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Anatomy

MIDDLE CEREBRAL ARTERY BRANCHING PATTERN AT ITS INSULAR PART IN INDIAN POPULATION.

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ABSTRACT Aneurysms at bifurcation point of the MCA are frequent targets for elective surgery (unruptured), acute surgery (ruptured), and emergency surgery (large intracranial bleed), even advanced approaches (giant). MCA bifurcation aneurysms are often broad necked and may be dysmorphic, involving one or both branches. The challenge is to clip the neck adequately, without neck remnants, while preserving the bifurcational flow.[1] This study aimed to examine and compare the macroscopic features, branching pattern and variations of the MCA in normal subjects of different age/sex categories. Fifty specimens of MCA through bilateral dissection of 25 brains of both sexes (post-mortem cases) without cerebro-vascular pathology. **Results:** M1 bifurcation incidence (60%) <pre-existing studies, whereas Trifurcation incidence was slightly different than previous literature; which was differentiated into true tri (trifurcate equally at same point 2%) and pseudo-trifurcation (bifurcated trunk again bifurcate before limen insula 38%).The association of aneurysms and stroke with MCA anomalies has been extensively documented but the etiology and pathophysiology are not well understood.

KEYWORDS : Middle cerebral artery, MCA Aneurysm, MCA bifurcation, MCA trifurcation&MCA branching pattern

Introduction

The MCA originates from the ICA lateral to the optic chiasma, and follows an antero-lateral course inferior to the anterior perforated substance. Reaching the medial end of the Sylvian fissure, it turns and crosses over the limen insulae to enter the insula. The main trunk is found before or at the limen Insulae, where it bifurcates or trifurcates. The secondary trunks course over the surface of the insular cortex, giving rise to cortical branches which turn around the opercular cleft to spread out over the cerebral convexity.[2] It supplies many parts of the lateral cerebral cortex as also the anterior temporal lobes and the insular cortices.[3] The left and right MCAs arise from trifurcations of the internal carotid arteries and thus are connected to the anterior cerebral arteries and the posterior communicating arteries, which connect to the posterior cerebral arteries. The MCAs are not considered a part of the Circle of Willis.[3] Surgical nomenclature divides the vessel into four parts or segments: [4,5,6]

- M1 (Sphenoidal): from the origin of MCA (termination of ICA) to genu (90° turn) of MCA; so named due to its origin and loose lateral tracking of the sphenoid bone. The M1 segment perforates the brain with numerous anterolateral central (lateral lenticulostriate) arteries, which irrigate the basal ganglia.M2 (Insular): from the genu of MCA to the circular sulcus of the insula; part of the artery or its divisions that lie on and supply the insula. Extending anteriorly on the insula, and also as the Sylvian segment when the opercular segments are included. This segment of the main trunk may bifurcate or sometimes trifurcate into branches which then extend to terminate towards the cortex. Because of bi/tri-furcation, this segment is more vulnerable for variations.

The intracerebral arteries have a high rate of variation. The middle cerebral artery (MCA) supplythe blood to frontal lobe, parietal lobe, temporal lobe, and basal ganglia which is also a frequent site of pathology (e.g., stroke, aneurysms, arteriovenous malformations). During both diagnostics and interventions (thrombectomy, clipping, and coiling),. These variations or anomalies can range from variations in morphology, the number of vessels, or in vessel origin.

MCA aneurysms are classified into proximal, bifurcational, and distal types based on their site. Proximal MCA aneurysms are located in the main trunk (M1), between the bifurcation of the ICA and the main bifurcation of MCA. Distal MCA aneurysms originate from the M2 segment or more distal branches of MCA.[7] Proximal MCA aneurysms were 14%, and their presence often indicates other associated aneurysms. Typically, proximal MCA aneurysms are located at the origin of the first branch of the main trunk, and are pointing downward, or are at the origin of lenticulo-striatal perforators and pointing upward (rare). An overwhelming majority of the MCA aneurysms (>80%) are located at the bi/trifurcation, usually pointing laterally and inferiorly. Distal are less frequent, in one series only 5% were located distally. Distal aneurysms may be fusiform or mycotic, but true saccular aneurysms are found in even most distal parts of MCA.[8]

The branching pattern is determined by the division of the main trunk into smaller trunks. Bifurcation and trifurcation are most commonly described, although other types have been observed and several subtypes can be identified. Eleven bifurcation subtypes (medial bifurcation, lateral bifurcation, medial pseudo-bifurcation, and lateral pseudo-bifurcation), trifurcation subtypes (true trifurcation, pseudo-trifurcation, proximal trifurcation, and distal trifurcation), monofurcation, tetrafurcation, and pseudo-tetrafurcation may be found.[9] Information of branching pattern maybe vital to ensure reliable diagnostic approaches and safer surgical interventions, particularly with MCA selective angiography.[10]

Anomalies observed in the first part of the MCA trunk, include extra vesselsandfenestration.[9] True anomalies occur more frequently are associated with aneurysms/stroke/CVA includefenestration, a duplicated MCA and an accessory MCA.[5,11-14]

Fenestrations(a vessel with common origin, splits into two channels and then rejoins.[15]).fenestrations being the most common.[16] Fenestrations of the MCA are typically observed in the M1 segments, although it may occur in the M2 segment. Three subtypes of M1 segment fenestrations are defined: the proximal, intermediate and distal types. Duplicated and accessory vessels are anomalous MCA vessels, send branches to the cortical areas. Duplication refers to an anomalous artery arising from the ICA whereas an accessory MCA is an anomalous artery arising from the anterior cerebral artery near the origin of the anterior communicating artery.[5,17] A duplicated MCA is associated mainly with a ruptured aneurysm and can provide collateral supply to the anterior temporal lobe but it does not seem to supply enough flow to the main MCA territory.[18] The duplicated MCA has been found to be present in 0.3% to 7.1% of cases in the literature.[9]

Compared to a duplicated, the accessory MCA is smaller and supplies a smaller area and may possibly give collateral supply to anterior frontal lobe but cannot maintain enough to the main territory in ischemic stroke.[18] This vessel usually arises from the A1 segment close to the origin of the anterior communicating artery, was observed in 0.1% to 9.1% by previous authors.[9] The accessory MCA is differentiated from a recurrent artery of Heubner, that the recurrent artery enters the anterior perforated substance, but the accessory MCA courses lateral to this area and sends branches to cortical areas normally supplied by the MCA.[5]

Aim & Objectives:

To examine and compare the macroscopic features, branching pattern and variations of the middle cerebral artery in normal subjects of

different age/sex categories, in order to correlate structural features with vascular pathology; also study and compare in normal Indian subjects of various age groups and in both sexes.

MATERIAL AND METHODS:

Study include fifty specimens of MCA through detailed bilateral dissection of 25 brain on fresh adult (age above 20 years with no history of stroke/aneurysm/CVA or any obvious signs of these on post-mortem. Indian post-mortem cases (both sexes) with no obvious cerebro-vascular pathology, in the Department of Forensic Medicine & Toxicology at AIIMS, New Delhiafter seeking permission from ethical committee of respective institute.Brain specimens, were divided into three age groups: 21-40, 41-60, 61-80), bilateral dissection of MCA was performed. (n = 25 x 2 = 50). Age / sex comparison of MCA gross features, branching pattern & variations were recorded and anatomical study done for assessing the variability of the middle cerebral arterywas carried out on the basis of autopsy exams with macroscopic evaluation.Demographic data (age, sex, medical history) was collected from the case sheet.

Circle of Willis (CW) present in interpeduncular fossa was exposed after removal of Duramater&Arachnoidmater. ICA at the lateral angle of the CW were identified and dissected to find out its terminal branches (MCA and ACA) then identify the MCA and manually retract lateral fissure to expose middle cerebral artery. MCA on either side were carefully dissected and traced from origin to its termination in the lateral cerebral fissure. Branching pattern was noted and well photographed without damaging brain tissue.

Fig. 1 shows pseudotrifurcation type branching pattern & all three trunks of MCA. Green arrow represents diameter measurements and blue arrow represents length measurements

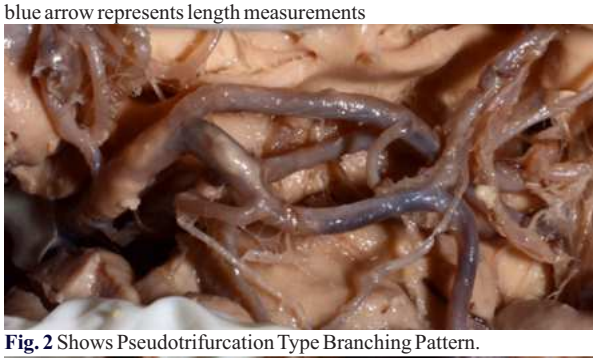

Fig. 2 Shows Pseudotrifurcation Type Branching Pattern.

Fig. 3 Shows Bifurcation Type Branching Pattern Right MCAs

Fig. 4 Shows Bifurcation Type Branching Pattern In Left MCA

The qualitative and quantitative data pertaining the MCA was systematically recorded, tabulated, compared & statistically analyzed among three age groups (21-40, 41-60 & 61-80) and for both sexes (male & female) using appropriate statistical tests

RESULT:

three types of branching patternswere found i.e. bifurcation; trifurcation and pseudo trifurcation. From 50 MCA specimens in 25 brain samples of which 66.7% in males and 33.3% in females have pseudo trifurcation, while bifurcation was almost equal in both males and females. And true trifurcation was found in only one male**.**

Table No. 1: Comparison Of Branching Pattern In Both Gender In 61-80yr Age Group

Branching pattern	Group 1(male)	Group 2 (female)
Bifurcation	43.7±63.6	56.25±90.0
trifurcation	100.0±18.1	0.0±0.0
Pseudo trifurcation	66.7±18.2	33.3±10.0

DISCUSSION

In present study Point of Bifurcation of the MCA occurs higher thanthe limen insulae,

Table No. 2: Branching Pattern Of MCA Based On Literature, Including The Sample Size.

Authors	cases	Bifurcation		Trifurcation		Pseudo trifurcation	
		cases	%	cases	%	cases	%
Pai et al. (2005)	10	8	80	2		0	
Gibo et al. (1981)	50	39	78	6	12		
Tanriover et al. (2003)	50	44	88	6	12	0	
Present study	50	30	60	1	2	19	38

The M1 bifurcation incidence (60%)was found to be lower than existing studies, whereasTrifurcation incidence was slightly different than previous literature; which was differentiated into true tri (trifurcate equally at same point 2%) and pseudo-trifurcation (bifurcated trunk again bifurcate before limen insula 38%).

CONCLUSION

Studies on bifurcation and trifurcation branching types failed to mention the different subtypes because of confusion on the criteria of defining these different subtypes. However specific criteria are still lacking.[19]

MCA anomalies prevalence mentioned earlier; but rarely elaborate on basis of their subtypes.[19] Moreover, the association of aneurysms and stroke with MCA anomalies had been extensively documented but the etiology and pathophysiology are still to be understood.

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