Original Research Article

International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(2.2):6516-20. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2019.156

ANATOMIC VARIANTS OF THE ANTERIOR PART OF THE CEREBRAL ARTERIAL CIRCLE: A CADAVERIC STUDY

A.Thenmozhi [1], R.Kalpana *[2], C.Subadha [3].

[1] Assistant Professor, Department of Anatomy, Dharmapuri Medical College, Dharmapuri, Tamilnadu, India.

*[2] Assistant Professor, Department of Anatomy, Dharmapuri Medical College, Dharmapuri, Tamilnadu, India.

3 Assistant Professor, Department of Anatomy, Dharmapuri Medical College, Dharmapuri, Tamilnadu, India.

ABSTRACT

Background: The Circle of Willis plays an important role as cerebral collateral channel. Aneurysms are commonly arising in the anterior half of the circle of Willis, those originating on the anterior communicating artery are regarded as the most complex. This complexity is caused by the frequent variants of normal anatomy. The two anterior cerebral arteries, Anterior communicating artery, Artery of Heubner and perforating vessels arising from these vessels are called the anterior cerebral- anterior communicating complex. The anatomy of this complex is characterized by numerous anomalies &variations, so it gains a great surgical importance.

AIM: To study the microanatomy of anterior portion of Circle of Wills in south Indian cadavers.

Materials and Methods: This study done in 100 formalin fixed human brains obtained from routine dissection from cadavers with 10x magnification. The length, various anomalies noted in the following arteries: A1, A2 segments of anterior cerebral artery, anterior communicating artery and photographed for documentation.

Results: The mean length of right and left A1 segments of anterior cerebral artery (ACA), anterior communicating artery (ACoA) was 14.44 mm, 13.61 mm, 2.73 mm. Standard deviation was 2.53, 1.69, 1.16 respectively. Hypoplastic A1 segment noted in 6% of right side. In A2 segment of ACA, the Median anterior cerebral artery found in 2% and azygous artery found in 2%. Anterior communicating artery duplicated in 10%, hypoplastic in 6%, fenestrated in 16% . ACoA was absent in 2% of specimens.

Conclusion: The variations found in our study was more in the ACoA and A2 segment of ACA rather than A1 segments of ACA. The knowledge of anatomical variations in this region is essential for neurosurgeons to planning the neurosurgical procedures to avoid unexpected neurological complications.

KEY WORDS: Anterior cerebral artery, Anterior communicating artery, Azygous artery.

Address for Correspondence: Dr. R.Kalpana, Assistant Professor, Department of Anatomy, Dharmapuri Medical College, Dharmapuri, Tamilnadu, India. **Mobile:** +91-9080663986
E-Mail: thencittu@gmail.com

Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar BY-NC-SA
	Article Information
DOI: 10.16965/ijar.2019.156	Received: 25 Feb 2019 · Accepted: 07 Apr 2019 Peer Review: 25 Feb 2019 · Published (O): 05 May 2019 Revised: None · Published (P): 05 May 2019

INTRODUCTION

Cerebral aneurysms are balloon-like swellings due to defect in the vessel wall. They are most commonly found in circle of Willis, particularly at or near the junction of vessels. International Cooperative study on the Timing of aneurysm

Surgery (1980-1983), reported the incidence of ACoA-ACA aneurysm was 39%. This is due to complex anatomy of the concerned compounded by the fact that variations of the normal anatomy are very frequent. The anterior cerebral artery is the smallest terminal branch of the internal carotid artery (ICA) [1]. ACA originates from ICA, at the medial end of stem of sylvian fissure, and the artery curves over genu of the corpus callosum and courses posteriorly along the upper surface as pericallosal artery and anastomoses with posterior cerebral artery [1]. According to Susan Standring (2005) surgical nomenclature divides the ACA into 3 parts. A1 - from the origin of ACA to the origin of Anterior communicating artery (ACoA). A2 - from junction with the ACoA to point of emergence of callosomarginal artery. A3 - distal to the emergence of the callosomarginal artery [2].

The anterior communicating artery connects the two anterior cerebral arteries across the commencement of the longitudinal fissure.

Our current understanding of the developmental anatomy of intracranial arteries based on Hager Paget's 1948 article [3].

At 35 days the primitive division of the ICA develops a distal branch that is the stem of the ACA. By 40 days, the stem of the ACA elongates medially toward its counterpart. At this stage that a midline cluster of plexiform anastomoses begins to form between the adjacent and elongating ACAs. At 44 days, the channels of the midline cluster of plexiform anastomoses coalesce and form one or more ACoAs. In addition, the coalescing channels of the midline cluster of plexiform anastomoses give rise to a median ACA that originates from the ACoA. In humans, the median ACA, also known as the median artery of the corpus callosum, subsequently regresses and disappears, but it persists in other vertebrates. The development of this artery may result in regression and dissolution of the paired ACAs. With the formation of the ACoA at 44 days the adult configuration of circle of Willis is established. Given this description, we can predict the most common congenital anomalies of this region, which are (1). Multiple or fenestrated ACoAs, (2). Triplicate A2 segments, and (3) the azygous A2 segment.

MATERIALS AND METHODS

100 adult formalin fixed human brains obtained from routine dissection at Thanjavur Medical College, Thanjavur, were included in the study. Institutional ethical clearance was obtained before commencement of study. The specimens were removed from the cadaver as described in Cunningham's manual of practical anatomy [4] and they were fixed in 10% formalin. The arachnoid was carefully removed from base of brain. The following observation were noted in anterior portion of the circle of Willis with 10x magnification.

1. Length of the A1 segment of the ACA from the ICA termination to ACoA junction.
2. Length of the ACoA between two anterior cerebral arteries
3. Variations in the A1,A2 segments of the ACA
4. Variations in the ACoA
5. Perforators

The most representative specimens were photographed with Nikon digital camera.

OBSERVATIONS AND RESULTS

The mean length of right and left A1 segment of ACA, ACoA and their standard deviation showed in table no:1. Length of anterior communicating artery positively correlated with length of right ACA (0.339) and length of left PCA (0.285). P value for this correlation is 0.05 statistically significant. Hypoplastic A1 segment (Figure 1) of ACA noted in 6% of the specimen. But we found only in right side. Anterior communicating artery duplicated (Figure 2) in 10%, hypoplastic in 6%, fenestrated (figure 3) in 16% and absent in 2% of specimens. In A2segment of ACA we found Median artery (Figure 4) 2% and azygous artery (Figure 5) 2% of the specimens.

Table 1: Length of Anterior cerebral artery, Anterior communicating artery.

S. No	Name of the Arteries	Mean length of arteries (mm)	Standard deviation	Range (mm)
1	ACoA	2.73	1.16	1-9
2	Right A1 segment	14.44	2.53	8-21
3	Left A1 segment	13.61	1.69	10-18

Fig. 1: Hypoplastic A1 segment of the anterior cerebral artery.

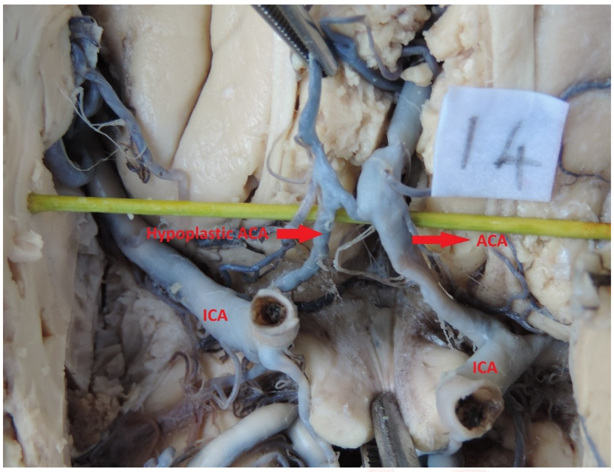


Fig. 2: Duplication of anterior communicating artery.

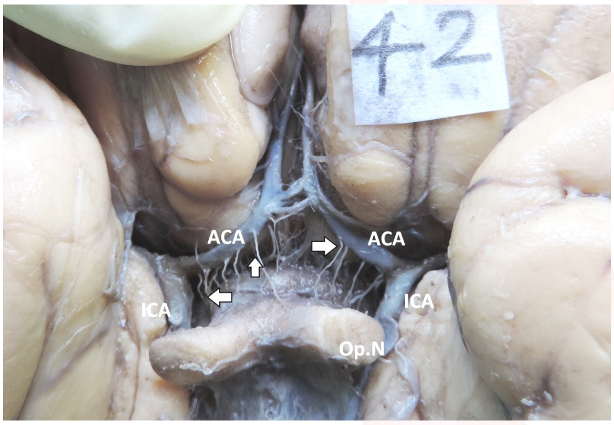


Fig.3: Fenestration in anterior communicating artery.

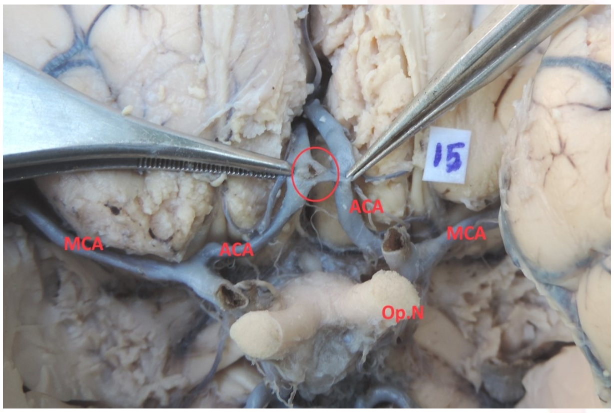
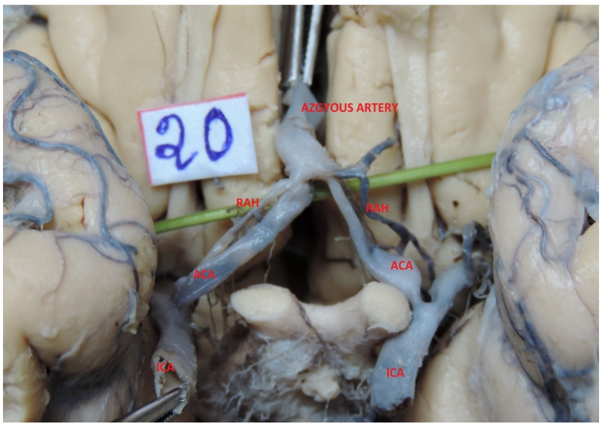


Fig.4: Median artery.

Fig.5: Azygous artery.



DISCUSSION

Each ACA courses over the superior surface of the optic chiasm or nerves. The shorter A1 segments were stretched tightly over the chiasm. The longer one passed anteriorly over the optic nerves. Riggs and Rupp found A1 hypoplasia on one side in 7% of 1647 circle of Willis, and the ACoA was so small it would restrict circulation between the carotids in 6% [5]. Table 2 shows comparison of length of ACA, ACoA in various literature.

In our observation only one ACoA length was 1mm all others were more than 1mm. Hypoplasia of an A1 segment has a high rate of association with anterior communicating aneurysms [9,10]. Wilson and others found that 85% of aneurysms of the ACoA were associated with hypoplasia of the first portion of one ACA and were located at a site of focal resistance [11]. In our case hypoplasia of ACA seen in 6% only right side.

Shweta kedia et al found ACoA duplicated in 5, fenestration in 1, and rudimentary in 1 case, and median artery in 6.6% [10]. Fawcett and Blachford (1905) stated that the ACoA was single in 92.2% of cases, double in 7.5% of cases, triplicate in 0.14% of cases and absent in 0.14% of cases [12]. Rani et al (2009) stated in 225 brains, single ACoA was 65%, duplicated 22%, triplicate 0.44%, hypoplasia 25.07, median artery 2% not absent in any cases [13]. In our study ACoA duplicated in 10% and absent in 2%of the specimens and fenestrated in 16%. In duplicated arteries both arteries same in size. None of the anterior communicating artery shown triplication in our study.

Table 2: Comparison of length ACA, ACoA in various literature.

Variations	Sylvia Kamath 1981 [6]	SB Pai et al 2005[7]	Shweta Kedia et al 2013 [8]	Present study
Country	South india	india	india	South india
Number	100	10	15	100
Mean length of Right ACA	14.7$\pm$3.0	14.6	12.09	14.44
Mean length of left ACA	13.8$\pm$2.7	14.5	12	13.61
Mean length of ACoA	2.50$\pm$1.8	2.45	3.3	2.73

In 2 case A2 segment of ACA divided in to three branches called median artery and in 2 cases found azygous artery. Median artery also known at times as the arteria termatica of Wilder, has been reported in 1.5% to 10% of brains [14]. Normally the median artery will disappear in human at 44 days of embryo, but 2 cases it persist in our study. Persistence of the median artery of the corpus callosum creates three A2 segments. Baptista identified triplicate ACA in 13.1% of his specimens [15]. But perlmutter and Rhoton found triplicate ACAs in only 2% of their specimens [16]. An azygous or solitary A2 segment arises when the paried ACAs regress after formation and enlargement of the median artery of the corpus callosum [3]. An azygous A2 has been identified in only 0.26 of general autopsies and in only 0.26% of unselected angiograms. The higher incidence of azygous A2 segments in aneurysm series results from the fact that 41.1% of azygous A2 segments have a terminal aneurysm [17].

CONCLUSION

ACoA aneurysms pose significant challenges in microsurgical and endovascular treatments, both of which are safe and effective options in properly selected patients. The microanatomy of the anterior part of circle of Willis is varied and consequently the surgery in this area is extremely challenging. The variations in our study among south Indians were found to be more in anterior communicating artery, A2 segment of the anterior cerebral artery than the A1segmets. Knowledge of the microvascular anatomy of the individual branches of the circle is essential for safer micro dissection plan in dealing with tumor and vascular lesions of this region by neurosurgeons and interpretation of imaging studies by radiologists.

Conflicts of Interests: None

REFERENCES

[1]. Susan Standring. Gray's Anatomy. 40th ed. Elsevier Limited. 2008:251-252.

[2]. Raymond C. Truex and Malcolm B. Carpenter. Human Neuroanatomy. 6th ed. The Williams& Wilkins company.1969; 62-74.

[3]. Hager Paget D. The development of the cranial arteries in the human embryo. 1948; 32:205-261.

[4]. G.J.Romanes. Cunningham's manual of practical anatomy.15th ed. Oxford University Press. 1996;page 14-15,46,50,51.

[5]. Riggs,H., and Rupp.C.: Variations in form of the circle of Willis,Arch.Neurol. 1963;8:24-30.

[6]. Sylvia Kamath. Observations on the length and diameter of vessels forming the circle of Willis. J.Anat. 1981;133(3):419-423.

[7]. Pai SB, Kulkarni RN, RG Varma. Microsurgical anatomy of the anterior cerebral artery-anterior communicating artery complex: An Indian study. Neurology Asia. 2005;10:21-28.

[8]. Shweta Kedia, Sahni Daisy, Kanchan Kumar Mukherjee, Pravin Salunke, Rakshith Srinivasa, Mathuriya Suresh Narian. Microsurgical anatomy of the anterior cerebral artery in Indian cadavers. J. neurology india. 2013;61(2):117-121.

[9]. Kirgis, H.D.,Fisher,W.L., Liewellyn,R.C.,and Peeble, E.M: Aneurysms of the anterior communicating artery and gross anomalies of the circle of Willis,J.Neurosurg. 1966;25:73-78.

[10]. VanderArk, G.D., and Kempe,L.C.: Classification of anterior communicating aneurysms as a basis for surgical approach, J. Neurosurg. 1970;32:300-303.

[11]. Wilson,G., Riggs,H.E., and Rupp,C: The pathologic anatomy of ruptured cerebral aneurysms, J. Neurosurg. 1954;11:128-134.

[12]. Fawcett E, Blachford JV. The circle of Willis. An examination of specimens. J Anat and Physiol.1905;40:63–70.

[13]. K.Ranil D.De Silva, Rukmal Silva, W.S.L Gunasekaara, and R.W. Jayesekera. Prevalence of typical circle of Willis and the variation in the anterior communicating artery. A study of a Sri Lankan population .Ann Indian Acad Neurol. 2009;Jul-Sep 12(3):157–161.

[14]. Dunker,R.O., and Harris,A.B.: Surgical anatomy of the proximal anterior cerebral artery, J. Neurosurg. 1971;35:16-24.

[15]. Perlmutter D, Rhoton AL Jr. Microsurgical anatomy of the anterior cerebral-anterior communicating-recurrent artery complex. J Neurosurg. 1976;45:259-72.

[16]. Baptista AG. Studies on the arteries of the brain. II. The anterior cerebral artery: some anatomic features and their clinical implications. Neurology. 1963;13:825-835.

[17]. Richard Winn .H. Youmans Neurological Surgery.6th ed. vol 4: Saunders. 2011;3834-870.

How to cite this article:

A.Thenmozhi, R.Kalpana, C.Subadha. ANATOMIC VARIANTS OF THE ANTERIOR PART OF THE CEREBRAL ARTERIAL CIRCLE: A CADAVERIC STUDY. Int J Anat Res 2019;7(2.2):6516-6520. **DOI:** 10.16965/ijar.2019.156