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Original Research Article

STUDY ON THE ANATOMICAL VARIATIONS OF THE ANTERIOR PART OF THE CIRCLE OF WILLI'S IN ADULT HUMAN CADAVERS

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ABSTRACT

Introduction: The anterior part of the circle of Willi's is made up of anterior cerebral arteries and anterior communicating artery. The variations of the anterior part of the circle of Will's may lead to some clinical conditions like Cerebrovascular diseases such as stroke, aneurysms, internal carotid artery occlusion and migraine. The present study was aimed to find out the incidence of the variations of the anterior part of the circle of Willi's in the Telangana Population.

Materials and Methods: A total of 40 adult brains (30 male and 10 female) were obtained from the dissection and the anterior part of the circle of Willi's were studied and the observed variations of the middle cerebral artery, the anterior cerebral artery and anterior communicating artery were recorded and photographed.

Results: Variations were observed in 27.5% specimens in which 7.5% specimens had double anterior communicating arteries, 7.5% specimens shown union and separation of anterior cerebral arteries, 2.5% specimens had an aneurysm of the anterior cerebral artery and anterior communicating artery, 2.5% specimen shown triple anterior cerebral artery, 5% specimens had the hypoplasia of anterior cerebral artery and 2.5% specimens had duplication of middle cerebral artery.

Conclusion: Knowledge of the anatomical variations of the anterior part of the circle of Willi's is of great value to the neurosurgeons while dealing with cerebrovascular stroke, aneurysms of the anterior cerebral artery, anterior communicating artery, and middle cerebral artery.

KEY WORDS: Anterior cerebral artery, Anterior communicating artery, Aneurysms, Brain, Middle cerebral artery

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INTRODUCTION

The human brain is made up of billions of specialized cells (Neurons and neuroglia) and it is richly supplied by blood vessels which provide adequate oxygen and essential nutrients. The brain receives blood from two sources: the two

internal carotid arteries and the two vertebral arteries which are connected by central anastomosis called as circulus arteriosus or circle of Willi's which is present around the interpeduncular fossa at the base of the brain [1]. Thomas Willis was the first scientist to describe the circulus arteriosus, the major blood supply to the brain in 1662 after that the circulus arteriosus of the brain was named as a circle of Willi's [2,3]. The internal carotid arteries branch to form two major cerebral arteries, the anterior and middle cerebral arteries which form the anterior circulation that supplies the forebrain [4]. The two anterior cerebral arteries are joined together by an anterior communicating artery which starts appears in the human embryo of size 18 mm, as a reticulated anastomosis between the two anterior cerebral arteries [5]. Many anatomical variations have been reported on the branches forming the circle of Willis. These anomalies and variations of the circle of Willis are developed in the early embryonic stage and persists into post-natal life which is genetically determined [6]. In another theory, the morphological variations of the circle may occur during postnatal development of brain with secondary modifications of collateral vessels which are developed due to pathological occlusive disease [7].

The circulus arteriosus has an important role in maintaining a stable and constant blood flow to the cerebral hemisphere. Any variations in it may cause a disturbance in its flow [3]. The variations of the anterior circulation of the brain may lead to some clinical conditions like Cerebrovascular diseases such as stroke, aneurysms, internal carotid artery occlusion, unilateral flow restrictive external carotid artery disease, and migraine [8-10]. In mentally challenged patients, a higher percentage of anomalies of the circle of Willis was also reported [11]. As there were many clinical conditions related to the variations of the circle of Willi's the present study was carried out to find out the incidence of the variations of the anterior part of the circle of Willi's in the Telangana Population which could be of valuable information to the neurosurgeons while dealing with the surgeries of these vessels.

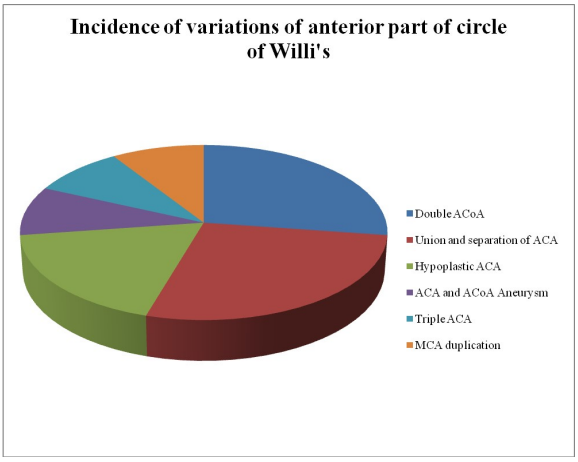
MATERIALS AND METHODS

The present study was carried out on a total of 40 brains. Out of 40 specimens, 30 specimens belong to the adult males of different age, remaining 10 specimens belong to the adult female. These brain specimens were obtained from the department of Anatomy while performing routine undergraduate dissection in formalin fixed cadavers. The intact brains were again fixed in 10% formalin after removing from the cadaver and numbered. The outer two meningeal layers, dura mater and arachnoid mater were carefully dissected and the formation of Circle of Willis was observed on the base of the brain around optic chiasma and interpeduncular fossa. Any brain with evidence of pathology or trauma, along with its supplying vessels that affected the topography of the arteries had been excluded from this study. Anatomical variations of the anterior part of the circle of Willi's were observed for any variations in the origin, course, length, diameter, form of asymmetry, the absence of component vessel and branching pattern. All the observed variations were noted and the photographs were taken. The vessel with a diameter of less than 1 mm has been described as hypoplastic.

RESULTS:

Out of 40 brain specimens, 11 (27.5%) specimens revealed marked variations and 29 (72.5%) specimens were normal. The incidence of observed variations in the component vessels of the anterior part of the circle of Willi's was shown in figure 1.

Fig. 1: Pie chart showing the incidence of the variations of the anterior part of the circle of Willi's.



Out of 40 specimens, 10 (25%) specimens were showing variations in the anterior cerebral artery (ACA) and the anterior communicating artery (ACoA). In 3 specimens (7.5%) double

anterior communicating arteries were observed where the anterior cerebral arteries were connected twice by the anterior communicating arteries either very closely or after a short distance (Figure 2).

Fig. 2: Showing the ACA connected twice by ACoA.

In 3 specimens (7.5%) union and separation of anterior cerebral arteries were observed where the proximal segments of the anterior cerebral artery was normal which is connected by the anterior communicating artery of normal size later the two distal segments of the anterior cerebral arteries joined with each other forming single trunk and immediately get separated (Figure 3).

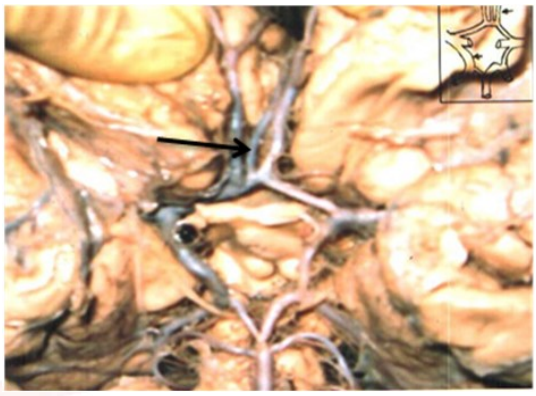
Fig. 3: Showing union and separation of ACA.

In one specimen (2.5%) aneurysm of the proximal segment of the anterior cerebral artery and the anterior communicating artery was observed on its right side (Figure 4).

Fig. 4: Showing aneurysm on right side of ACA & ACoA.

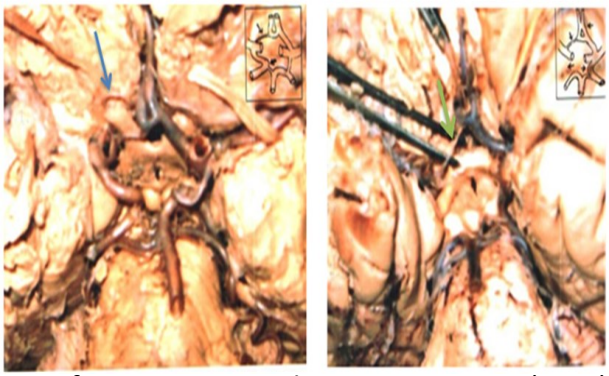
In one specimen (2.5%) triple anterior cerebral artery was observed where the two proximal segments of the anterior cerebral arteries were connected by the single anterior communicating artery and a median artery was taking origin from this communicating artery (Figure 5).

Fig. 5: Showing a median artery from the ACoA.



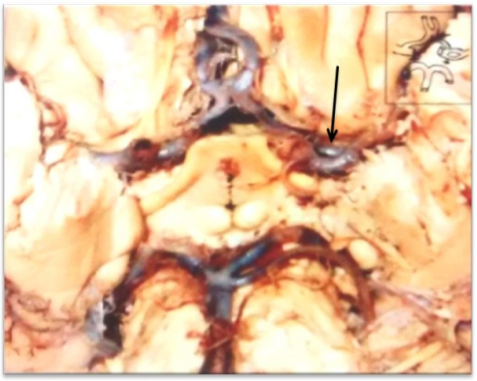
In two specimens (5%) on one side the proximal segment was hypoplastic and joined with the opposite component by a normal anterior communicating artery and the distal segment of the hypoplastic anterior cerebral artery was normal which is mainly formed by the contribution of the opposite ACA (Figure 6).

Fig. 6: Showing hypoplastic ACA on right side.



Out of 40 specimens only in one specimen (2.5%) on its left side the middle cerebral artery (MCA) originated by two roots and joined immediately to form a single trunk (Figure 7).

Fig. 7: Showing the origin of MCA by 2 roots.



DISCUSSION

The anatomical variations of the anterior cerebral artery and anterior communicating artery are very common and in the present study, the incidence of variations of ACA and ACOA were reported as 25%. The knowledge on the possible variations of ACA-ACOA is essential for the neurosurgeons while dealing with the cerebrovascular diseases.

In the present study, the most common variations observed were double anterior communicating arteries in 7.5% specimens and Union and separation of anterior cerebral arteries in 7.5% specimens. The incidence of double ACoA is correlating with other studies by Fawcett & Blachford et al., Puchades –Orts et al., and S Iqbal where the incidence was 7.28, 6.4 and 6 respectively [3,12,13]. The union and separation was described as azygous pattern of ACA and the incidence of the present study was little lower than Vaibhav V Sande et al., where they reported in 10% cases [14]. Triplicate ACA was observed in 2.5% specimen in the present study which was higher than the incidence of Sandya Arvind et al., and lowers than S Iqbal reported it as 09% and 4% respectively [13,15]. The third artery was considered as an accessory artery which was of variable length and has almost the same diameter as both the anterior cerebral arteries and was described as the Median artery of Corpus Callosum as it supplies to it. This artery was also named as the Arteria Telematics of Wilder [6,16,17].

In 2.5% specimens, an aneurysm was observed extending from the proximal part of ACA to ACoA. Berry aneurysms structural defects in the tunica media of the vessel wall at or near the branching of an intracranial artery may cause berry aneurysms [7,18]. Structural malformations such as asymmetry of the anterior part of the circle of Willis with local alterations in intravascular hemodynamics may lead to the development of aneurysms [17]. Kapoor et al., concluded after examining 1000 cadaveric brain specimens that all the aneurysms are located in the anterior part of the circle of Willi's, especially at the junction of ACA and ACoA [19].

The incidence of the Hypoplasia of the proximal segment of ACA was reported in the present study as 5% whereas S Iqbal, Rigg & Rupp, Kamath et a., and Milenkovic reported as 4%, 11.97%, 2% and 9.16% respectively. The incidence was ranging from 2 to 11.97% where the present study was to it [6,11,13,18].

In the present study duplication of the middle cerebral artery was found in one (2.5%) specimens. The middle cerebral artery was originated as two roots and immediately united to form single middle cerebral artery. Till now no cases reported with this type of anomaly. In many CT and MRI, angiographic studies duplication of the middle cerebral artery was reported with the incidence ranging from 0.2 to 2.9%. The duplication of the middle cerebral artery has no much clinical significance [20,21]. Kai et al., reported that all the aneurysms associated with the double middle cerebral artery were found at its origins which can be due to higher hemodynamic stress [22].

CONCLUSION

The observed variations of the anterior part of the circle of Willi's in the present study is of a great value to the neurosurgeons and the cerebrovascular surgeons while dealing with the clinical conditions related to cerebrovascular problems like the cerebrovascular stroke, the aneurysms of the anterior cerebral artery, the anterior communicating artery, and the middle cerebral artery.

Conflicts of Interests: **None**

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