ORIGINAL RESEARCH

Analysis of variations in branching pattern of middle cerebral artery

Dr. Mohd Hassan Ali

Associate Professor, Department of Anatomy, Dr S S Tantia Medical College Hospital and Research Centre, Sriganganagar, Rajasthan, India

Corresponding author
Dr. Mohd Hassan Ali
Associate Professor, Department of Anatomy, Dr S S Tantia Medical College Hospital and Research Centre, Sriganganagar, Rajasthan, India

Received: 11 June, 2023 Accepted: 16 July, 2023

ABSTRACT
Background: The largest and most intricate vascular network in the brain is the middle cerebral artery (MCA). The present study was conducted to assess variations in branching pattern of middle cerebral artery. **Materials & Methods:** 50 cadavers were studied. The internal carotid artery was identified and the origin of the middle cerebral artery was determined. **Results:** Length of M1 segment was >20 mm in 9, 17-19 mm in 8, 14-16 mm in 17, 11-13 mm in 10 and <11 mm in 4 cases. The difference was significant (P< 0.05). Outer diameter of M1 segment>5 mm was present in 4, 3-5 mm in 40 and <3 mm in 6 cases. The difference was significant (P< 0.05). Branching pattern of middle cerebral artery was bifurcation in 38, trifurcation in 10 and ramification in 2 cases. The difference was significant (P< 0.05). **Conclusion:** The bifurcation pattern was seen in the majority of cases. The M1 segment's length and diameter fell within the usual range.
Key words: Middle cerebral artery, vascular network, Branching

INTRODUCTION

The largest and most intricate vascular network in the brain is the middle cerebral artery (MCA). To properly interpret radiological pictures and determine the most effective treatment strategy, one must have a thorough understanding of the cerebral artery's typical structure, branching pattern, and distribution segment.[1] The four main surgical portions of the MCA are designated M1 through M4. Sphenoidal refers to the M1 segment, Insular to the M2 segment, which runs in the lateral fissure, Capsular to the M3 segment, which emerges from the lateral fissure, and Cortical to the M4 segment. After beginning in the lateral cerebral fissure and continuing posterosuperior to the Insula, the middle cerebral artery splits into several branches. 2 The origin of cortical branches varies depending on the branching pattern of the MCA and includes orbital branches, frontal branches.[2]
Neurovascular disorders have been associated with anatomical abnormalities of the MCA; for instance, higher hemodynamic stress brought on by structural irregularities may contribute to saccular aneurysms.[3]
In the setting of neurologic diseases, computed tomography angiography is employed for preliminary assessments of the cerebral circulation, and numerous studies have documented MCA changes as a radiologic reference.Clinical importance exists for 4 MCA variants on several levels.[4] They might affect the clinical presentation or predispose people to particular diseases, for instance. Additionally, they can direct neurosurgical planning and establish the available alternatives for managing postoperative problems.[5] The present study was conducted to assess variations in branching pattern of middle cerebral artery.

MATERIALS & METHODS

This study was conducted in the department of Anatomy on 50 cadavers. Ethical approval was obtained before starting the study.
A skin incision was done in the coronal plane in front of each ear during the post-mortem examination of the cadavers. The cranial vault was removed in one piece with extra care taken not to harm the dura. The skin was reflected both anteriorly and posteriorly. Over the middle of each frontal lobe on either side, a tiny nick was formed. With the aid of non-toothed forceps, the durometer was split in half. The durometer was then further split into four flaps. After cutting the flax, the dura was transversely opened from the frontal base, and the frontal lobes were slowly drawn back. The internal carotid artery (ICA) and optic nerves were revealed and carefully severed attheir entrance into the cranial cavity.The brain was taken out of the skull

cavity, stored in a 5% formalin solution, and serially numbered for future research. The specimen was submerged in 10% formaldehyde solution for ten to fifteen minutes. The internal carotid artery was located, and the middle cerebral artery's source was found. Results were studied statistically. P value <0.05 was considered significant.

RESULTS

Table I Length of M1 Segment

Length (mm)	Number	P value
>20	9	0.05
17-19	8	
14-16	17	
11-13	10	
<11	6	

Table I shows that length of M1 segment was >20 mm in 9, 17-19 mm in 8, 14-16 mm in 17, 11-13 mm in 10 and <11 mm in 4 cases. The difference was significant (P< 0.05).

Table II Assessment of outer diameter of M1 segment

Diameter (mm)	Number	P value
>5	4	0.01
3-5	40	
<3	6	

Table II, graph I shows that outer diameter of M1 segment>5 mm was present in 4, 3-5 mm in 40 and <3 mm in 6 cases. The difference was significant (P< 0.05).

Graph I Assessment of outer diameter of M1 segment

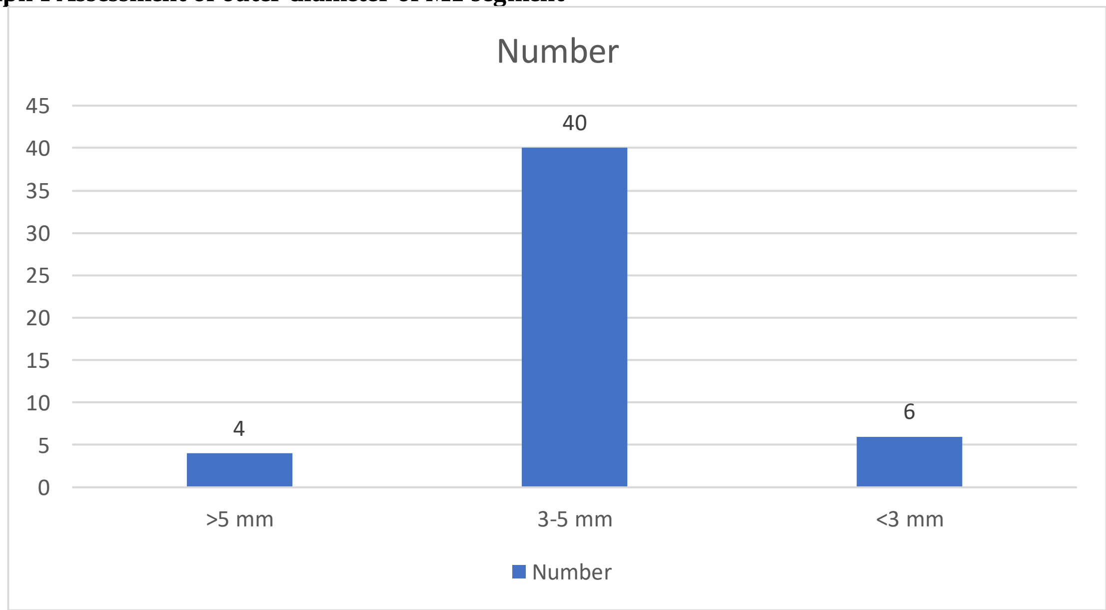

Table III Branching pattern of middle cerebral artery

Pattern	Number	P value
Bifurcation	38	0.01
Trifurcation	10	
Ramification	2	

Table III shows that branching pattern of middle cerebral artery was bifurcation in 38, trifurcation in 10 and ramification in 2 cases. The difference was significant (P< 0.05).

DISCUSSION

Numerous cortical regions and deep brain structures are supplied with blood via the middle cerebral artery (MCA), which is the largest, most significant, and most complex of the cerebral veins.[6] Its population variations affect the coverage area, leading to various clinical symptoms. Neurovascular disorders have been associated with anatomical abnormalities of the MCA; for instance, higher hemodynamic stress brought on by structural irregularities may contribute to saccular aneurysms.[7] In the setting of neurologic diseases, computed tomography angiography is employed for preliminary assessments of the cerebral circulation, and numerous studies have documented MCA changes as a radiologic reference.The MCA emerges from the ICA posterior to the olfactory tract and lateral to the optic chiasma. The (e artery then follows a lateral path, lying anterior to the optic tract and extending perforating branches to internal cerebral regions below the APS. The artery enters the lateral fissure and splits into two, three, or one major trunks from there.[8] The artery extends several cortical branches over the convex superolateral surface of the cerebral hemisphere and overlies the cortical tissue of the insula within the lateral sulcus.[9] The goal of the current study was to evaluate changes in the middle cerebral artery's branching pattern.

We found that length of M1 segment was >20 mm in 9, 17-19 mm in 8, 14-16 mm in 17, 11-13 mm in 10 and <11 mm in 4 cases. Oo et al.'s[10] investigation and documentation of the MCA's extent in 100 freshly harvested brain hemispheres from 50 deceased patients was done in 2011. In 2% of specimens, double MCA was seen. Bifurcation (72%), trifurcation (16%), and major trunk (12%), along with an early bifurcation of 3%, were the three most common termination types. The main trunk's (MT) average length was 20.6 mm plus 6.2 mm. The number of perforators varied from 4 to 15, with the majority (96%) originating from the MT. The remaining perforators also came from the bifurcation point (3%) and post-bifurcation divisions (1%). 100 percent of the perforators had just one branching pattern.The orbitofrontal (98%), prefrontal (99%), precentral (95%), central (98%), temporopolar (87%), anterior temporal (89%), middle temporal (24%), posterior temporal (62%), temporo-occipital (69%), anterior parietal (88%), angular (83%), and posterior parietal (57%) arteries were among the 6–13 cortical branches that were present. In 52% of cases, early cortical branches emerged from the MT.

We found that outer diameter of M1 segment>5 mm was present in 4, 3-5 mm in 40 and <3 mm in 6 cases. According to Mohr et al[11], the orbitofrontal and prefrontal regions are always present in the superior division of a bifurcation pattern. The tempora-polar, anterior and temporal, and middle temporal are all parts of the inferior division. The posterior temporal is always in the upper division, whereas the central branch is always there as well.

We found that branching pattern of middle cerebral artery was bifurcation in 38, trifurcation in 10 and ramification in 2 cases. In order to evaluate the factors and explain their significance with anatomical and surgical considerations, Mohan et al[12] set out to explore the variances in the microsurgical anatomy of the MCA in our community. The MCA measured in this study had a mean length of 12.8 mm and a standard deviation of 3.79 mm. The M1 segment had an outside diameter of 3.75 mm and a mean length of 3.75 mm. The cerebral artery exhibits bifurcation in 69.2% of the middle, trifurcation in 20%, and ramification branching patterns in 10.8%. Temporopolar, 21.7% orbitofrontal, 9.1% anterior temporal, 6.6% prefrontal, and 4.1% middle temporal branches are present in 39.1% of the cases. Additionally, our findings show that the middle cerebral artery's lenticulostriate branch originated 85.85% from the main vessel and14.2% from division, respectively.

CONCLUSION

Authors found thatthe bifurcation pattern was seen in the majority of cases. The M1 segment's length and diameter fell within the usual range.

REFERENCES

1. Cohen M, Biller J, Saver JL. Advances in the management of carotid disease. Curr Problems Cardiol. 1994;19:477–530.
2. Horikoshi, I. Akiyama, Z. Yamagata, M. Sugita, and H. Nukui, Magnetic resonance angiographic evidence of sexlinked variations in the circle of willis and the occurrence of cerebral aneurysms. Journal of Neurosurgery 2002; 4: 697–703.
3. Niederberger, J.-Y. Gauvrit, X. Morandi, B. Carsin-Nicol, T. Gauthier, and J.-C. Ferre. Anatomic variants of the anterior part of the cerebral arterial circle at multidetector computed tomography angiography. Journal of Neuroradiology 2010; 139–147.
4. Standring S, Ellis H, Healy J, Johnson D, Williams A, Collins P, et al. Gray's anatomy: the anatomical basis of clinical practice. Am J Neuroradiol. 2005;26(10):2703.
5. Eecken HV. Discussion of "collateral circulation of the brain. Neurology. 1961;11(4):16–9.
6. Umansky F, Dujovny M, Ausman JI, Diaz FG, Mirchandani HG. Anomalies and Variations of the Middle Cerebral Artery: A Micro anatomical Study. Neurosurgery. 1988;22(6P1-P2):1023–7.
7. J. A. Ogeng'O, W. Njongo, E. Hemed, M. M. Obimbo, and J. Gimongo. Branching pattern of middle cerebral artery in an African population. Clinical Anatomy2011;24:692–698.
8. Tanriover, M. Kawashima, A. L. Rhoton Jr., A. J. Ulm, and R. A. Mericle. Microsurgical anatomy of the early branches of the middle cerebral artery: morphometric analysis and classification with angiographic correlation. Journal of Neurosurgery 2003; 1277–1290.
9. S. J. Dimmick and K. C. Faulder. Normal variants of the cerebral circulation at multidetector CT angiography," Radiographics2009; 29: 1027–1043.
10. Oo EM, Saw KE, Oo HN, Than T, Thida K. Variable Anatomy of the Middle Cerebral Artery from Its Origin to the Edge of the Sylvian Fissure: A Direct Fresh Brain Study. The Scientific World Journal. 2021 Mar 10;2021.
11. Mohr JP. Middle cerebral artery. In: Barnett HJM, Mohr JP, Stein BM, Yatsu FM, editors. Pathophysiology, Diagnosis, and Management. New York: Churchill Livingstone; 1992. p. 361–417.
12. Mohan K. A study of the anatomical variations in branching pattern of middle cerebral artery. Indian J Clin Anat Physiol 2021;8(2):98-101.