



ORIGINAL RESEARCH PAPER

Anatomy

AN ANATOMICAL STUDY OF CIRCLE OF WILLIS AND ITS VARIATIONS IN HUMAN CADAVERS - A SHORT REVIEW.

KEY WORDS: ACA, PCA, ACoA, PCoA.

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ABSTRACT

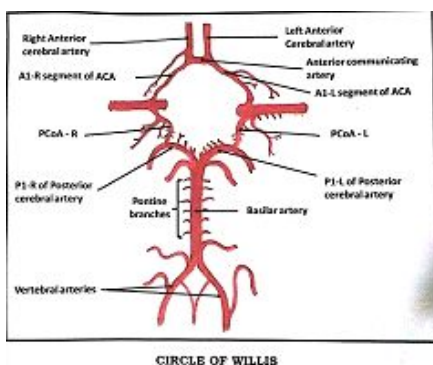
The blood supply of the central nervous system is of great importance because of the metabolic demands of the nervous system. Major part of the brain is supplied by the branches of two vertebral arteries and two internal carotid arteries. A significant anastomosis, the circle of willis exist between the vertebral and carotid arterial systems. The classical form of circle of willis is complete, of symmetrical normal calibre and polygonal in shape. Anatomic variations in the formation of circle of willis are studied by many scientists. The posterior part of the circle is more anomalous than anterior part and the posterior communicating artery is the most anomalous segment when compared to all the segments of the circle. Various diseases of carotid and vertebral arterial systems like stroke, hemorrhage, aneurysm, etc. are directly or indirectly related to the anatomic patterns of the circle of willis.

INTRODUCTION:

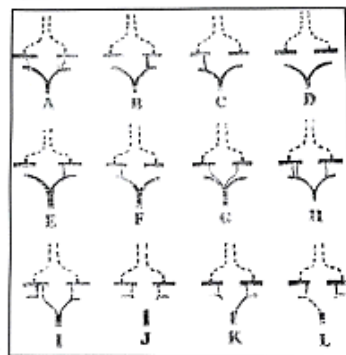
Thomas Willis, an english anatomist as well as physician first described the presence of a circular arterial anastomosis at the base of the brain in the interpenduncular fossa and hence the arterial circle is commonly termed as "circle of willis". It is formed by the internal carotid artery which is interconnected via the anterior cerebral arteries on both the sides (right and left) and an anterior communicating artery which connect the right and the left anterior cerebral arteries. The carotid system is connected to the posterior cerebral arteries of the vertebral system by two posterior communicating arteries (right and left).

The classical form of circle of willis, which is complete, of symmetrical normal calibre and polygonal in shape. There is considerable individual variation in the pattern and calibre of vessels. About 60% of circle display 'anomalies'. Ozaki et al (1977) described variations of the circle of willis and classified it as follows:

- TYPE 1:** Fenestration of the anterior communicating artery which included—
 - 'V' shaped,
 - 'Y' shaped,
 - 'H' shaped,
 - 'N' shaped,
 - Double, triple and plexiform.
- TYPE 2:** 'X' shaped of anterior cerebral arteries
- TYPE 3:** Median anterior cerebral artery.
- TYPE 4:** Asymmetrical proximal segments of ACA.
- TYPE 5:** Accessory middle cerebral artery.
- TYPE 6:** Early duplication of middle cerebral artery.
- TYPE 7:** String-like posterior communicating arteries.
- TYPE 8:** Asymmetry of PCoAs.
- TYPE 9:** Primitive PCoAs and
- TYPE 10:** Asymmetry of vertebral arteries.



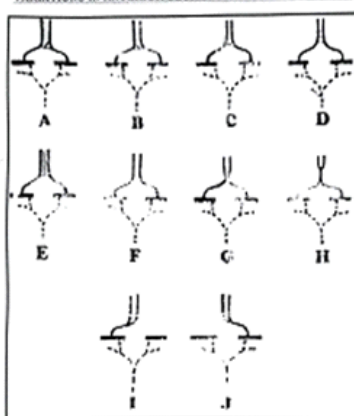
VARIATIONS IN POSTERIOR SEGMENT OF CIRCLE OF WILLIS



PK Jain et al classification of Circulus Arteriosus Variations

- A : Fenestration of PCoA-L
- B : Absent PCoA-R
- C : Absent PCoA-L
- D : Bilateral PCoA absent
- E : PCoA-L hypoplasia with PCoA-R absent
- F : PCoA-R hypoplasia with PCoA-L absent
- G : Bilateral PCoA hypoplasia
- H : Duplication of PCoA-R
- I : PCA arising from ICA on right side
- J : Bilateral P1 segment absent
- K : P1-R absent
- L : P1-L absent

VARIATIONS IN ANTERIOR SEGMENT OF CIRCLE OF WILLIS



PK Jain et al classification of Circulus Arteriosus Variations

- A : ACoA fenestration right side
- B : ACoA fenestration left side
- C : Duplication of ACoA
- D : Triplication of ACoA
- E : Trifurcation of ACA
- F : Absence of ACoA
- G : V-shaped ACoA-ACA complex
- H : Argyous/Median trunk ACA
- I : A1-L absent
- J : A1-R absent

REVIEW OF LITERATURE:

The literature related to the circle of willis goes back to the 16th century.

Casserio(1616) was the first to construct an accurate figure of the circle of willis.Windle (1887), showed in a study that out of 200 specimens,the anterior cerebral arteries were normal in 181 cases.In 9 cases a third branch was found and was named as Arteria Cerebralis Anterior Media.

Fawcett & blackford (1905), in a study on 700 specimens found the circle of willis complete in 673 specimens (96.1%).He found the doubling of the ACA was rare,occurring in only 2 cases.

Vare & Bansal (1970) did a study on 175 specimens and they observed that only 47 specimens had the typical picture of circle of willis.The commonest anomaly was the origin of the PCA from the internal carotid artery.

Kamath S (1981) studied a 100 circle of willis and found that abnormally narrow diameter was found in 25 vessels of 24 circles and was most frequently seen in the PCA followed by PCoA.

Lippert H & Padst R (1985) ,in an anatomic study, noted the absence of ACoA in 1% of subjects.

M ilenkovic et al (1985) based on previous works and their observations postulated that genetic factors are probably responsible not only for development of the circle of willis but also for its caliber.

Stephen P Lownie & Jhon (1991) stated that in 14% of the cases,the PCA was arising from the ICA.He further observed that in 23% of the cases ,the PCoA was missing on one side.

Michael LJ et al (1993) in a study showed that the frequency of normal circle of willis in cadavers ranges from 20-50%. 75% of the circles show one ,two or three communicating arteries to be hypoplastic with asymmetry of the ACA or PCA segments.

Don F Schomer et al (1994) ,conducted a study on the anatomy of PcoA in ipsilateral watershed infarctions in 32 hemispheres using MRI & 3D – contrast MRI angiograms.The study concluded that the smaller diameter of < 1 mm or absence of PcoA is a risk factor for ischemic cerebral infarction subjects with internal carotid artery occlusion.

Standring S. et al (2008) noted that the greatest variation in caliber occurs in the PCoA.Agenesis or hypoplasia of the initial segment of the ACA are more frequent than anomalies of the ACoA.

CONCLUSION:

The posterior part of the circle is more anomalous than the anterior part and the PCoA is the most anomalous segment when compared to all the segments of the arterial circle.

The study of normal as well as variations of the circle of willis is very important for us to understand the location of the lesion ,the knowledge of which may be of considerable help to the neurosurgeons who perform different vascular surgery of brain.

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