

# Variable Arterial Supply of Motor Areas of Human Brain

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## ABSTRACT

**Objective:** To study the arterial supply of motor areas of human brain regarding its variable source due to its significance in neurosurgical practice and angiography.

**Study Design:** It is prospective descriptive study on cadaveric human brains

**Place and Duration of Study:** This study was conducted on different cadaveric brains collected from anatomy and Forensic Departments of various teaching institutes during July2007-July2008

**Materials and Methods:** A total 100 brains were collected. skull cap was cut by electric saw meinges were saved, Skull cap was removed. Brain was removed through epidural space without any injury to blood vessels. After putting one week in 10 % formaline jar, dura was removed and branula No.24 was passed into each anterior and middle cerebral arteries separately at different times. Blue Indian ink was injected into anterior cerebral artery after ligating anterior communicating Artery. After injection branula was removed and ligature applied to the artery so that dye may not escape. Now branula was passed into middle cerebral Artery and the red Indian ink was injected so that contrasting colours clearly demarcate the blood vessels supplying the motor areas of brain. Arteries supplying from functional areas were divided in two groups A and B. Group A include primary motor cortex and group B include motor speed area or Broca's area. Each of this group is further subdivided into three sub groups A1, A2, A3 and B1, B2, B3. Sub group A1 and B1 include area supplied by single artery, Sub group A2 and B2 include area supplied by multiple arteries whereas subgroup 3 include variant arteries supplying that area. Results were statistically evaluated. Sign test was used to test for presence of variant artery in each area and it was statistically significant.

**Results:** In group A out of 100 cases no case fell in such group A1, 96 cases (96%) fell in such group A2, where middle cerebral Artery and anterior cerebral Artery supplying the area. The frontal branches of middle cerebral artery two to three in number and anterior parietal branch of middle cerebral Artery supply 80% of area while one to two branches of frontopolar Artery, branch of anterior cerebral Artery supply 1.0 to 1.5 cm strip on supero medial surface of motor area. The anterior cerebral Artery supply the leg area and middle cerebral Artery the face trunk and upper limb area. In sub group A3, 4 cases (4%) accessory middle cerebral Artery appeared as variant Artery.

In group B out of 100 cases 90 cases (90%) fell in sub group B1. 9 cases (9%) fell in sub group B2 where middle cerebral Artery through frontal branch and accessory middle cerebral Artery supply the area 1 case (1%) fell in such group B3. Where anterior temporal branch of inferior trunk of middle cerebral Artery supply the area as variant Artery. 19 cases out of 100 (19%) showed variations among these 4 cases (4%) showed variations in arterial supply of primary motor cortex and 1 case (1%) showed variations in the arterial supply of motor speech area. Collateral vessels may modify the effects of cerebral ischaemia.

**Conclusion:** anatomical variations of the cerebral arteries are of immense importance in surgery, angiography and all non-invasive procedures to help in interpretation of cranial angiogram. The major variations include duplication segmental duplication, aplasia, hypoplasia and fenestration of the vessels.

**Key Words:** Primary motor area, motor speech area, Artery, variation, cerebral vessels.

## INTRODUCTION

The brain is highly vascular organ. It has branching arterial network. It demands 15% of the cardiac output and utilizes 25% of the total oxygen. Arterial supply is from two sources, the carotid system with its two branches to brain, that is anterior and middle cerebral arteries whereas vertebral system terminate as basilar and posterior cerebral arteries. The functional areas under consideration derived their blood supply from anterior and middle cerebral arteries<sup>1,2</sup>.

Anterior cerebral Artery is branch of internal carotid Artery which soon join with its opposite Artery by

anterior communicating Artery. Artery enter the longitudinal fissure ascends on the medial surface of hemisphere and continue on the superior surface corpus callosum and ends by anastomosing with the posterior cerebral Artery. It gives medial striate Artery, orbital branches, the frontopolar Artery. It supplies medial parts of frontal lobe and extends on convexity of cerebral hemisphere. Occlusion of the trunk of one anterior cerebral, Artery may produce a contralateral hemiplegia which is greatest in lowerlimb<sup>3,4</sup>.

Middle cerebral Artery enter between temporal lobe and insula emerges through lateral sulcus to be distributed on the supero lateral surface of hemisphere

to supply frontal parietal and temporal lobe. Its cortical branches include lenticulo striate, anterior temporal, orbito-frontal. Pre-Rolandic Rolandic anterior and posterior parietal branches, a posterior temporal branch and angular branch which is its terminal branch. Middle cerebral supply Broca's area, the motor and pre motor areas. Occlusion of the middle cerebral artery may produce a severe contralateral hemiplegia most marked in upper limb and face, severe aphasia occur when dominant hemisphere is involved<sup>5,6,7</sup>.

Primary motor areas is situated in frontal lobe. It is bounded anteriorly by pre central and behind by central sulcus. It is located in pre central gyrus, the anterior wall central sulcus and anterior part of paracentral sulcus. It controls voluntary movements of opposite side of body, the micturition and defecation reflexes. The human body is represented in an inverted form in this area. A frontopolar branch of the anterior cerebral Artery supply leg area. The frontal branches of the middle cerebral Artery supply remaining part of the motor area<sup>8,9</sup>.

Motor speech area or Broca's area is situated in inferior frontal gyrus. It is centre for initiation of speech, movements of tongue lips and laryngeal musculature. A lesion of this area results in motor aphasia. The frontal branches of the middle cerebral Artery supply this area<sup>10</sup>.

## MATERIALS AND METHODS

It is Prospective Descriptive study on cadaveric brains. Study population is 100 human brains done in one year duration. It includes only healthy brains. Associated functional areas were excluded and brains with perforated and injured vessels were excluded. The brains were collected from various teaching institutes with permission. Skull cap was cut. Meninges were saved, brain was removed through epidural space without any injury to blood vessels. Each brain was put in 10% formaline jar for one week. After one week dura was removed and branula No.24 was passed into each anterior and middle cerebral arteries. Blue ink was injected by syringe into anterior cerebral artery after ligating anterior communicating artery. After injection branula was removed and ligature applied to artery so that dye may not escape. Now the branula was passed in the middle cerebral artery and red Indian ink was injected so that contrasting colours clearly demarcated the blood vessels supplying the motor areas of the brain. By this method all the branches of anterior and middle cerebral arteries were fully displayed. Statistical analysis included calculations of proportions of cases by type of blood supply for each functional area. Non parametric methods (sign) test, friedman test and mann whitney u tests) were used for statistical significance. groups of blood vessels supplying the motor areas were divided into two groups A and group B. Each group

was subdivided into three subgroups A1, A2, A3, B1, B2, B3.

Subgroup A1 and B1 include the area supplied by single artery. Subgroup A2 and B2 include the area supplied by multiple arteries. Subgroup A3 and B3 include the area supplied by variant arteries.

## RESULTS

**Table No.1. Number of single, multiple and variant arteries supplying motor areas.**

Group	Motor area supplied	Subgroup	inference	Results of total 100 cases No. of cases found	%age
Group A	Primary motor cortex	A1	Single artery	0	0%
		A2	Multiple arteries	96	96%
		A3	Variant arteries	4	4%
Group B	Motor speech areas (Broca's area)	B1	Single artery	90	90%
		B2	Multiple arteries	9	9%
		B3	Variant arteries	1	1%

Statistically significant P value < 0.05 Sign test was used to test for presence of variant artery in each motor area and it was statistically significant (P -value < 0.05). To test for difference in presence of variant artery between two motor areas. friedman test was used which was significant table 2.

**Table 2 Difference in presence of variant artery between two motor areas**

Presence of variant Artery	Motor Area	
	A	B
Present	4	1
Absent	96	99

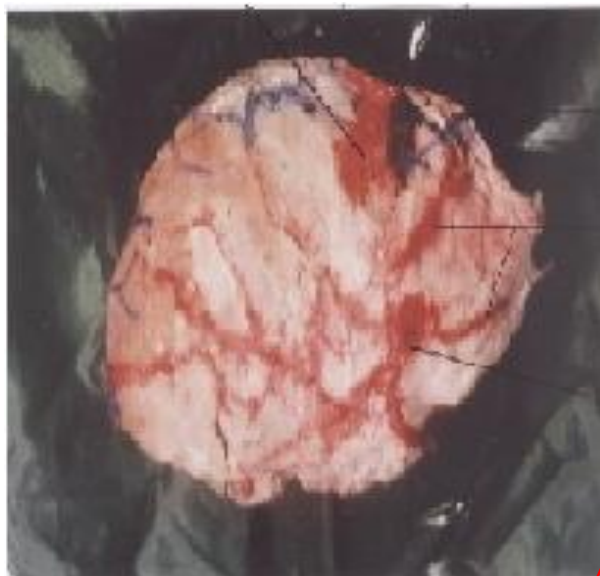
( Chi-square statistic=26.407, d.f =4, P value=0.000).

To determine which groups of motor area were different Mann whitney U test was performed variant artery was found in significant number in area A as compared area B. A and B=0.007 statistical significant P-value < 0.05.

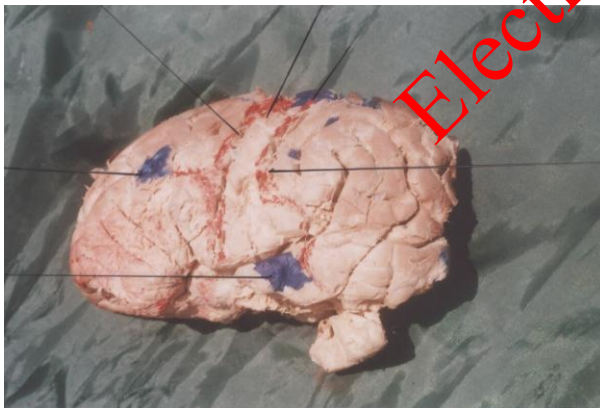
These groups were treated as follows.

**Group A:** It includes arteries supplying to primary motor cortex. Subgroup A1, A2, A3 out of 100 cases no case fell in subgroup A1, 96 cases fell in subgroup A2, where middle cerebral and anterior cerebral artery supply the area. The frontal branches of middle cerebral

artery two to three in number and anterior parietal branch of the middle cerebral artery supply 80% of the area while one to two branches of the frontopolar artery branch of anterior cerebral artery supply 1 to 1.5 cm strip on the superomedial border of the motor area. Thus the anterior cerebral artery predominantly supply the leg area and the middle cerebral artery, the face trunk and upper limb areas. These results are comparable to earlier studies. In such group A3. 4 cases (4%) accessory middle cerebral artery appeared as variant artery. (Figures 1 & 2).



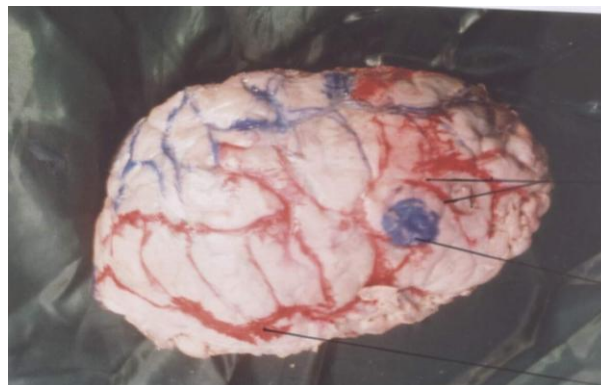
**Figure No.1:** Showing the branches of anterior and middle cerebral artery supplying the motor area.



**Figure No. 2:** Showing accessory middle cerebral artery supplying the motor and sensory area

**Group B:** It includes arteries supplying to the primary motor speech area. Out of 100 cases (90%) fell in subgroup B1 superior trunk of the middle cerebral artery through one to two frontal branches supply this area. 9 cases (9%) fell in sub group B2 where middle cerebral artery through frontal branch and accessory middle cerebral artery supply the area. 1 case (1%) fell in such group B3 where anterior temporal branch of

middle cerebral artery supply the area as variant artery (Figures 3 & 4).



**Figure No.3:** Showing the frontal branch of middle cerebral artery and accessory cerebral artery supplying the motor speech area.



**Figure No.4:** Showing the anterior temporal branch of inferior trunk of cerebral artery supplying the motor speech area.

Anomolies of the cerebral circulation are not rare and have profound clinical implications 19 cases (19%) out of 100 cases showed variation. Among these 4 cases (4%) showed variations in arterial supply of primary motor area and 1 case (1%) showed variation in arterial supply of motor speech area Collateral vessels may modify the effects of cerebral Ischaemia.

## DISCUSSION

Anomolies of cerebral circulation are not rare and have clinical implications. According to different studies, cerebral vascular diseases present one of the leading problem<sup>11</sup>. They are followed by the risk of high mortality rate and caused high level disability. This study has shown 19% variation in supply of anterior and middle cerebral arteries to motor areas of brain and superficial anastomosis between the cortical branches of these arteries are found to exist profoundly.

Different studies proved that one of duplication of middle cerebral artery and one of the accessory middle cerebral artery were studies in two cases and it was noted that the double vascularization of hemisphere can give rise to strokes with better progress despite the

Occlusion of one of the middle cerebral artery. In these studies, 4% of duplication of middle cerebral artery and 3% of accessory middle cerebral artery were noted.<sup>12,5,7,13</sup> In another study, proved by cerebral angiography images on M.R.I of 891 patients were examined and various variation of the anterior cerebral artery like unilateral A1, segment aphasia in 5.6% cases, three A2 segments in 3% cases and unpaired A2 segments in 2% cases and fenestration in 1.2% cases. In this study 4% cases showed hypoplasia of the A1 segment of anterior cerebral artery and duplication of the anterior communicating artery in 2% and fenestration in 8% cases.<sup>13</sup>

Two studies relating duplication of middle cerebral artery has been reported. In first study radiological images revealed presence of two branches of left middle cerebral artery. In second study the frequency of MCA duplication is reported to be 0.2 - 0.9%.<sup>14,15</sup>

In another study, anatomical variation of the anterior cerebral artery were observed. A single ACA was present in one case and three in three cases.<sup>16</sup>

## CONCLUSION

Anatomical variation of the cerebral arteries are of immense importance in surgery, angiography and all non-Invasive procedures. They may help in interpretation of the cranial angiograms. The data provided in the study may provide important information to the neuroanatomists operating in these areas as well as the teaching the vascular supply of the brain.

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