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Anatomy

CIRCULUS ARTERIOSUS- POSTERIOR CIRCULATION: A MORPHOLOGICAL STUDY

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ABSTRACT In the era of high technology and consumer litigations, the disease management has leaped to very high level to nanotechnology and further. As life span of individual human has increased, so are the disease pattern and its natural course. But human anatomy has very few deviations from its basic organogenesis. Identification of disease particularly of vascular origin and in particular of brain vascular pattern is very essential for the management. The present study was an attempt to find out the pattern of circle of Willis among South Indian population.Completeness of circle of Willis and anterior communicating artery as well as anomaly . we have examined 50 brain specimens. In the present study we noted that the normal circle was found only in 72% of brains examined. Posterior communicating artery:In fifty specimensthepostericommunicating arteries were examined (100 numbers). Out of these 100 arteries examinedeighty six (86) were normal. The remaining fourteen (14) were abnormal. In the presence study the posterior communicating artery was absent on the right side in3 specimens, which is significant. It was stated that the most common defect the circle of Willis was the absence of one or bothposteriorcommunicatingarteries

KEYWORDS : circle of willis, Anomaly, Anterior communicating artery, morphology,brain

INTRODUCTION:

Brain is a highly vascular organ. Its profuse blood supply is characterized by a densely branching arterial network. It has a high metabolic rate that shows the consumption of energy requirements of constant neural activity. It receives approximately 15% of the total cardiac output. It uses 25% of the total oxygen consumption of the body. The brain is supplied by 2 internal carotid arteries, 2 vertebral arteries that form a complex anastomosis (circle of Willis) on the base of the brain. Blood vessels diverge from this anastomosis to supply the various cerebral regions. In general internal carotid arteries, and the vessels arising from them supply the forebrain. Except of the occipital lobe of the cerebral hemisphere. The vertebral arteries and their branches supply the occipital lobe, the brain stemand the cerebellum. Venous blood from the brain drains into sinuses within the dura mater. Interruption of the blood supply to the brain for, more than a few minutes may cause permanent neurological injury. Such ischaemic damage along with intracranial haemorrhage is major contemporary sources of morbidityand mortality. The blood supply to the brain are derived from the internal carotid and vertebral system, which lie, together with their proximal branches, within the subarachnoid space. The internal carotids and their major branches (the internal carotid system or 'anterior' circulation) supply blood to the most of the forebrain. Some parts of the occipital and temporal lobes are supplied by branches given off by the vertebrobasilar system. The circulus arteriosus (circle of Willis) is a large arterial anastomosis which joins the internal carotid and vertebrobasilar systems. It lies in the subarachnoid space within the interpeduncular cistern, and surrounds the optic chiasma and infundibulum. Anteriorly, the anterior cerebral arteries, derived from the internal carotid arteries, are linked by the small anterior communicating artery. Posteriorly, the two posterior cerebral arteries ,formed by the division of the basilar artery, are joined to the ipsilateralinternal carotid artery by a posterior communicating artery. There is considerable change in the pattern and caliber of vessels that make up the circulus arteriosus. Although a complete circular channelalmost always exists, one vessel is usually sufficiently narrowed to reduce its role as a collateral route and the circle is occasionally functionally complete. Cerebral and communicating arteries individually or collectively may all be not formed, not well developed, double or even triple invariations .The hemodynamic of the circle of Willis, are influenced by many variations in the luminal caliber, of communicating arteries and in the segments of the anterior and posterior cerebral arteries. Which lie in between their origins and their junctions with the corresponding communicating arteries. The greatest change in caliber, between individuals vessels occurs, in the posterior communicating artery, which is normally very small, so that only limited blood flow is possible, between the anterior and posterior circulations. Commonly, the diameter of the pre communicating part of the posterior cerebral artery is larger, than that of the posterior communicating artery, in which case the blood supply to the occipital lobes is, mainly from the vertebrobasilar system. However, sometimes the diameter of the pre communicating part ofthe posterior cerebral artery, is smaller to that of the posterior rcommunicating artery, in which case the blood supply, to the occipital lobes is largely from the internal carotids via the posterior communicating arteries. Since the primary purpose of the vascular circle is, to provide anastomotic channels if one vessel is occluded. It is important to note that a normal-sized posterior communicating artery cannot fulfill this change. Agenesis or hypoplasia of the initial segment of the anterior cerebral artery, are more frequent, than anomalies in the anterior communicating artery and contribute to defective circulation, in about a third of individuals. Aneurysms are balloon-like bulge, which occur on arteries as a result of defects, in the layers of vessel wall. They are commonly found on the vessels of the circulus arteriosus, particularly at or near the junctions of vessels. Aneurysms on the internal carotid artery, near its termination may compress the lateral aspect of the optic chiasma.They compromise axons derived from the temporal side of the ipsilateral retina, which causes a defectin visual field. Aneurysms in the vicinity of the oculomotor nerve, e.g. onthe posterior communicating artery, superior cerebellar artery, or the tip ofthe basilar artery, causes third nerve palsy by pressure effect. Bleeding into the subarachnoid compartment, subarachnoid haemorrhage, is the most common pathology, that involves the subarachnoid space. There are many causes; in adults the commonest is, rupture of ananeurysm of the intracranial vessels, that run within the subarachnoid space. A person who has had a subarachnoid haemorrhage, usually complains of a very sudden onset of headache, that is frequently described as being their 'worst ever headache' . When this is suspected, the first investigation is a CT examination which has a very high sensitivity, for detecting fresh haemorrhage. Blood will be seen in the basal cisterns and entering the depths of the cortical sulci, i.e. delineating the anatomy of the subarachnoid space, a presentation that permits an accurate diagnosis. In marked contrast, the spread of blood in a subdural haemorrhage, is limited by the arachnoid mater on its deep surface, and the blood therefore remains on the surface of the brain. Brain has a rich blood supply, which is supplied with blood through the confluence of vertebrobasilar and internal carotid system. The oxygen consumption of the neural tissue is very high (25% of the oxygen that is breathed in). Acute arrest of circulation produces loss of consciousness in about seven seconds. The cerebrovascular accidents (CVA) occurs due to infarction, hemorrhage and embolism result in stroke, in which the entire half of the body or a limb or one half of face is paralysed. In persons in whom there is narrowing of arteries is they are more prone to stroke . The common causes of cerebral hemorrhage are aneurysm of major arteries, small arteriolar aneurysms due to hypertension and arteriovenous malformations. Therefore, the blood supply of the brain assumes a great importance. This arterial circle equalizes the pressure of the brain flow to the two sides of the brain, as it is the main collateral channel. Variations are very common in the circle of Wills. Circle of

Willis is the arterial arcade formed by the carotid system and vertebrobasilar system. It is polygonal in shape and is situated in the interpeduncular fossa. The knowledge of topography of blood supply of brain is very essential to indentify the affected brain tissue, to localise any tumour, to perfuse medicine locally on the pathological area, to ligate the feeding vessel and to excise or remove the tissue or tumour.

2.AIM OF THE STUDY:

The present study was an attempt to find out the pattern of circle of Willis among South Indian population.

- In how many arterial circle of Willis were complete
- In how many brains the posterior communicating artery was complete and well developed or showed any variations.

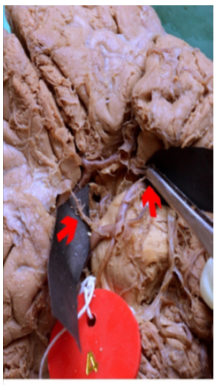
3.MATERIALS AND METHODS

Fifty human brains of both sexes were collected for the present study from the Department of Forensic Medicine, Madurai Medical College, and Madurai 20. The age of the deceased from whom the brains were removed ranged from 24-75 years. All specimens were collected within two to eight hours after death. Brains were removed by detaching the falxcerebri from cristagalli and the falxcerebri was pulled posteriorly from between the hemispheres. The head allowed to fall back. Olfactory bulb was visualized by elevating the frontal lobe and olfactory nerves were severed. Optic nerves were severed closely to optic foramen. Internal carotid arteries and the infundibulum of hypophysis were visualized and severed. The brain was allowed to fall backwards. Coulometer nerves were visualized. Lateral to the coulometer nerves free margins of tentorium cerebelli were observed and cut along the attachment. The brain was allowed to fall. All the nerves were identified. A knife is passed into the vertebral canal in front of medulla oblongata and a cut was made from side to side to severe two vertebral arteries and spinal medulla and the brain was delivered.The brain was washed with water to remove any blood stain. After clamping the internal carotid arteries a scalp vein set without needle was introduced into the basilar artery and tied to it. Normal saline was pushed through the scalp vein set using 50ml syringe. Following that 100ml of10%formalin was injected. The scalp vein set was removed and the basilarartery was tied. The specimen was preserved in 10% formalin solution.50 circulus arteriosus on the 10%formalin embalmed brains were studied. Duraion of study period was 3 years in the dissection hall of Madurai Medical College, Madurai. The formation and branches of circulus arteriosus was observed by removing the arachnoid mater carefully, in the interpeduncular cistern. Posterior cerebral artery was traced from its origin to the termination,posteriorcommunicating, anterior cerebral, anterior communicating, arteries was also observed.The variations encountered were noted. And the photography of the bestobserved anomalous circulus arterious was taken.

4.RESULTS:

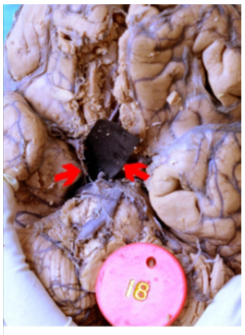
The arterial circle or “Circle of Willis” is formed by anastomosis between the branches of internal carotid arteries and the basilar artery. It is located in the interpeduncular cistern at the base of the skull. The “Circle ofWillis" or circulus arteriosus, has a great importance as the main braincollateral circulation specially in the old people who may have reduced brainblood supply due to senile arteriosclerosis. In normal condition, this circle isformed anrteriorly by two anterior cerebral artery, right and left internalcarotid and anterior communicating artery. Posteriorly on each side eachinternal carotid artery by its posterior branch, the posterior communicating artery, communicate with posterior cerebral artery, branch of basilar artery. The circle of Willis and the arterial branches which participate to make it show many variations, some of them may be hypoplastic are absent. The anterior communicating artery may frequently be double or even triple while the posterior communicating arteries seem to be more hypoplastic. A total of 50 specimens collected from the Department of Forensic Medical, Madurai Medical College, Madurai -20. where examined for present study. They were classified according to age, In females it ranges from 28 years to 56 years. In males in ranges from 24 to 79 Sex among these 50 adult brains 35 were from malecadavers and 15 were from female cadavers. Internal carotid artery: In the fifty circle of Willis hundred internal carotid arteries werepresent both right and left side. Anterior cerebral artery: Among the fifty specimens hundred anterior cerebral arteries were examined no abnormality was found in any of the specimen. Posterior communicating artery:In fifty specimenstheposteriorcommunicating arteries were examined (100 numbers). Out of these 100 arteries examinedeighty six (86)were normal. The remaining fourteen (14) were abnormal. In the presence study the posteriorcommunicating artery was absent on the right side in3 specimens , which is significant. It was stated that the most common defectn the circle of Willis was the absence of one or both posterior communicating arteries

FIGURENO:1 POSTERIOR COMMUNICATING ARTERY



Posterior communicating both right and left slender

FIGURE NO:2 SLENDER POSTERIOR COMMUNICATING ARTERY



Posterior communicating Slender on right side absent on left side

5. DISCUSSION& CONCLUSION

According to PP Poudel [1]and C Bhattarai[1] 2010, Nepal Med Coll Journal, “Circle of Willis” is a large arterial anastomotic ring of the brain, ofthe internal carotid and vertebrobasilar systems, lying in the subarachnoid space within the deep interpeduncular cistern. Anastomosis slows down the blood flow before it reaches the brain It also helps in collateral circulation. The pulsations of the arteries also help in drainage of the cerebrospinal fluid. There were variation in the pattern and caliber of vessels in their study which make up the circulus arteriosus. Many a times complete circular channel almost always exists, but occasionally one vessel is usually sufficiently narrowed as a collateral route. Cerebral and communicatingarteries individually may all be absent, variable hypoplastic, double or even triple. The circle is rarely functionally complete. Anomalies of the branchescan lead to conditions like stroke. The anomalies of the cerebral circulation, as theyare not rare and may have profound clinical implications. Cerebral – vascular diseases present one of the leading problems. Which have the risk of high mortalityrate and disability with people who survive cerebral – vascular incident(stroke, apoplexy). The knowledge of cerebrovascular variants is essential ineducation, training and treatment. In the present study of fifty human brains (male and female) collected from autopsy specimens from the Institute of Forensic Medicine, Madurai Medical College, Madurai -20, analysed for the pattern of circle of Willis along with the variations of contributing arteries also. Age of the specimens collected ranged from 24 - 79 in male & in females from 28 - 56. 15 from females and 35 from males were collected. Out of these 3 of females pecimens and 11 of male specimens showed variations. There was no relationship with advancement of age and abnormalities observed in the present study. The pattern of abnormalities classified according to the sex found to be maximum in males and minimum in females. Circle of Willis: Normal pattern In this study, of the 50 brain specimens observed 36 cases (72%) had normal anatomy of circle of Willis Circle of Willis: Completeness of Arterial Circle.“Circle of Willis” is complete in 44 (88%) specimens and incompletein 6 specimens (12%) in contrast to

the study of Fawcett and Blachford(3.9%)[2].Thus the findings of the present study have a correlation with thefindings of P N Jain and V Kumar (1990)[3]and Hartkamp et at[4](1998) with respect to location of variations.

The absence of posterior communicating arteries was unilaterally and bilaterallyit was 0.3% in the complication studies of Bergman16 et al. The absence ofposterior communicating artries was 7% in Stopford110 (1916) series of 150cases, 3.9% in Fawcett and Blachford [2](1905) series of 700. PosteriorcommunicatingSlender:Hypoplasia of the posterior communicating artery (PCoA) wafrequently associated with embryonic derivation of the posterior cerebraartery with duplication of the ACoA.In the present study posterior communicating arteries were slender in6 cases. In 2 specimens it was slender on both sides and in one brain on rightsite and in the another left site. Among 100 posterior communicating 7 (7%)absent. In 2 specimens it was absent on both sites. In 2 brains it was absentof left site and in the rest of the 1 on the right site.Bilateral absence of posterior communicating artery was reported by Bergman[5]etal. PosteriorCommunicating Artery: AbsenceQuan Zhang[6] from department of Radiology, Tianjin medicaluniversity, Tianjin, China.Carefulcomputedangiographic evaluation and an understanding of the vascular interrelationships in the circle of Willis are essential for a successful postoperative course, especially when very rare vascular anomalies treated.

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