

Variation in Blood Circulation of Brain-Circle of Willis

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Abstract: Human brain and its complex vascular network may be viewed as a “three pounds biological computer”. It is supplied by two internal carotid arteries, two vertebral arteries connected by a central anastomosis i.e. Circle of Willis in the interpeduncular fossa at the base of the brain. The circle of willis has been shown to exhibit many kinds of anatomical variations. The classical circle is bilaterally symmetrical and a complete ring of vessels. We have studied 20 cadavers during the routine dissection over the period of two years i.e. August 2015 to July 2017. In our study, out of 20 cadavers, we found one variation in branching pattern in circle of willis. Here, the posterior communicating artery on the right side was very large while the posterior cerebral artery of the right side was very small.

Keywords: cerebral, migraine, vessels, aneurysm, hypoplastic, duplication

1. Introduction

Human brain and its complex vascular network may be view as a “three pounds biological computer”. It is supplied by two internal carotid arteries, two vertebral arteries connected by a central anastomosis i.e. Circle of Willis in the interpeduncular fossa a the base of the brain [1].

The normal circle of willis is considered as a closed circuit in which fluid may circulate from any entrance point and then return to the same point by means of their vessels [2].The circle of willis may exhibit many kinds of anatomical variations. The internal elastic lamina particularly, the regions around the bifurcations is an important layer of the arterial wall, especially in the cerebral vessels. Thus, disruption of this layer would promote formation of aneurysms [3]. The classical circle is bilaterally symmetrical and a complete ring of vessels. Vessels generally vary in caliber, often they are hypoplastic, duplicated or even absent [4]. Several studies have shown that these variations play an important role in development of the cerebrovascular diseases [5].

The anatomical variations are probably genetically determined deeply in early embryonic stage & persist in post natal life [6].

A thorough knowledge of variations of vessels is useful to the surgeons in planning their shunt operation & the choice of the patients [1]

The inference obtained from this study is helpful to the anatomists, radiologists in enhancing their knowledge in teaching & investigative procedures.

2. Material & Method

In our present study, we had studied 20 cadavers during the routine dissection over the period of two years i.e. August 2015 to July 2017. Brain with circle of willis were carefully dissected and fixed in 10 % formalin & preserved. Variations such as vessels more than 1cm in external diameters, extra vessels or any duplication of the vessels were studied. The circle of willis, each major cerebral artery from origin to the point of its division distal to the circle, basilar artery and the subarachnoid portion of each vertebral artery were carefully dissected and studied under a magnifying lens. The circles were then photographed and analyzed. In our study, out of 20 cadavers, we found one variation in branching pattern in circle of willis

3. Result

Out of 20 cadavers, in the study of circle of willis we found one variation in the branching pattern in the circle of willis.

Here, the posterior communicating artery on the right side was very large while the posterior cerebral artery of the right side was very small.

The internal carotid artery on the right side gave three branches, anterior cerebral, middle cerebral, posterior communicating artery.

In our case, posterior communicating artery was continuing as the posterior cerebral artery.



4. Discussion

The normal circle of willis is formed by

- a) Basilar artery - divides into posterior cerebral arteries. These two posterior cerebral arteries join with the internal carotid arteries on both sides by the posterior communicating arteries.
- b) Internal Carotid artery - On each side, the internal carotid artery bifurcates into anterior and middle cerebral arteries.

The two anterior cerebral arteries are joined by anterior communicating arteries.

The study conducted was silent about the similarity of 3 postmortem diameters in vivo measurement as well as effect of absent perfusion pressure followed by possible postmortem shrinking of the arteries [7]. If cerebral blood flow is reduced for half than normal blood flow, ischaemia develop. This is represented by TIA (transient ischemic attack) till the time, the communicating arteries enlarge to maintain the normal perfusion for proper functioning of brain [1]. But however if there is extensive types of hypoplasia associated with vascular occlusion, the collateral

circulation is deranged and this leads to stroke with irreparable brain damage [8].

The collateral circulation in circle of willis is assessed by using, transcranial colour coded duplex ultrasonography with common carotid artery compression test in atherosclerotic patients who are not having any symptoms. This test concluded that posterior collateral pathway is nonfunctional as compared to anterior cell pathway [1]. In our study there was hypoplasia of posterior cerebral artery on right side. Instead the posterior communicating artery on right side was very large.

The occlusion of one of the cerebral vessels and adequacy of recover after the vascular occlusions may be explained by anatomy of circle of willis [7]. There are well documented evidences of cerebral aneurysm with the association with anomalies of circle of willis. A high incidence of these anomalous circles of willis is seen in patients of vascular aneurysm of their arteries [9]. Also there may be structural anomalies in vessel wall in the form of absent tunica media which causes berry aneurysm [9, 10].

Kamath stated that a higher percentage of anomalies of circle willis has been reported in the those patients who are

mentally ill, with cerebrovascular catastrophe and so the two are linked to each other [11]. Lasaro concluded that presence of the circle of willis anomaly is important criterion for selection of patients for treatment & prevention of aneurysm [12] But these observations also need further studies as there is no definite evidence.

If we compare left and right anterior and posterior side of the brain, the more commonly found alterations in morphology were on bilaterally posterior portion. Also the correction is found between variations in posterior circulation and the coronary dominance pattern [13] But such comparison and relations do not have specific explanation and may be related to embryological development. As it is, the arteries from circle of willis are constituting a network around the neural tube in embryo which further divide to form the anterior cerebral artery & posterior communicating artery [2]

However, alteration in MCA (middle cerebral artery) are quite uncommon and rarely found. Only 3 % population have accessory MCA originating from the anterior communicating artery (Morris) [14]. The posterior communicating artery variation are regarded as the most common of all in circle of willis. This can be absent (Murkkola et al) [15] or hypoplastic in 12 % (External diameter less than one mm) (Eflekar 2006) [16]

In a study by Moritale showed aneurysm always occurred on the thicker side of internal carotid artery to posterior communicating artery junction [17]. Only the increase impingement of axial flow to the aKpex cannot explain the development of aneurysm [18, 19] However other hemodynamic factors are also to be taken into consideration in the development of aneurysm [20, 21]

The internal elastic lamina is an important layer of the arterial wall, especially in the cerebral vessels. Thus, disruption of this layer would promote formation of aneurysms [3]. Particularly, the regions around the bifurcations have atypical wall structures with a discontinuity of the muscle cells of the tunica media as a medial defect in connection with a predominance of collagen fibers over the elastic ones [22, 23].

Some authors studied and reported that anomalies in circle of willis are commonly associated with migraine in aura patients than in control and this is useful for the diagnosis according to etiology of migraine and their selection for therapeutic strategies [24].

5. Conclusion

In conclusion, the variations in circle of willis have a definite clinical impact. The anomalies of circle of willis play an important role in occurrence, manifestation, treatment and recovery of certain cerebrovascular disorders like stroke, aneurysm, migraine etc.

The anomalies include duplications or triplication or hypoplasia of component vessels in circle of willis. Hypoplasia were common in posterior than anterior circulation. Neurological importance lies during the

exposure of these region for different surgical and radiological procedures

However, a thorough knowledge of vascular variant will increase the success of various neurological procedures.

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