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Research Article

Morphometric Analysis and Variations of the Circle of Willis

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Abstract: Circle of Willis is an arterial anastomosis between the internal carotid and vertebral system. Anterior and middle cerebral arteries are the branches of internal carotid artery and Posterior cerebral artery is an terminal branch of the vertebral artery. These form the cortical branches of the circle of Willis along with the anterior and posterior communicating arteries. We observe the variations in the communicating arteries. The diameter of the arteries is directly propositional to flow of blood volume. The knowledge of anatomical variations in the circle of Willis is useful for Neuro surgeons and psychiatrists. The study of morphology and variations in the formation of circle of Willis was observed in the routine cadaveric dissection in the department of anatomy, Kamineni institute of medical sciences, Narketpally.
Keywords: Circle of Willis (COW), Anterior communicating artery (ACoA), Posterior communicating artery (PCoA)..

INTRODUCTION

The brain is one of the most metabolically active organs of the human body [1]. The continuous blood supply to the brain is of importance because of its high metabolic demand for oxygen and glucose [2]. It is highly sensitive to hypoxia and hypoglycaemia [3-5].

Blood flow through whole brain in adult is 54 ml/100 g/min, Cerebral blood flow is 55 to 60 ml/100 g brain tissue/min. Blood flow rate through each carotid artery is 350 ml/min while blood flow rate through basilar artery is 100-200 ml/min [6, 7].

The brain is supplied by paired internal carotid and vertebral arteries. Two vertebral arteries unite to form basilar artery [2].

'Circle of Willis' is the principal arterial anastomotic trunk of brain. It is formed by the anastomosis between the branches of internal carotid arteries and terminal branch of basilar artery. It is responsible for brain's collateral blood supply [8]. So that knowledge of the formation and variations in circle of Willis in the brain is essential for proper diagnosis and treatment of the diseases.

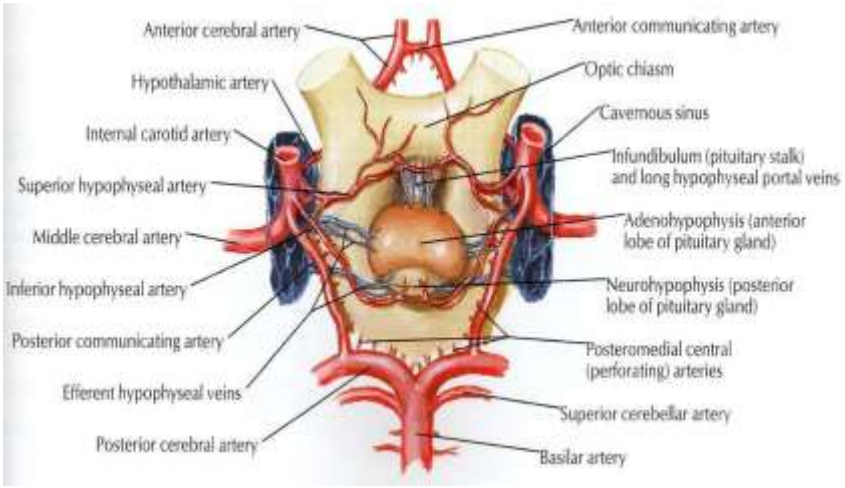

Fig. 1: Showing the normal pattern of the circle of Willis

Anterior and Posterior communicating arteries are the important branches for the formation of circle of Willis.

We observed the variations in the diameter of communicating arteries. The diameter of the arteries was directly propositional to flow of the blood volume.

The purpose of study was to provide some information regarding the anatomical variations of the circle of Willis in the brain and to determine the relationship between variations in the circle of Willis and volume of blood flow in the circle of Willis.

MATERIALS AND METHOD

This study was approved by the Kamineni Institute of Medical Sciences and performed in accordance with institutional guidelines. This study was followed by Cunningham's dissection manual.

Fifty brains were used in this study. These were collected from human cadavers (35 male and 15 female), from the Department of Anatomy, Kamineni Institute of Medical Sciences, Narketpally for dissection and research purpose over last five years. Cadavers all were originated from Telengana region.

Brain was removed carefully from the cranial cavity and stored in 10 % formal saline for fixation. Diameter was measured by Verniearcallipers then variations are photographed. The pattern of the arterial circle and related variations were noted.

RESULTS

In this study the variations of circle of Willis were observed in naked eye. Of the 50 subjects (35male, 15 female) considered suitable for morphological measurement, 48 showed as textbook type, and two (2) showed variations. Studies in the various diameters in the branches of internal carotid and vertebral arteries are observed. In that we had observed two variations

1. Various diameter of posterior communicating artery.
2. Double anterior communicating arteries.

Case 1

The diameter of the arteries is directly propositional to flow of the blood volume. Various diameters of posterior communicating arteries influence the flow the blood volume. Diameter of common carotid artery- 6mm, diameter of posterior communicating artery in right side- 4mm, diameter of left posterior communicating artery is- 2mm.

Fig. 2: Showing wide right posterior communicating artery and narrow left posterior communicating artery

Case 2

Double anterior communicating arteries influence the blood flow.

Fig. 3: Showing double anterior communicating arteries

DISCUSSION

Circle of Willis is formed at the base of the brain for nourishing it.

It contributes the overwhelming majority of blood supply to the brain [9].

Crossman AR *et al*. [10] evaluated the vascular supply of the brain and studied about the posterior communicating artery variations. Schomer DF *et al*. [11] studied the anatomy of the posterior communicating artery as a risk factor for ischemic cerebral infarction. Papantchev V *et al*. [12] reported variations of the circle of Willis, important for cerebral protection in aortic surgery.

Kapoor K *et al*. [13] had studied variations in the configuration of the circle of Willis. Variations were noted and grouped into different categories. 45.2% conformed to the typical pattern. In remaining 54.8%) there were variations in the circulus arteriosus. The circle was deficient in 3.2%. The anterior cerebral

artery was absent in 0.4%; hypoplastic in 1.7%; duplicated in 2.6%; triple in 2.3% and single in 0.9% while anterior communicating artery was absent in 1.8%, duplicate in 10%, triplicate in 1.2% and plexiform in 0.4%

Vaibhav Sande and S. P. Wanjari [14] studied variations in the arterial Circle of Willis in cadaver. Circle of Willis was complete in 80% cases. Anomalies were more common in posterior part (43.33%) than in the anterior part (16.66%).

Efterkhar B *et al*. [15] found no evidence suggesting the distributions of variations of circle of Willis that are different in different populations.

Seyed Mahmood Ramak Hashemi *et al*. [16] also found that there was no evidence that the distribution of the variations of the anatomy of the circle of Willis, different in various societies.

To define hypoplasia of the circle of Willis artery various authors used different measurement.

The occipital lobe, supplied mainly by the posterior cerebral artery naturally will suffer the most in aplasia or hypoplasia of posterior cerebral artery, as this will not take place when vertebro-basilar or carotid arterial system develops a blockage or a narrowing [17].

CONCLUSION

Variations on the anterior communicating artery were double in their form, and posterior communicating arteries calibre showed asymmetry in either side. Variations in the circle of Willis correlate significantly with relative contributions by the flow rates of the bilateral internal carotid and basilar arteries. The calibre influences the volume flow rates in the feeding arteries of brain. The circle of Willis variations have been used to evaluate blood flow dynamics in vascular diseases. Of the 50 subjects (35male, 15 female) considered suitable for morphological measurement, 48 showed as textbook type, and two (2) showed variations. Two variations include various diameters of posterior communicating artery and double anterior communicating arteries. This anatomical study is useful for neurologists, psychiatrists, post graduates and undergraduates.

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