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Original Research Article

A Morphometric Assessment of the Anatomical Variations in Branching Pattern of Middle Cerebral Artery: An Observational Study

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Abstract

Aim: The study aimed to study the anatomical variations in branching pattern of middle cerebral artery.

Material & Methods: A total of 50 cadavers were studied in the department of Anatomy, Patna Medical College, Patna, Bihar, India . During post-mortem examination of the cadavers, a skin incision was made in front of one ear to another ear in the coronal plane.

Results: The average mean outer diameter of the M1 segment was 3.70mm with a standard error of 0.69 mm. The pre-central branch shows the highest superior division in the trifurcation branching pattern, whereas the posterior parietal shows the highest in the middle division. In lenticulostriate trunk were shown in 85% whereas division pattern was shown in 15%.

Conclusion: MCA branching pattern is slightly higher in trifurcation pattern as compared to bifurcation and ramification. Thorough knowledge of the microvascular anatomy and the myriads of variations are essential for the operating surgeon to choose the ideal technique to avoid any catastrophe during and after surgery and give the best possible functional outcome.

Keywords: anatomical variations, branching pattern, middle cerebral artery

Introduction

Middle cerebral artery (MCA) is the larger terminal branch of the internal carotid artery (ICA). [1] It supplies a large area of distribution as compare to the anterior cerebral artery (ACA) and posterior cerebral artery (PCA). [2-5] However, the MCA supplies a wider area and has more cortical branches than the other two arteries, literature does not provide detailed information on it[4]. Middle cerebral artery is phylogenetically the youngest intracranial artery. Its evolution is closely related to the development of cerebrum (frontal, temporal and parietal lobes). Cortical vessels, which will form MCA, appear on lateral aspects of hemispheres before infolding and deepening of hemispheres occurs, leading to formation of insula. In this period (8–12 weeks'

gestation) these cortical vessels originate directly from terminal segment of internal carotid artery (ICA). When insula develops, the arteries penetrate the forming Sylvian fissure. Also, in this period they form MCA, which continues to develop up to birth [6].

Gibo et al. in 1981 found that branching patterns of the cortical vessels vary immensely. He stated that M1 segments typically encompass the entire Middle Cerebral artery stem and initial short segments of the post bifurcation or trifurcation division. [7]

Few studies are solely devoted to the anatomy of MCA. The present work aims to determine the morphological variations, branching pattern, symmetry, and morphometry of MCA in our population, compare the variables with the studies, and discuss their importance with anatomic and surgical considerations.

Material & Methods:

A total of 50 cadavers were studied in the department of Anatomy, Patna Medical College, Patna, Bihar, India.

During post-mortem examination of the cadavers, a skin incision was made in front of one ear to another ear in the coronal plane. The skin was reflected both anteriorly and posteriorly and the skull vault was removed as a single piece taking special care not to injure the dura.

A small Knick was made over the middle of each side of the frontal lobe. The durameter was divided into two halves with the help of non-toothed forceps. Followed it durameter was further divided into four flaps. The dura was opened from the frontal base in a transverse direction, and after cutting the flax, the frontal lobes were retracted slowly. The optic nerves were exposed and carefully cut along with the internal carotid artery (ICA) at their entrance into the cranial cavity. The brain was removed from the cranial cavity and preserved in 5% of formalin solution and numbered serially for further study. The specimen was soaked for 10–15 min 10% formaldehyde solution. The internal carotid artery was identified and the origin of the middle cerebral artery was traced by peeling off the diameter. An incision was made on the brain's lateral surface and the front parietal operculum was removed and the temporal lobe was pulled downward. MCA's MI segment was carefully dissected, and the early branches from the superior aspect and the perforators from the inferior aspect were exposed.

Results:

The 50 Specimens were dissected for anatomical study of the Middle Cerebral Artery in all the different samples. The branching patterns, the branches of MCA were carefully examined and the following observation was recorded.

The length of the M1 segment was found to be within the range of 5nm-20nm and above. The shortest length of the M1 segment was in the range of 5-7mm and the longest was 20mm and above, as shown in Table 1. The average mean length of the M1 segment was found to be 12.6 mm with a standard error of 3.68 mm.

The outer diameter of the M1 segment was found to be within the range of 3-5mm. No specimen had the outer diameter to be more than 5mm, as shown in Table 2. The average mean outer diameter of the M1 segment was 3.70mm with a standard error of 0.69 mm.

Table 3 depicts Bifurcation branching pattern in 91 specimen following trifurcation in 33 and ramification in 16.

The different branching pattern arising from the stem, i.e. Temporo polar branching was seen in 39.1% Orbito Frontal in 21.7% Anterior Temporal in 9.1%, Prefrontal 6.6% and Middle Temporal in 4.1% of the total population as shown in Table 4.

The pre-central branch shows the highest superior division in the trifurcation branching

pattern, whereas the posterior parietal shows the highest in the middle division. Angular branching pattern arises highest from middle division and in Temporo occipital only middle and inferior division was observed in all the specimens as shown in Table 5. In lenticulostriate trunk were shown in 85% whereas division pattern was shown in 15% as shown in Table 6.

Table 1: Distribution of the length of M1 Segment in all the sample studied

Length	No of Samples
20mm & above	5
17-19mm	7
14-16mm(normal)	41
11-13mm	32
8-10mm	20
5-7mm	9

Table 2: Distribution of outer diameter of M1 segment

Outer diameter of M1	No of samples
Above 5mm	-
3-5mm (normal)	108
Below 3mm	18

Table 3: The distribution of the branching pattern in the sample studied

Branching Pattern	No of Samples
Bifurcation	91
Trifurcation	33
Ramification	16

Table 4: The distribution of the branching pattern in the sample studied

Branches	Number of Sample	Percentage
Temporo Polar	24	40 %
Orbitol Frontal	15	30 %
Anterior temporal	10	20 %
Prefrontal	7	14 %
Middle Temporal	4	8 %

Table 5: Branching pattern of superior, middle and inferior distribution

Branch	Superior	Middle	Inferior
Precentral	94%	4%	-
Posterior parietal	-	100%	Nil
Angular	-	84%	15%
Temporo	-	60%	34%
Occipital			

Table 6: Distribution of trunk and other division in the study group

Branches	Trunk	Division
Lenticulostriate	85%	15%

Discussion:

Accessory MCA and duplicated MCA, are the most commonly seen variations involving the MCA. [8] When two vessels originate from the distal end of the ICA, the condition is called a duplicated MCA, and an anomalous vessel which originates directly from ACA is termed as accessory MCA. [9]

Some authors states that an accessory MCA takes part in collateral blood supply to the territory of the main MCA and partly compensate for its occlusion, thus leading to an improved prognosis in patients with disease of this vessel. [10-11]

According to Cekirge et al.[12] cerebral aneurysms are encountered more frequently in specimens with anatomic variations, such as an accessory MCA; however, the reason for this association is still vague. In the present study, we could not found any relation between accessary MCA with aneurysm.

Varder Fecken in 1961 found that the orbitofrontal and anterior temporal branches may arise from a common truck.[13] Umansky in 1988 studied the perforating branches of MCA and stated that four to five perforating branches originate from the main trunk of MCA before its division. The remaining vessels arise 8.5% from superior trunk vessels, 6% from the inferior truck and 0.8% from the middle trunk, 5.3% from an early temporal branch and 0.4% from an early frontal branch. [14] It is also stated that when the middle Cerebral artery trifurcates, superior division contain orbitofrontal and prefrontal and even pre-central. [15]

Several authors have given importance to point of bifurcation that is, point of separation of MCA into two trunks. After this point of separation, the artery may separate into three (trifurcation), four (quadrifurcation), and multifurcation trunk, etc. Intermediate trunk is the middle trunk in the case of trifurcation.[2,12,30] [7,16] Kahilogullari et al. proposed a new way of classification made in relation to the terminology of the intermediate trunk. [17,5] Despite the MCA's complex structure, variations are less commonly observed than in the other two arteries. [5,10,11]

Conclusion:

MCA branching pattern is slightly higher in trifurcation pattern as compared to bifurcation and ramification. Thorough knowledge of the microvascular anatomy and the myriads of variations is essential for the operating surgeon to choose the ideal technique to avoid any catastrophe during and after surgery and give the best possible functional outcome.

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