

Variations of Blood Supply to Primary Motor Area of Human Brain

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ABSTRACT

Objectives: To add to existing knowledge in performing various techniques used in radiology and operations of this area.

Methods: One hundred cerebral hemispheres were obtained from cadavers and put in 10 percent formalin for one week so as to fix them. Different coloured Indian ink was injected by placing cannula in anterior cerebral artery, middle cerebral arteries and posterior cerebral arteries. Measurements of length of each vessel was taken with electronic digital vernier caliper from origin to termination and mean length was calculated along with standard deviation. Measurement of diameter of each vessel was measured by electronic digital vernier caliper at origin, middle and distal end. Mean diameter was computed along with standard deviation for each vessel.

Results: The middle cerebral (MCA) and anterior cerebral arteries (ACA) are the major blood vessels supplying the primary motor area and the accessory middle cerebral artery is the collateral artery to this area. The posterior cerebral arteries (PCA) were not noted in any case. Variations of arteries supplying these major functional areas already mentioned were noted frequently. Variations in appearance were noted as smooth and nodular. Variations regarding course were noted as straight or tortuous. Nodularity and tortuous course could explain the high incidence of cerebrovascular accidents

Key words: CVD, PMA, MCA

INTRODUCTION

The brain is a highly vascular organ. Its profuse blood supply is characterized by densely branching arterial network. It has a high metabolic activity due to the energy requirements of constant mental activity. It demands about fifteen percent of the cardiac output and utilizes twenty five percent of the total oxygen consumption of the body¹.

The two cerebral hemispheres constitute the greatest bulk of the brain. Each cerebral hemisphere is formed by frontal, parietal, occipital and temporal lobe². The primary motor area is situated in the frontal lobe (area 4). Functionally it controls voluntary movements of the opposite side of the body, the micturition and defecation reflexes. This area facilitates flexors and inhibits extensors. The human body is presented in an inverted form in this area. The sequence from above downwards is leg, thigh, trunk, upper limb, face, larynx, lip, jaws and pharynx³.

In a recent study on the circle of Willis major cerebral arteries showed considerable variations in distribution, origin, course and appearance 46% variations and 54% normal configuration⁴. The intracranial aneurysm were described for the first time at autopsy in 1705. The development of angiography in 1927 facilitated the diagnosis and

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treatment of cerebral aneurysms⁵. The middle cerebral artery supplying the primary motor area showed the two most recognizable anomalies which are the duplication of MCA and the accessory MCA⁶. The knowledge of vascular supply and variations enable the surgeon to choose the right approach⁷.

MATERIAL AND METHODS

It was a cross sectional analytical study conducted at the Post Graduate Medical Institute Lahore. One hundred embalmed and non-embalmed human cerebral hemispheres were collected from recently deceased adult males between twenty to sixty years of age from various teaching institutes, forensic department KEMU Lahore and Anatomy departments of SIMS, KEMU, FJMC and AIMC with permission. Skull cap was cut by electric saw passing through middle of frontal bone, squama of the temporal bone and the occipital bone. Skull cap was removed. After incising the falx cerebri and tentorium cerebelli hand was passed over the surface of brain and it was removed through epidural space without any injury to the blood vessels or compression on the brain. After one week dura was removed gently by forceps and intravenous cannula 24 was passed into each anterior, middle and posterior cerebral arteries separately at different times. An injection medium consisting of mixture of gelatin with undiluted blue Indian ink was injected by syringe. As the vessels of

the brain were torturous it was difficult to measure their length by digital caliper, so a flexible copper wire was molded along the course of each vessel and straightened out and actual length of the vessel was computed on the digital caliper. The diameter of the blood vessel was computed by digital electronic vernier caliper. The external diameter of each vessel was measured at proximal middle and distal compartments. The mean diameter was noted for statistical analysis significant.

RESULTS

Out of one hundred cerebral hemispheres anterior cerebral artery and middle cerebral arteries were found to supply the precentral gyrus (primary motor area) in all cases. The posterior cerebral artery does not contribute to supply this area in any of the cases examined. The accessory middle cerebral artery appeared as collateral artery to the primary motor area in four cases (4%). Fronto polar artery, a branch of the ACA was seen in the upper one third of

precentral gyrus (primary motor area) along the superomedial border in all cases. The callosomarginal artery, branch of ACA was found to supply the anterior part of paracentral lobule in 30 cases (30%). Out of 100 cases the anterior parietal artery was found to supply the lower part of precentral gyrus in 84(84%). In another 16(16%). this area was supplied by the central parietal artery. Out of 100 cases we noted the accessory middle cerebral artery as a collateral vessel to the primary motor for area in 4 cases (4%). The smooth appearance of blood vessels was predominant as compared to nodular surface in all groups. Chi square test observed significant of smooth appearance in the primary motor area. P value <0.05. The straight course followed by cerebral blood vessels was predominant as compared to tortuous course in the primary motor area. P value <0.05. The presence and significance of collateral blood vessels was found in each of the five study group with the application of Chi square test p value <0.05.

Table 1: Morphometric Variables of Fronto polar Artery (N=100)

Origin	Appearance		Course		Mean Diameter (mm)	Average Length (mm)
	Nodular	Smooth	Curved	Straight		
ACA	11(11%)	89(89%)	7(7%)	93(93%)	1.23±0.03	17.26±0.23

Table 2: Morphometric variables of callosomarginal artery (n=100)

Origin	ACA	Appearance		Course		Mean diameter (mm)	Average length (mm)
		Beaded	Smooth	Curved	Straight		
Pericallosal artery	10(33.3%)	8(26.6%)	22(73.4%)	3(10%)	27 (90%)	1.32±0.03	18.72±0.23

Table 3: Morphometric variables of anterior parietal artery (n=84)

Origin		Appearance		Course		Mean Diameter (mm)	Average Length (mm)
Superior Trunk of MCA	Middle Trunk of MCA	Beaded	Smooth	Curved	Straight		
67(79.9%)	17(19.1%)	21(25%)	63(75%)	4 (4.7%)	80(95%)	1.19±0.03	15.26±0.23

Table :4 Morphometric Variables of Central Parietal Artery (n=16)

Origin		Appearance		Course		Mean diameter (mm)	Average Length (mm)
From Superior Trunk of MCA	From middle Trunk of MCA	Beaded	Smooth	Curved	Straight		
13(81.25%)	3(19.75%)	6(37.5%)	10(62.5%)	5(31.25%)	11(69.75%)	1.15±0.03	17.26±0.23

Table 5: Morphometric Variables of Accessory Middle Cerebral Artery (n=4)

Origin		Appearance		Course		Mean Diameter (mm)	Average Length (mm)
From ACA	From ICA	Nodular	Smooth	Curved	Straight		
3(75%)	1 (25%)	1(25%)	3(75%)	2(50%)	2 (50%)	2.14±0.02	26.24±0.25

Table:6

Variable	Total No of Vessels	Smooth	Nodular	Chi-square value	P-value
Appearance	234	187	47	19.62	0.000

Table 7:

Variable	Total No of Vessels	Straight	Tortuous	Chi-square value	P-value
Course	234	213	21	417.36	0.000

Table 8:

Variable	Total No of Vessels	Present	Absent	Chi-square value	P-value
Collateral vessels	234	4	96	249.14	0.000

DISCUSSION

It is important to emphasize the anomalies of cerebral circulation of primary motor area of brain as they are not rare and may have immense clinical implications. Variations of appearance of cerebral vessels supplying the functional areas of brain are described to represent some diseases of intracranial vasculature. Fibromuscular dysplasia involving the intracranial vessels revealed the beaded appearance of the vessels⁸ our study has shown significant difference of smooth and beaded appearance in primary motor area. The beaded appearance may be indicative of various pathological conditions of vessels. Gamma radiations delivered to brain can change the appearance of vessels supplying the functional areas of brain. Intracranial aneurysm formation following radiotherapy has been claimed. Gamma radiations can induce some sort of vasculopathy⁹.

Myogenic properties of cerebral blood vessels supplying the primary functional area of brain were analysed from normotensive and hypertensive rats. In case of posterior cerebral arteries hypertensive rat vessels were significantly narrowed and both wall thickness and wall to radius ratios were increased¹⁰. The tortuous worm like vessels were found in primary motor area of our study. This could be linked to such hypertensive phenomenon.

It is reported that an anatomic and morphologic variations of the vertebral artery are of immense importance in surgery, angiography and all non invasive procedures. The abnormal origin of vertebral artery may favour cerebral disorders because of alterations in cerebral hemodynamics¹¹ in our study callosomarginal artery was found to show variable origin from the peri callosal artery.

In another study¹² duplication of middle cerebral artery and one accessory middle cerebral artery were studied in two patients and it was noted that the double vascularization of the hemisphere can give rise to strokes with a better progression and prognosis despite the occlusion of one of the middle cerebral artery. In our study 4 cases (4%) of accessory middle cerebral artery were noted.

It was described that an accessory middle cerebral artery arises from the anterior cerebral artery and go to a territory usually supplied by the middle cerebral artery. This occurred in 3% of 347 cases¹³. In our study the incidence of accessory middle cerebral artery was same 4 cases (4%).

In another study¹⁴ on the variations of anterior and middle cerebral arteries it was found in 65% cases, the path is arch shaped but in 44% it is straight and oblique in direction while in 1% the pre

communicant segment of anterior cerebral artery it has wavy path. The results are comparable to our study.

In a study the ACA supplied the medial one third and the MCA supplied the lateral two thirds of the PG. the PCA did not reach the PG in any of the hemispheres. In 16 hemispheres (40%), the callosomarginal artery and, in 13 hemispheres (32.5%), the pericallosal artery were dominant of the medial one third of the PG. MCA branches at the lateral tip of the PG were classified into precentral, central, and postcentral groups. In 29 hemispheres (72.5%), the central group, and in 4 hemispheres (10%), the precentral group were dominant for the lateral two thirds of the PG. In 7 hemispheres (17.5%), the precentral and central groups were equally dominant¹⁵. In our study MCA and ACA nourished the same area of cortex.

CONCLUSION

This study gives a comprehensive knowledge of blood supply of primary motor area of brain. ACA and MCA area the arteries which supply the primary motor area of cortex. PCA did not supply this area in all specimens examined. Variations of arteries supplying the primary motor area were noted frequently and significantly. Variations in appearance were noted as smooth and nodular. Variations regarding course were noted as straight or tortuous. Nodularity and tortuous course could explain the high incidence of cerebrovascular accidents in mankind. The presence of collateral vessels to each functional area can modify the outcome of cerebral infarcts. The present study will have obvious implication for determining the technical feasibility for diagnostic and surgical procedure related to cerebral vasculature

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