study, we investigated the presence of anatomical variations in the MCA by dissecting and studying 50 cadaveric brains. We did not find any gross anatomical variations, all originated from the internal carotid artery and travelled lateral to the optic chiasma. The cortical branches typically arise from the main MCA trunk, which can be divided into four segments; the sphenoid or horizontal segment), the insular segment, the opercular segment, and the cortical branches. Early branch is the cortical artery which originates prior to the initial branching, which can be divided into early frontal or early temporal branches branches.[2]Some authors have suggested that there is only one early branch present[3], while other authors suggestedthat an early frontal branch was frequently positioned between two early temporal branches.[4]This is was supported by the results of a study by Ogeng'o et alwho observed 104 cases of early frontal branches and 184 cases

of early temporal branches.[5]Kahilogullari et al described the branching structure of MCA in 25 fresh human brains from routine autopsy.[6] The intermediate trunk was present in 61% of cadavers and originated from a superior trunk in 55% and from an inferior trunk in 45%.

Though not observed in the present study sample, accessory and duplicate MCA are the most commonly seen variations of the MCA. Duplicate MCA is when two vessels originate from the distal end of internal carotid artery. Lee et al[7] reported a case of a ruptured aneurysm of the right accessory MCA and Uchino et al demonstrated the duplicate origin and fenestration of the MCA[8].Chang and Kim investigated 25 patients with duplicate MCA using conventional angiography, magnetic resonance-angiography and computed tomography-angiography. In their study, dilated MCAs which originated near the internal carotid artery terminalhad diamters same or slightly smaller than those the rest of the dilated MCA. MCAs which originated between the anterior choroidaland terminal carotid artery artery had diameters as same, slightly smaller, or very much smaller than that of the other branches of the dilated MCA. Rare aneurysms have been reported at the origin of dilated MCAs, thus identification of dilated MCA has a clinical implication while performing surgical dissection of aneurysms associated with dilated MCAs. In addition, dilated MCA supply collateral flow to the frontal lobe and basal ganglia through the perforating arteries.

We reported a mean length of MCA in the right and left side to be 18.9 and 17.6 cm respectively, while the mean diameter was 3.12 and 3.24 mm in right and left side respectively. Gunnal et al reported mean length of MCA as 25.54 and 27.86 mm in the right and left side, while the reported mean diameter was 3.0 mm both on right and and left side.[9] Previously reported mean lengths of MCA by Pai et al[10] 20 mm, which is higher than that reported in the present study. Zurada et al suggested that a shorter length may play a role in aneurysms formation and changes in diameter can indicate certain diseases.[11]This is true for branching pattern of MCA as well and having this knowledge is important in aneurysm related surgeries.
There are a few limitations of this study. First is the small sample size, because of which the results of the present study might not be generalizable to other geographical locations. Also, we could not confirm the morphometric measurements with the use of modern imaging techniques like the magnetic resonance or computed tomography angiography.

CONCLUSION

Physiciansdealing with surgical patients should be aware of the anatomical variations in the morphometric measurements and branching patterns of MCA. Since these variations are rare, multi-centric studies with larger sample size are required to understand the association of different pathological conditions like aneurysm with these anatomical variations.

Table 1. Origin and course of middle cerebral artery

	Right Middle Cerebral Artery (n=50)	Left Middle Cerebral Artery (n=50)
Origin from Internal carotid artery	50 (100%)	50 (100%)
Course lateral to optic chaisma	50 (100%)	50 (100%)

Table 2. Morphometry of middle cerebral artery

	Minimum	Maximum	Mean	Standard deviation
Length (in mm)				
Right	12.2	26.2	18.9	1.32
Left	11.3	23.7	17.6	2.47
Diameter (in mm)				
Right	2.6	4.6	3.12	0.67
Left	2.5	4.8	3.24	0.71

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