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Original Research Article

STUDY OF ANATOMICAL VARIATIONS OF ANTERIOR CEREBRAL ARTERY

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ABSTRACT

Introduction: The paired anterior cerebral arteries arise from the internal carotid arteries, connected by the anterior communicating artery to complete the anterior portion of the circle of Willis.

Aim and objectives: Aim of the present study was to provide information regarding anatomical pattern and variations of anterior cerebral artery in human cadavers.

Materials and Methods: One hundred apparently normal formalin fixed brain specimens were collected and the anterior cerebral arteries were identified, coloured, photographed, numbered and the abnormalities if any, were noted.

Result: 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 were found in the adults because of persistence of embryonic pattern.

Conclusion: The knowledge of such variations is of vital importance during surgeries, the aim being to preserve arteries in unusual location which if injured determine invalidating sequelae.

KEY WORDS: Anterior cerebral artery, azygous artery, median anterior cerebral artery, hypoplastic.

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INTRODUCTION

The paired anterior cerebral arteries arise from the internal carotid arteries, connected by the anterior communicating artery to complete the anterior portion of the circle of Willis. These arteries then supply the medial surface of each cerebral hemisphere, superior to the corpus callosum extending posteriorly as far as the parieto-occipital sulcus [1].

Present study was conducted to find out variations in the anterior cerebral artery. The Anterior cerebral artery displays many variations. Various diseases of carotid artery and its branches including cerebrovascular accidents are directly or indirectly related to these anatomical variations [2].

The clinical significance of variant anterior cerebral

artery lies in the alteration of arterial hemodynamics of the frontal lobe and the increased incidence of malformations like agenesis of the corpus callosum, hydranencephaly, saccular aneurysms and arteriovenous malformations [3].

MATERIALS AND METHODS

With prior permission and approval of the Ethical Committee, one hundred apparently normal brain specimens were collected from human cadavers with known age and sex.

The intact brains removed from the cranial cavity were washed in running tap water and fixed in 10% formalin. Each brain was placed in a separate container to avoid distortion. The dura mater and arachnoid mater were carefully dissected out from base of the brain as per the instructions given by Cunningham's Manual [4].

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.

RESULTS

In the present study, 100 formalin fixed specimens of brain were studied from human cadavers, of which 58 were males and 42 were females.

Fig. 1: Schematic diagrams of variation of anterior cerebral artery.

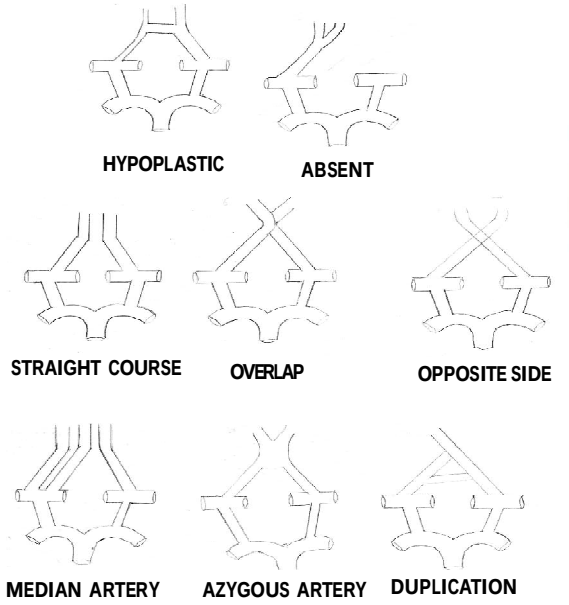


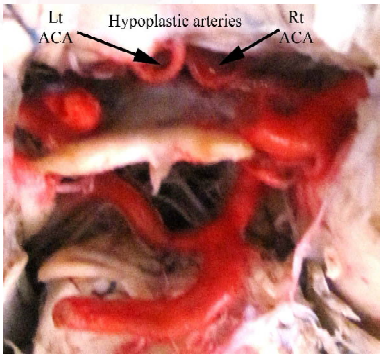
Table 1: Anterior cerebral arteries with variations.

Variations	MALE		FEMALE		TOTAL
	Right	Left	Right	Left	
Hypoplasticity	2	-	-	-	2
Absence	1	-	1	-	2
Anomalous origin	1	-	1	-	2
Straight course	-	-	1	1	2
Overlap	2	-	-	2	4
Opposite course	-	-	1	1	2
Median ACA	1	-	1	-	2
Azygous artery	2	-	-	-	2
Duplication	2	1	2	-	5

The most common variation observed in the anterior cerebral artery, as shown in Table 1 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.

Hypoplastic artery - When the diameter of a component vessel forming Circle of Willis is less than 1 mm, it is said to be hypoplastic, attenuated or string artery. In the present study hypoplastic anterior cerebral artery was found in two cases on right side in the males. (Figure 2)

Fig. 2: Showing Hypoplastic ACA artery.

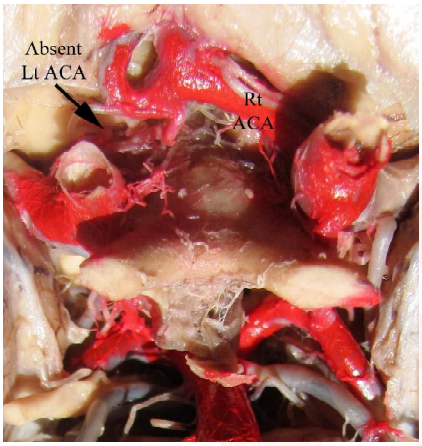


Absence of anterior cerebral artery - In two specimens, one male and one female both from the right side, proximal part of the right anterior cerebral artery was absent. The left anterior cerebral artery originated from left internal carotid artery. The left anterior cerebral artery divided into 2 branches. One branch of its own side continued as distal segment of left anterior cerebral artery and the other was substitute for distal segment of right side. (Figure 3)

Anomalous origin of anterior cerebral artery- Anomalous origin of right anterior cerebral artery from the left anterior cerebral artery was found in 1 male and 1 female cadaver. Proximal segment of left anterior cerebral artery arose from left internal carotid artery which continued

as distal segment. The distal segment of left anterior cerebral artery then gave one branch which continued as distal segment of right anterior cerebral artery. A very fine attenuated artery connected the right internal carotid artery with distal segment of right anterior cerebral artery. This attenuated artery represented proximal part of the right anterior cerebral artery. (Figure 3)

Fig. 3: Absent LT ACA.



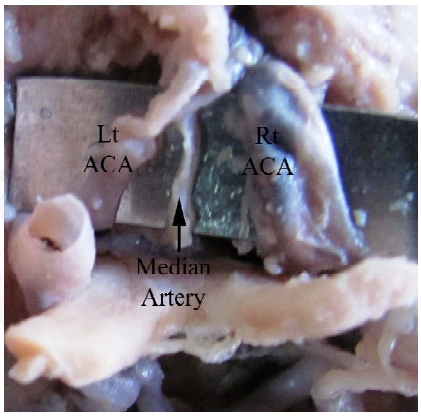
Straight course of anterior cerebral artery - The proximal segment of anterior cerebral artery passed anteromedially from its origin towards the midline then over the posterior part of gyrus rectus and entered the median fissure to resume its normal course. It communicated with its fellow artery after entering into the fissure. It had a long course in the interpeduncular fossa. The straight/long course of the anterior cerebral artery was found in one case on right side and one case on left side only in females.

Overlapping of the anterior cerebral artery- The right anterior cerebral artery moved anteromedially, crossed the midline towards the left side to overlap on the left anterior cerebral artery then entered the median fissure. In the median fissure it had normal course. In case of overlapping on the left side, the left anterior cerebral artery moved towards the right side, overlapped the right anterior cerebral artery then it entered the median fissure. In the fissure it had normal course. Overlapping of the right anterior cerebral artery was found in 2 cases in the males. Overlapping of left anterior cerebral artery was found in 2 cases in females.

Opposite side- In this variation the right and left anterior cerebral artery after overlapping each other entered the median fissure. In the fissure, the right anterior cerebral artery passed on the left side of the fissure while the left anterior cerebral artery had a course along the right side. This variation was found only in females.

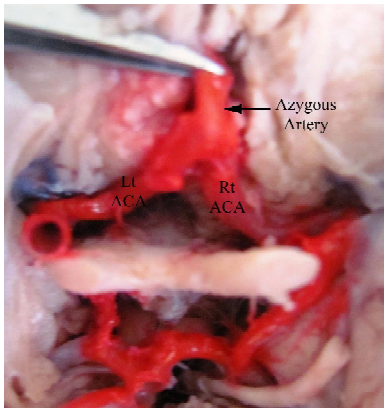
Median artery of corpus callosum arising from anterior cerebral artery was found in one male and one female cadaver, in which the right anterior cerebral artery before entering the median fissure duplicated. The left anterior cerebral artery had normal course. Left anterior cerebral artery and the two branches of right anterior cerebral artery could be followed in the fissure. The median anterior cerebral artery occupied central position. (Figure 4)

Fig. 4: Showing the median artery.



Azygous artery- Two specimens showed this variation in males, in which the proximal segment of right and left anterior cerebral arteries passed anteromedially for a short distance then the two arteries joined with each other to form a single trunk of distal segment of the anterior cerebral artery. The distal segment which entered the median fissure is known as Azygous artery. (Figure 5)

Fig. 5: Showing azygous artery.



Duplication of anterior cerebral artery- In one case the main trunk of the anterior cerebral artery bifurcated into two components and re-

joined to form a single artery. Thus a loop was formed. In one case two anterior cerebral arteries originated separately from internal carotid artery of the left side. After a short distance these two arteries united to form a single trunk which united with the anterior cerebral artery of the right side. In one case the proximal trunk of the right anterior cerebral artery bifurcated into two segments which did not join with each other. They separately united with the left anterior cerebral artery and there was absence of anterior communicating artery. This type of variation was described as button-hole or island formation by some authors. In males duplication of anterior cerebral artery was found on right side in two cases and left side in one case. In case of females the duplication of anterior cerebral artery was found on right side in 2 cases and no duplication was seen on the left side. Total 5 cases showed this variation.

DISCUSSION

Anterior cerebral artery is a major vessel responsible for the blood supply to the interhemispheric region [5].

Table 2: Comparison of variations in the anterior cerebral artery.

Variations	Vare et al 1970 [6]	Kapoor K. 2008 [2]	Jain P.N. 1990 [7]	Present study
No. of brains	175	1000	144	100
Absence	2.30%	0.40%	3.47%	2%
Hypoplastic	2.30%	1.70%	-	2%
Splitting	3.40%	5%	-	5%
Median artery	1.70%	0.90%	3.47%	2%
Azygous artery	-	-	-	2%
Anomalous origin	2.30%	0.40%	3.47%	2%

The above Table 2, compares variations in anterior cerebral artery in present study with such similar studies. The most common variation seen in anterior cerebral artery was splitting, in 5% cases. Study of Kapoor K[2] also showed splitting as most common variation (5%) as well as Vare et al [6].

In present study, absence of anterior cerebral artery was found in 2% cases on the right side. Almost similar observations were made by Vare et al [6] (2.3%) and Jain PN[7] (3.47%), but the findings of Jain PN[7] differed from the present study as they observed the incidence of absence of the anterior cerebral artery was more on left side. Kapoor K [2] study revealed absence of anterior cerebral artery in 4 cases only (0.4%), 2 on right side and 2 on left side.

In the present study 2% of anterior cerebral arteries showed hypoplasticity. K. Kapoor [2] got 1.7% cases of hypoplasticity while Vare et al [6] found same variation in 2.3% cases, almost similar to present study.

Hypoplasticity of the proximal part of the anterior cerebral artery is often described with a wide variation in the incidence ranging from 4% to 44.3% [De Vries (1905) [8]; Puchades-Orts (1976) [9]]. This wide variation in the incidence may be due to the fact that some workers [Riggs and Rupp (1963) [10], Battacharji (1967) [11]] have studied pathological or infracted brains. Battacharji et al (1967) [11] studied arterial pattern in the normal and infracted brains. The incidence of string like vessels was found to be higher in infracted brains.

Some abnormal branches may sprout during embryological period leading to duplication. In present study splitting of vessels to duplicate was found in 5% cases similar to the finding by Kanchan Kapoor [2], Vare and Bansal [6] found it in 3.4% cases.

Median artery arising from anterior cerebral artery was first reported by Windle (1888) [12]. It was a normal pattern in lower primates e.g. Chimpanzee [Kassel and Langfitt, (1965)] [13]. In the present study, persistence of this lower primate pattern was seen in 2% subjects. Vare and Bansal [6], Jain P.N [7] and Alper et al [14] found it in 1.7%, 3.47% and 1.71% cases respectively which was quiet similar to the present study. Kapoor K et al [2] mentioned this artery to be present in 0.9% cases.

Fusion of both anterior cerebral arteries into single azygous artery for a short distance is found as a typical pattern in dogs and monkeys. In the present study this pattern was seen in 2% of subjects. Alper et al (1959) [14] found this variation in 1.71%. Partial fusion of anterior cerebral artery was found in 2% by Macchi et al (1996) [15]. Hence our findings matches with the findings of Alper et al (1959) [14] and Macchi et al (1996) [15]. Baptista (1964) [16] distinguished the Azygous anterior cerebral artery from other variants as the unpaired anterior cerebral artery and observed it in only

one case.

Anomalous origin of both the anterior cerebral arteries from internal carotid artery of one side was relatively rare [12]. In our study it was found in 2% cases. Our finding was similar to that of Vare and Bansal [6] who found this anomaly in 2.3% cases. The incidence was more in study by Jain P.N [7]. This anomaly can be explained on the basis that anterior cerebral artery fails to develop or atrophies on one side with persistence of median artery of corpus callosum and development of anterior cerebral artery from the internal carotid artery of the other side [17]. Other explanation of this anomaly by Vare and Bansal [6] is that there is atrophy of proximal part of anterior cerebral with persistence of distal part.

In our study total 8 variations in the course of anterior cerebral artery were observed. Straight course was found in 2, overlapping of vessels in 4, moving of anterior cerebral artery to opposite side in the median fissure in 2 specimens. Similar variations in the course of anterior cerebral artery were observed by Vare and Bansal[6]. According to Stehben [18], topographical modifications of the circle like variations in the course of vessel occurs during postnatal development of brain and secondary modifications occur in pathological occlusive diseases.

CONCLUSION

From the present study we can conclude that the Azygous and Median anterior cerebral artery were found in the adults because of persistence of embryonic pattern. Duplication was the most common variation of anterior cerebral artery (5%) followed by overlapping seen in 4 subjects.

The main purpose of component vessels of this anastomotic circle of Willis is to act as a bypass in the event of obstruction of any main channel which depends on the size and patency of the component vessels. It helps to slow down the blood before it reaches the brain and help in drainage of the cerebrospinal fluid in the interpeduncular cistern [19].

The knowledge of variation in the course is of vital importance during surgeries, the aim being to preserve arteries in unusual location which if injured determine invalidating sequelae. The association of variations and the incidence of aneurysm can be interpreted in terms of haemodynamic stress caused by variations [20].

Conflicts of Interests: None

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