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Fetal Origin of Posterior Cerebral Artery: Morphological Case Study.

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ABSTRACT

The circle of willis and its branches are subjected to numerous variations. The variations not only differ from person to person but also on the side of the individuals. The brain receives its blood supply from four arterial trunks. Two internal carotid arteries and two vertebral arteries. The circle of Willis is a large arterial anastomosis which unites the internal carotid artery and vertebral artery. It is named after Thomas Willis, an English physician. Both the arteries together with their branches lie within the subarachnoid space called interpeduncular cistern at the base of the brain. It is a ring like network of blood vessels which is essential for perfusion of the brain. The two internal carotid arteries contribute 80% of the blood supply to the brain and the two vertebral arteries contribute 20% of the blood supply. In this study, 50 cadaveric human brain specimen is dissected to study the anomalous origin of Posterior cerebral artery from Internal Cerebral artery and to report the incidence with the previous studies

Keywords: cerebral artery, morphology, fetal

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NTRODUCTION

The brain receives its blood supply from four arterial trunks, two internal carotid arteries and two vertebral arteries. The internal carotid artery arises from the common carotid artery at the level of upper border of thyroid cartilage(Ranganathan T.S edit 3rd) The vertebral artery is a branch of first part of subclavian artery. The circle of Willis is a large arterial anastomosis which unites the internal carotid artery and vertebral artery. It is named after Thomas Willis, an English physician(Shane Tubbs 2013, Willis T 1664).. Both the arteries together with their branches lie within the subarachnoid space called interpeduncular cistern at the base of the brain. Approximately 15% of the total blood supply reaches the brain and approximately 20% of the oxygen utilization is consumed by the adult brain. The blood flow to the brain is estimated to be around 800ml/min (50ml/100g) of brain tissue. The blood flow is faster in the grey matter (70-80ml/100g/min) than in white matter (30ml/100g/min). Blood flow of less than 15ml/100g/min leads to irreversible brain damage(Grand W 1999)

Under normal condition, the blood flow in the communicating arteries are negligible. If a subject has an atypical circle (missing of one of the main artery or the communicating artery) or under pathological condition (partial or complete occulusion of cerebral or carotid vessels), the flow can be redirected to perfuse deprived areas. It has been found that in 50% of the normal brain and in 80% of the dysfunctional brain, the circle of Willis is often incomplete or underdeveloped. The most common morphological variations are absent vessels, hypoplastic vessels and extra vessels(Vare AM 1970, Neeta kulkarni 3rd edit)

The anatomy of the circle of Willis and its possible variations are essential while interpreting Computerized Tomography and Magnetic Resonant Imaging pictures of patients who exhibit anatomical or functional deviations. . Knowledge of the morphological, and radiological features of the circle of Willis is essential in diagnostic and therapeutic procedures and for understanding of most of the cerebrovascular diseases(Ayse Karatas 2015)

AIM AND OBJECTIVES

50 cadaveric adult brain specimen were taken for the study. The brain were dissected after removing the skull cap using chisel and hammer and the vault of the skull was opened and the meninges are reflected. The vertebral arteries, basilar artery and internal carotid arteries are traced. Then the Circle of Willis is exposed by opening the interpeduncular cisterns at the base of the brain. Circle of Willis and its major branches were carefully dissected. The photos of Circle of willis and their variations were taken and documented.

- The aim is to study the anomalous origin of posterior cerebral artery from the internal carotid artery.
- To study the cause of this variation and incidence with the previous studies.

EMBRYOLOGICAL CONSIDERATIONS:

The vascular system develops in two stages: Vasculogenesis and Angiogenesis. The embryological development of the circulatory system supplying blood to the brain begins with the formation of the six pairs of primitive branchial arteries at the 1.3mm embryonic stage (Battacharji Sk 1967).

The brain vascular system arises from the perineural vascular plexus which sprout radially into the neuroepithelium. They subsequently branch off laterally in the subventricular zone, the subventricular plexus(Mall FP 1905). Foxc1 gene is required for early stage telencephalic vascular development as it is expressed in endothelial cells and pericytes, as well as in the cranial mesenchyme surrounding the brain tube (Streeter GL)

Most of the branches of the circle of willis are derived from the internal carotid artery which is embryologically formed from the third arch artery distal to the external carotid bud and cranial part of the dorsal aorta distal to the attachment of third arch artery (Langman embryology 12th edit). The ventral portion of the 2nd branchial artery disconnects from the dorsal aorta near the origin of the internal carotid artery and becomes the ventral pharyngeal artery. Then the ventral pharyngeal and the ICA fuses to form the common carotid artery.

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At the 4mm stage, the Internal carotid artery branches off into anterior and posterior divisions. The anterior division gives rise to the anterior cerebral artery (ACA), middle cerebral artery (MCA) and anterior choroidal artery. The posterior division gives rise to posterior cerebral artery (PCA) and the posterior choroidal artery.

The vertebral artery is a composite vessel and it is developed from four sources (Mall FP 1905).

- The first part of the artery develop from the dorsal ramus of the intersegmental artery.
- The second part of the artery develop from the enlargement of the post-costal anastamosis with the consequent regression of the stems of the upper six intersegmental arteries.
- The third part of the artery develops from the spinal branch of the first cervical intersegmental artery.
- The fourth part of the artery develop from the pre-neural division of the spinal branch which meets with the corresponding branch of the opposite side at the caudal border of the pons to form the basilar artery.

The intracranial vertebrobasilar system develops after the internal carotid system. A number of segmental branches arise from the dorsal aorta supply the endodermal, ectodermal and mesodermal elements and supply the neural tube. Longitudional anastamosis between the vessels give rise to vertebral artery and because of its segmental nature, the vertebral artery is more prone to variations such as hypoplasia, fenestrations etc.

CASE STUDY:

The fetal origin of posterior cerebral artery from the internal carotid artery is common variant in the posterior part of the circle. Here the posterior cerebral artery is small, hypoplastic or even absent and inorder to compensate for the posterior circulation, the PCA is connected by a small communicating type of vessel. In this study, fetal origin of Posterior cerebral artery were found in one specimen (fig 1)

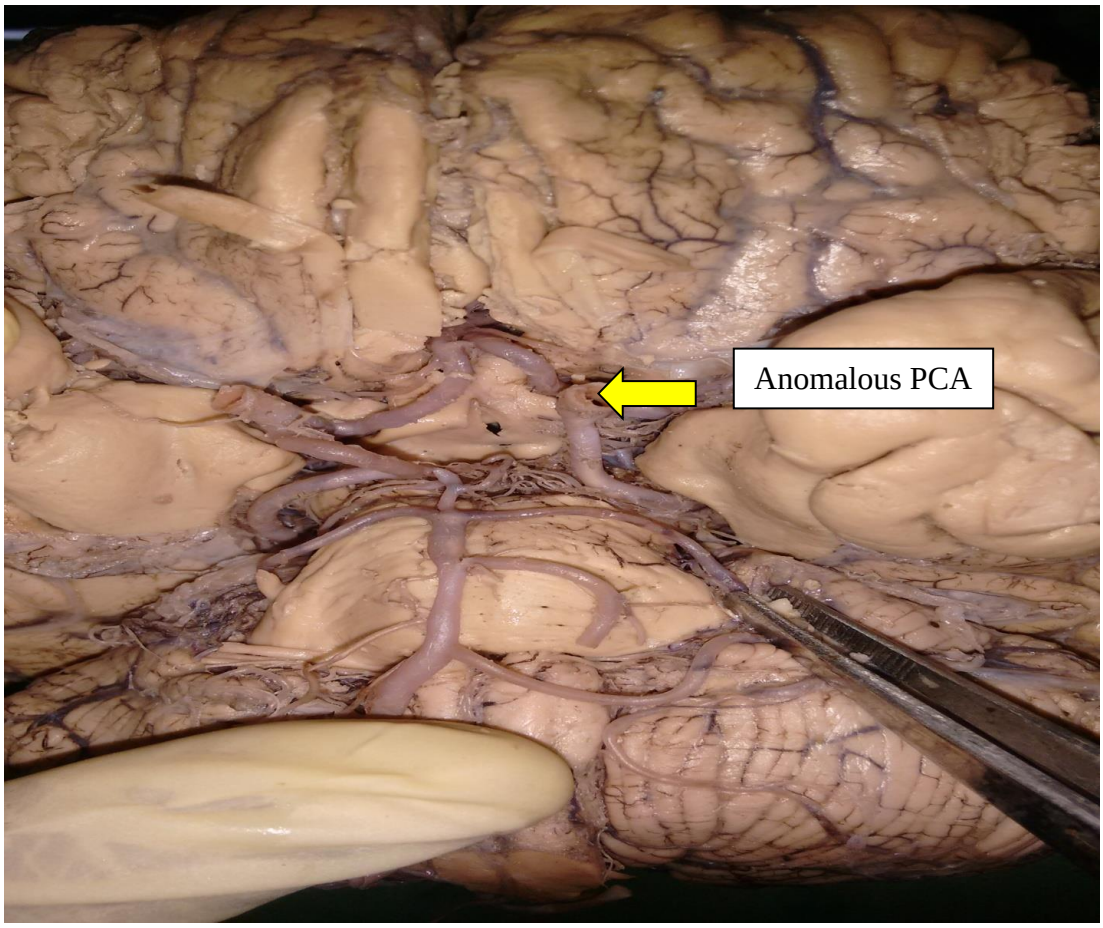

Fig 1: Anomalous origin of Posterior cerebral aretery

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DISCUSSION

The circle of willis and its branches are subjected to numerous variations. The variations not only differ from person to person but also on the side of the individuals. The role of arterial circle is to equalize the pressure and under normal condition, little interchange of blood takes place along the anastamotic channel due to equality of blood pressure. In case of occlusion, the arterial circle tends to equalize the pressure, thereby maintaining the circulation. The prevelance of the typical circle that is "normal text book type" polygon ranges from 5% to 72% (S.Iqbal). The incidence of embryonic origin of PCA from Internal Carotid artery is tabulated below.

Name of the author	Incidence of embryonic origin of PCA from ICA(%)
S.Iqbal	10%
Riggs & Rupp	22%
Alpers et al	15%
Milenkovic et al	21%

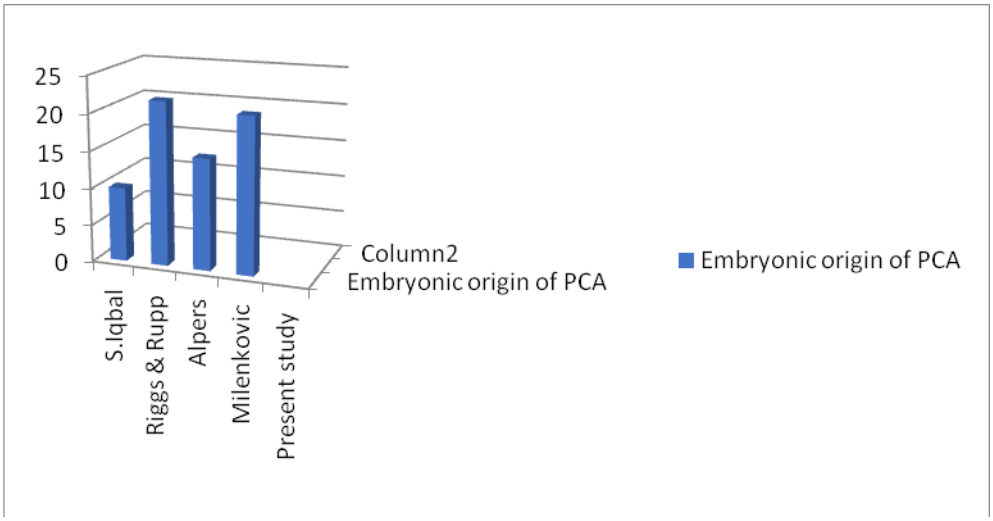

Table 1: Comparing the incidence of anomalous origin

In this study, one specimen showed fetal origin of Posterior cerebral artery from Internal Carotid artery.

CONCLUSION

Cerebrovascular diseases such as stroke, thromboemboli, aneurysms together with their signs and symptoms depend upon the variations of the anatomical pattern of the circle of willis. The main collateral blood flow is through the communicating arteries and obstruction of the collateral pathway determines the severity of hemodynamic impairment**.** (Yu-Ming Chuang). The state of circle becomes important in determining the adequacy of the brain circulation. Hence, anomalous origin of Posterior cerebral artery is an normal variant inorder to compensate for the lost posterior circulation.

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