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Research article

MICROSURGICAL ANALYSIS OF VARIATIONS OF THE POSTERIOR SEGMENT OF CIRCLE OF WILLS

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ABSTRACT: The microsurgical anatomy of the posterior circulation is very complex and variable .Surgical approaches to this area are considered risky due to the presence of the various important blood vessels and neural structures .Researches done so far proved that beginning ,course and result of the cerebral-vascular diseases depend immensely of the possibility to establish collateral blood circulation and first of all on so called tertian level that is actually the circle of wills .The circle of wills, thanks to communicating ,provide detour way to procure parts of the brain which ,due to insufficiency ,do not get enough quantity of blood. To document the microsurgical anatomy of the posterior circulation along with variations 30 cadaveric brain specimens studied. By analysis of series of anatomical dissections of the circle of wills we reached following results: complete posterior configuration of the circle of wills has been found in 26 (86.67%) brains. Out of variations hypoplastic p1 segment found in 2 (6.67%) brains, trifurcation of the basilar artery was found in one case (3.33%) and fenestration of the p1 segment was found in one specimen (3.33%) which is considered as one of the rare and unusual anatomical pattern. The existence of such "anomalies "can be explained by the embryological development of the region

Key words: Circle of willis, posterior cerebral artery, fenesteration, hypoplasia.

INTRODUCTION

The circle of wills, located at the base of the brain ,is a potential collateral pathway through which adequate distribution of cerebral blood flow can be maintained in case of impaired or decreased flow through one or more of its proximal feeding vessel[1].Posterior segment of circle of wills formed by the Posterior cerebral artery which is a terminal branch of the basilar artery formed at the upper pontine border where it join the posterior communicating artery to help complete circle of wills in human being[2]. Each posterior cerebral artery is subdivided anatomically into four segment i:e P1 toP4. P1 segment extends from its origin from basilar artery upto posterior communicating artery. P2 segment extends from its junction with posterior communicating artery to its major branch- the lateral posterior choroidal artery whereas P3 andP4 are distal segments of posterior cerebral artery [3]. Variations ranging from subtle to remarkable affect every part of the human body. Many authors at different times studied the anomalies of the posterior segment of circle of wills. A large number of authors have described the variability in percentages of hypoplasias of p1 segment in healthy subjects: 2.2%(Krishnamurthy et al) and 17%(Riggs and Rupp) [4,5] The Basilar artery which forms the spine of the posterior cerebral circulation and its various mode of termination –bifurcation, trifurcation, quadrifurcation can subject to abnormal flow patterns predisposing them to atherosclerosis and aneurysm[6,7]. Fenestrations of the cerebral arteries are uncommon, with a reported angiographic incidence of 0.03–1% [8,9] and a reported postmortem incidence ranging between 1.3%[10] to 5.3%[11]. Typical locations for cerebral arterial fenestrations include the anterior communicating artery, the vertebrobasilar system, and the anterior cerebral artery [12]. Aneurysms in association with fenestrations are even rarer, although those fenestrations are widely believed to predispose patients to aneurysm formation[13,9] .Frequency of occurrence of observed variations of posterior cerebral artery is extremely variable in the published litearature.The purpose of present study was to enlighten the important and rare variation.

MATERIALS AND METHODS

Thirty embalmed brains of adult human cadavers from Department of Anatomy, Government Medical College, Patiala comprised the material for the present study. Study was done over a period of three years (2006-2009). The whole formalin [10%] embalmed brains with intact meninges and blood vessels in place, were dissected. In each specimen, the area immediately anterior [rostral] to the terminal bifurcation of basilar artery was explored for the origin of posterior cerebral artery. The careful observation of the posterior communicating artery has required, because it may be hidden by the thickened arachnoid membrane.Each posterior cerebral artery numbered, photographed and observed for related variation.

RESULTS

Out of total 30 brains 26 show normal pattern of posterior cerebral artery .Anomalous origin of posterior cerebral artery was seen in two cases, In which the P1 segment of posterior cerebral artery was hypoplastic [Foetal type] i.e. size of P1 segment of posterior cerebral artery was smaller than the size of posterior communicating artery [Figure1]. In both specimens, P1 segment of posterior cerebral artery on right side was hypoplastic and major stem of posterior cerebral artery seemed to be arising from Internal Carotid Artery, whereas Basilar artery continued as posterior cerebral artery on left side. In one brain trifurcation of Basilar artery was noticed. One branch continued as common stem for PCA & SCA of right side and the origin of superior cerebeller artery was seen from P1 segment instead of directly arising from basilar artery. One branch was seen to be a direct continuation of basilar artery and it gave origin to left PCA and PCoA of left side was seen to be joining on the inferior aspect of PCA at its origin and one branch was the superior cerebeller artery of left side [Figure 2]. Unilateral Fenesteration of p1 segment of posterior cerebral artery was seen in one brain, where posterior cerebral artery on right side arises as duplicate origin and in further course join to form a single trunk [Figure 3].

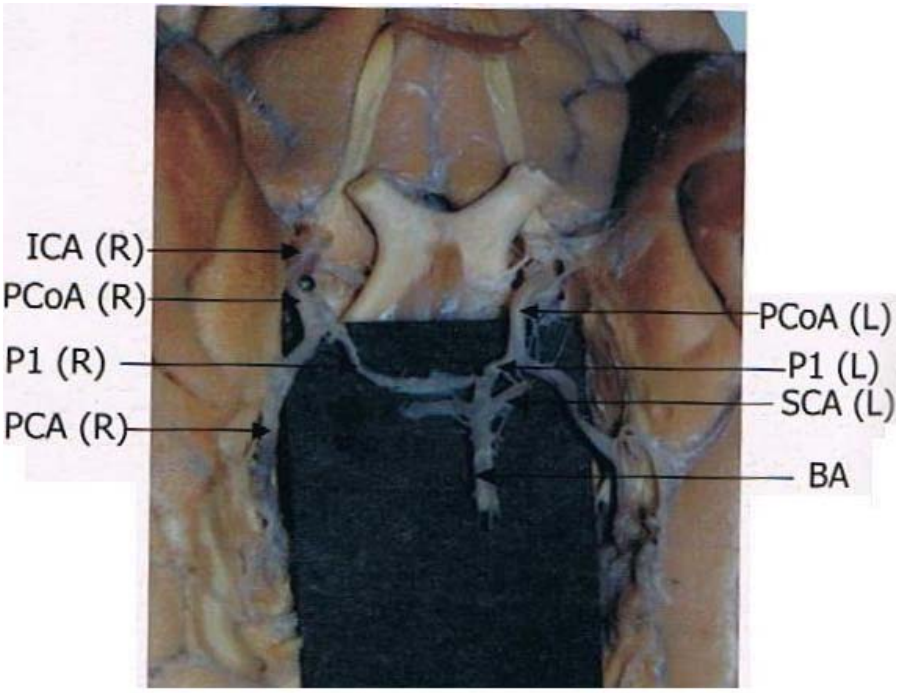

Fig 1: Hypoplastic P1 Segment of Posterior Cerebral Artery

P1 (R)	-	Hypoplastic Segment (Foetal Type)
PcoA(R)	-	Posterior Communicating Artery
ICA(R)	-	Internal Carotid Artery (Right)
BA	-	Basilar Artery
SCA(L)	-	Superior Cerebellar Artery(Left)
PCA	-	Posterior Cerebral Artery

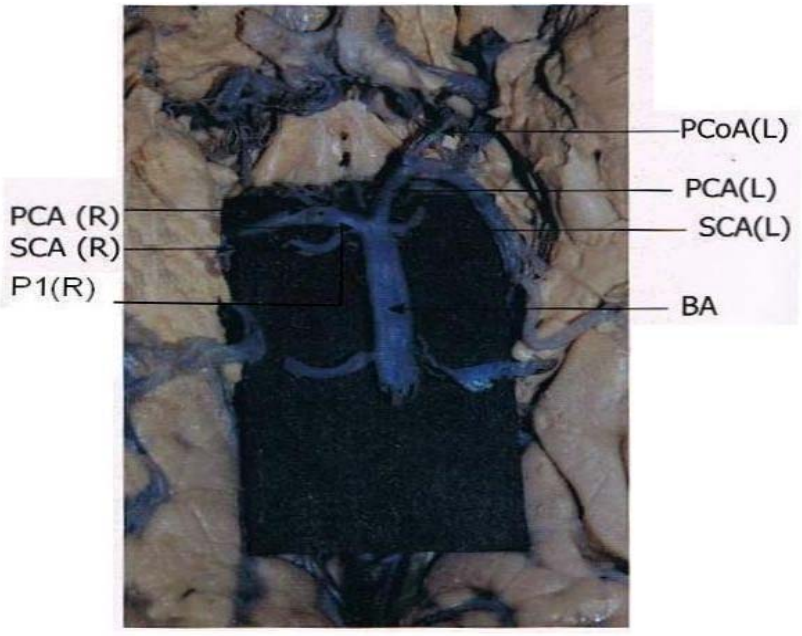

Fig 2 : Trifurcation of Basilar Artery

P1 (R)	-	Common Stem for PCA & SCA of right Side
PcoA	-	Posterior Communicating Artery
BA	-	Basilar Artery
SCA(L)	-	Superior Cerebellar Artery(Left)
PCA(L)	-	Posterior Cerebral Artery (Left)
SCA(R)	-	Superior Cerebellar Artery (Right)

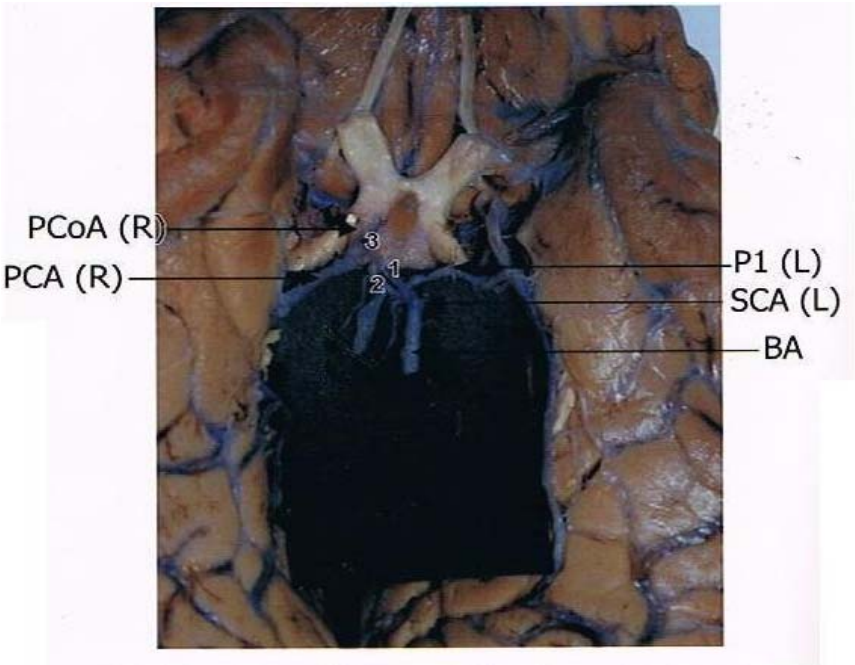

Fig 3: Fenesteration of P1 Segment of Posterior cerebral Artery

P1 Segment(R)	- 1 & 2 are Proximal part with duplicate origin , 3 distal part as a single trunk.
PcoA(R)	- Posterior Communicating Artery (Right)
BA	- Basilar Artery
SCA(L)	- Superior Cerebellar Artery(Left)
PCA	- Posterior Cerebral Artery

DISCUSSION

The present study was conducted on 30 embalmed brains of adult human cadavers obtained from Department of Anatomy, Government Medical College, Patiala. The study was undertaken to add to our knowledge concerning the degree of variability of the arterial supply of major area of cerebral cortex i.e., visual area that lies in occipital lobe of cerebral hemisphere. Collateral circulation in the brain is important for maintaining a sufficient level of cerebral blood flow in case of obstructive disease in the main afferent arteries. This arterial network consists of extracranial and intracranial routes. The intracranial collateral vessels comprise the so-called primary collaterals, consisting of the arterial segments of the circle of Willis, which are used in case of acute need (Raamt et al 2006).The knowledge of variations is essential for the brain and any change in its morphology may lead to the appearance and the severity of syndrome of vascular insufficiency in adults [14]. Besides normal configuration three types of variations in P1 segment of posterior cerebral artery (PCA) were noticed. One of the important variation was hypoplasia of P1 segment i.e., foetal type of P1 segment in both cases the hypoplasia was seen on right side. This type of variation can be explained on the embryological basis. At the 4- to 5.7-mm stage of the embryo (28-30 days), the ICA, which develops as a cranial extension of the paired dorsal aorta, is formed [15]. Paired longitudinal neural arteries appear along the hindbrain and coalesce to form the basilar artery at the 5- to 8-mm stage. The caudal divisions of the ICA anastomose with the neural arteries and become PCoAs. At the 40-mm stage (8 weeks) the PCAs are an extension of the PCoA. The vertebrobasilar system develops and thus participates in the supply of the PCA through the segment between the basilar artery and the postcommunicating part of the PCA, the P1 segment. In that phase, the component vessels of the circle of Willis all have the same caliber. In the remaining fetal period, the circle develops into one of three variants: an adult configuration, a transitional configuration or a fetal (embryonic) configuration [16]. In the adult configuration, the P1 segment has a larger diameter than the PCoA. In the transitional configuration, the PCoA and P1 have an equal diameter. Both the basilar artery and the ICA thus contribute equally to the PCA. The fetal or embryonic configuration is the variant in which the P1 is smaller than the PCoA and the ICAs are the main blood suppliers to the occipital lobes. It has been shown that these variations in morphology arise during fetal brain development [17]. In this period, the frequency of adult and fetal configurations increases, while the number of transitional configurations decreases.

Trifurcation of basilar artery was seen in one case. In present case right superior cerebellar artery originated from p1 segment of the posterior cerebral artery instead of basilar artery gives appearance of trifurcation of basilar artery. Accordingly, trifurcation observed in the present case of basilar artery thrombosis,embolic occulusion of the branches is most likely occur.. This type of variation had been reported earlier by McCullough (o.14%) and Caruso et al (1%) as a rare variation [18,19]. The existence of such variation can also be explained by the embryological development. Embryologically basilar artery is first represented by a plexus of vessels. Soon thereafter the paired longitudinal neural arteriesdevelops and anastomose into a single basilar artery. In our case, the basilar artery retained this primitive stage. It can also be developed by a cranial shift of the closely related Abducens nerve and caudal shift of the vessel brought about by the developing cerebellum [16].This variation has clinical importance in cerebellopontine angle and clivus surgery [20].

Fenestration or segmental duplication is a rare congenital anomaly noticed in one brain. A fenestration is a division of the arterial lumen, with resulting separate channels, each with its own endothelial layer and muscularis tunica; the adventitial layer may or may not be shared between channels. At the most, a fenestration results in multiplication, usually duplication, of the vessel. Duplications commonly involve the anterior communicating artery [21-24], where spiderlike connections have been demonstrated in as many as 19% of autopsy specimens [11]. The embryologic basis for segmental duplications of cerebral arteries is consistent with an incomplete or absent fusion between primitive neural arteries [16]. In addition to medial defects, flow phenomena at the proximal end of fenestrations, where hemodynamic stress and increased turbulence are present, may contribute to aneurysm formation [10].However, some have also suggested that the incidence of fenestration-related aneurysms is the same as that of berry aneurysms in the general population [9].

CONCLUSION

Knowledge of the presence and clinical relevance of normal variants such as fenestrations, duplications, and persistent fetal arteries plays a crucial role in the diagnosis and management of acute stroke and subarachnoid hemorrhage and may aid in surgical planning.

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