



Study of variations of anterior cerebral artery in human cadavers of South Indian population

Name of the Corresponding author & Co-authors:

1st author: Dr.s.umarani
Associate professor,
Department of Anatomy
Raja muthiah Medical College, Annamalai university

2nd author: Dr.Arjun. R
Associate professor,
Department of Anatomy,
SRM Medical College Hospital and Research Centre,
Trichy

3rd author: Dr Shishir Kumar
Professor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

4th Author: Dr.R.sivaraj.
Professor of Pharmacology.
Department of pharmacology.
Aarupadai Veedu Medical college & Hospital.
Kirumampakkam.
Puducherry.

5th Author: Dr Sanjay Kumar Revankar
Associate Professor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

6th Author: Reddy Spoorti Channa
Tutor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

7th Author: Aparna
Tutor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

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8th Author: Chetana YK
Tutor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

Corresponding author addresses:

Dr Sanjay Kumar Revankar
Associate Professor
Department of Anatomy
Kanachur Institute of Medical Sciences, Mangalore.

ABSTRACT

Background: Neurovascular anatomy of the brain is most complex and the variations encountered are as distinct as a finger print. Anterior Cerebral Artery (ACA) contributes to the major part of anterior circulation of human brain by completing the anterior component of Circle of Willis. Present study was aimed to study variations of anterior cerebral artery in human cadavers.

Material and Methods: Present study was multiple institute based, descriptive study, conducted in normal brain specimens from human cadavers with known age and sex. The origin, course, and termination of anterior cerebral artery were traced. The length of different parts and the associated variations were noted.

Results: 100 human brains (50 male & 50 female), from age 40-70 years were studied. Common variations noted with anterior cerebral arteries were duplication (4), absence (3), azygous artery (3), median ACA (2), hypoplasticity (2) & anomalous origin (1). We compared various parameters from right & left side, such as mean diameter (2.31 ± 0.34 mm vs 2.36 ± 0.41 mm, p value 0.81), mean length (12 ± 1.8 mm vs 12.9 ± 1.6 mm, p value 0.84), no. of perforators (4.5 ± 0.64 vs 3.5 ± 0.92 , p value 0.78) & mean diameter of perforators (0.29 ± 0.11 mm vs 0.32 ± 0.12 mm, p value 0.79). All parameters were comparable & difference was not statistically significant.

Conclusion: With an increasing number of cerebrovascular accidents, grave morbidity associated with it & increasing surgical/radiological intervention, present study findings will help surgeon/radiologist during intervention.

Keywords: variations, anterior cerebral artery, cadaveric study, cerebrovascular accidents

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INTRODUCTION

Neurovascular anatomy of the brain is most complex and the variations encountered are as distinct as a finger print. The advent of micro neurosurgery and the knowledge of the tiny perforating vessels and their arrangements along the base of the brain in relation to neurovascular structures has made much awaited changes in the outcome of patients undergoing surgery.¹

Anterior Cerebral Artery (ACA) contributes to the major part of anterior circulation of human brain by completing the anterior component of Circle of Willis along

with the Anterior Communicating Artery (ACoA). Variations in anterior circulation of the brain is important in Neuro surgical Interventions particularly related to aneurysms and craniotomies.² Different abnormalities such as absence or aplasia, split, hypoplastic and accessory vessels had been observed.³ The variation in the arterial circle, which is associated with alteration of blood flow to the brain, enhances the problem in the vascular diseases of the brain.⁴

Ischemia of the area normally supplied by anterior cerebral artery can lead to symptoms like constant weakness and

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sensory loss in the lower limb and behavioural changes, known as Anterior cerebral artery Syndrome.⁵ Present study was aimed to study variations of anterior cerebral artery in human cadavers.

MATERIAL AND METHODS

Present study was single institute based, descriptive study, conducted in Department of Anatomy, at Kanachur Institute of Medical Sciences, Mangalore, Our friends from Raja muthiah Medical College, Annamalai university, SRM Medical College Hospital and Research Centre, Trichy were the main think tank behind the project. And since we wanted the study in from different regions of South India we made it a multiple institute study. Study period was from January 2019 to December 2021.

Apparently normal brain specimens from human cadavers with known age and sex were studied. Only brain specimens with intact Circle of Willis were included in the study. The intact brains removed from the cranial cavity were washed in running tap water and fixed in 10% formalin. The duramater and arachnoid mater were carefully dissected out from base of the brain. Specimen were

studied by gross dissection, mapping of blood vessels, painting, and photography. The origin, course and termination of anterior cerebral artery were traced. The length of different parts and the associated variations were noted.

The anterior cerebral arteries were then coloured, photographed, numbered and the abnormalities were noted. Gross variations in the course, origin, form of asymmetry, absence of component vessel (if any), branching (duplication, trifurcation), pattern and vessel with diameter less than 1 mm were noted.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

RESULTS

100 human brains (50 male & 50 female), from age 40-70 years were studied. Common variations noted with anterior cerebral arteries were duplication (4), absence (3), azygous artery (3), median ACA (2), hypoplasticity (2) & anomalous origin (1).

Table 1: Anterior cerebral arteries with variations.

Variation	Male		Female		Total
	Right	Left	Right	Left	
Duplication	1	1	2	-	4
Absence	1	1	0	1	3
Azygous artery	1	1	1	-	3
Median ACA	1	-	1	-	2
Hypoplasticity	2	-	-	-	2
Anomalous origin	0	0	0	1	1

In presents study, we compared various parameters from right & left side, such as mean diameter (2.31 ± 0.34 mm vs 2.36 ± 0.41 mm, p value 0.81), mean length (12 ± 1.8 mm vs 12.9 ± 1.6 mm, p value 0.84), no. of

perforators (4.5 ± 0.64 vs 3.5 ± 0.92 , p value 0.78) & mean diameter of perforators (0.29 ± 0.11 mm vs 0.32 ± 0.12 mm, p value 0.79). All parameters were comparable & difference was not statistically significant.

Table 2: Diameter, length, and perforators of A1 segment of Anterior cerebral artery

Parameter	Left	Right	P value
Diameter (mm)	2.31 ± 0.34	2.36 ± 0.41	0.81
Length (mm)	12 ± 1.8	12.09 ± 1.6	0.84
No. of perforators	4.5 ± 0.64	3.5 ± 0.92	0.78
Diameter of perforators (mm)	0.29 ± 0.11	0.32 ± 0.12	0.79



DISCUSSION

Anterior cerebral artery (ACA) is an often-encountered structure in common neurosurgical cases, and it is important for a surgeon to be well versed with the demographically prevalent variations in its anatomy.

The anterior cerebral artery is the smaller terminal branch of the internal carotid artery. Surgical nomenclature divides the anterior cerebral artery into three parts.^{6,7,8}

1. A1 - from the termination of Internal Carotid Artery to the junction of ACA and Anterior Communicating Artery. The anterior cerebral artery starts at the medial end of the lateral fissure and passes anteromedially above the optic nerve to the great longitudinal fissure, where it is connected by the anterior communicating artery to another anterior cerebral artery.
2. A2 - from the junction with Anterior Communicating Artery to the origin of the Callosal Marginal Artery
3. A3 - distal to the origin of the Callosal Marginal Artery (CMA). This segment is also known as the pericallosal artery.

Recurrent artery of Heubner (Medial Striate Artery) is an important perforator from the proximal A2 segment is the Medial Striate Artery. The length of the Heubners artery is generally twice as that of the A1 segment. Its increased length increases its exposure to injury during surgery. It supplies the anterior striatum, a portion of the outer segment of the Globus pallidus and the anterior limb of the Internal capsule. Its injury typically results in a moderate paresis of the contralateral upper extremity and mild paresis of the contralateral face.⁹

Sandhya Arvind Gunnal et al.,¹⁰ in her study on 112 cerebral hemispheres, observed that the average length of A1 segment was 15.7mm. The greatest length of A1 segment measured was 25mm and the least is 11mm.

Smita B. Shinde et al.,¹¹ observed that on the right side, the maximum length of the A1 segment observed was 1.5cm and the

minimum length observed was 1.1 cm. The mean length of the A1 segment observed on the right side was 1.3cm. On the left side, the maximum length of the A1 segment observed was 1.3cm and the minimum length observed was 1.1cm. The mean length of the A1 segment observed on the left side was 1.20cm.

Cessy job et al.,¹² have observed that the greatest length measured for the A1 segment of ACA in their study was 1.9cm and the smallest was 0.5 cm. Variations of anterior cerebral artery was found to be 7.6%. It is usually associated with anterior cerebral artery syndrome. Anterior cerebral artery showed variations in 8 cases, like absence, thin and short (Hypoplasia), enlarged and thickened, partial duplication and distal anterior cerebral artery.

In study by Poorwa B K et al.,¹³ Among 100 cadaveric brains, 23 variant anterior cerebral arteries were noted. The most common variation observed in the anterior cerebral artery was duplication in 5 subjects followed by overlapping in 4 subjects. Most of the variations were observed on the right side in both males and females. Some variations like azygous anterior cerebral artery, median anterior cerebral artery was found in the adults because of persistence of embryonic pattern.

Kedia S et al.,¹⁴ noted that mean length and external diameter of right and left A1 segment was 12.09 mm and 12.0 mm and 2.32 mm and 2.36 mm respectively. Narrowing, duplication, and median ACA were seen in 6.6%, 3.3% and 6.6% of the vessels respectively. Complex ACoA type was seen in 40% cadavers. RAH originated at an average point of 0.2 mm distal to ACoA, but in one cadaver it arose 5 mm proximal to ACoA. Double RAH was found in 26.6%. The course of RAH in relation to A1 was superiorly in 60%, anteriorly 30% and posteriorly in 10% of cadavers. The orbitofrontal artery (OFA) and frontopolar artery (FPA) arose from A2 in 83.3% to 40% respectively. The mean distance of OFA and FPA from ACoA was 4.17 mm and



8.5 mm respectively. After giving rise to central, callosal and cortical branches, pericallosal artery terminated near the splenium of the corpus callosum or on the precuneus as the inferomedial parietal artery.

Agensis and hypoplasia resulting in defective circulation has been reported in the medical literature. If the artery on one side is narrowed, the vascular insufficiency is compensated by crossing over by opposite side artery, or by giving branches that cross over to the other side. It indicates that the circulus arteriosus offers a potential shunt in abnormal conditions such as occlusions and spasms.^{7,8}

This should be understood as an effort to generate essential knowledge for the approach to vascular pathology in our environment, and to motivate the development of more studies aimed at deepening our knowledge in microsurgical neuroanatomy.

CONCLUSION

With an increasing number of cerebrovascular accidents, grave morbidity associated with it & increasing surgical/radiological intervention, present study findings will help surgeon/radiologist during intervention. Also, identification of such variations in population is important in the evaluation of cerebral vascular morbidity for adequate treatment.

Conflict of Interest: None to declare

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