Original Article

Variations in the Origin and Contributions of Arteries supplying the Human Hippocampus: An Anatomical Study

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Summary:

Background:
Variations in the arterial supply in the human brain are not uncommon. Of particular interest is that of the hippocampus. Knowledge of the vascular anatomy is a key to the surgical treatment of pathologies in this region.

Objectives:
The aim of the work is a detailed description of the variations and contribution of the anterior choroidal artery and the branches of the posterior cerebral artery to the supply of the hippocampus and comparing the results with previous studies.

Materials and Methods:
Formalin-fixed brains from 15 adult cadavers (30 hemispheres) were examined using a magnifying lens. The hippocampus is identified, and the arteries that are in the vicinity to hippocampus were carefully dissected and studied.

Results:
The anterior choroidal artery (AchA), and the lateral posterior choroidal arteries (LPChAs) were present in 100% of the specimens examined. AChA anastomosed with the anterior branches of LPChA in 31% of specimens. The hippocampal artery, a brunch of the posterior cerebral artery, was present in 82.8% of specimen. The anterior and middle temporal arteries were present in 80% of hemispheres.

Conclusions:
ACA has the most constant origin, course and distribution. It supplied the rstra1 and middle portions of the hippocampus and in the absence of the hippocampal arterial branches of the posterior cerebral artery (PCA), AchA supplied the major portion of the hippocampus.

The branches, mainly from P-2A and P-2P segments, of the PCA supplied the middle and posterior portions of the hippocampus. Variations in their origin from different segments were noted. The major branches were: the LPChAs, the hippocampal arteu, the anterior and middle temporal arteries. The common temporal arterydid not contribute to the arterial supply of the hippocampus.

Key Words: Anatomical study, hippocampus-blood-supply.

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Introduction:

The mesiobasal limbic system is of particular significance in the surgical treatment of temporomedial tumours and epilepsy (1). This system consists of the uncus, amygdaloid body, the cornu ammonis, dentate gyrus, subiculum, fasciolar gyrus and the parahippocampal gyrus. Knowledge of the vascular anatomy is a key to the surgical treatment of pathologies in this region.

The term "hippocampus" is often restricted to the macroscopic swelling in the floor of the inferior horn of the lateral ventricle: it consists of complexly folded layer of dentate gyrus and the cornu ammonis, the latter being continuous through the subicular region with the parahippocampal cortex (2).

In this study the contributions of the vessels supplying the region are presented and compared with variation found in other studies.

Material and Methods

Formalin-fixed brains from 15 adult cadavers (30 hemispheres) were examined under x6 to x16 magnification using a magnifying lens.

The hippocampus is identified as it lies in the infero-medial margin of the temporal lobe. It is enrolled in the floor of the inferior horn of the lateral ventricle. The veins in the area were removed, and the contributions of the anterior choroidal (AChA) and the posterior cerebral arteries (PCA) that supply the hippocampus were studied.

Results

Both the anterior choroidal (AchA) and the branches of the posterior cerebral arteries (PCA) contribute to the supply of the hippocampus.

The anterior choroidal artery (AchA) was present in all the specimens examined (l00%), originating from the supraclenoid segment of the internal carotid artery (ICA). It ran medially beneath the optic tract, and lateral to the crus cerebri, and into the choroids fissure. It gave origin to 1-2 hippocampal branches that supplied the uncus, the hippocampus gyrus (comu ammonis) and the dentate gyms (Fig. l,2, 3).

Posterior cerebral artery (PCA):

Several different classifications have been used for the PCA (3,4). We followed the classification of the PCA by Zeal and Rhoton (5) which divided this artery into three segments from P- 1 to P-3.

The P-2 segment, which began at the posterior communicating artery and terminated at the posterior aspect of the midbrain, was further subdivided into an anterior and posterior half, and designated as P-2A and P-2P segments respectively.

The branches of the PCA include: the circumflex artery, the thalamogeniculate artery, the medial posterior choroidal artery (MPChA), the lateral posterior choroidal artery (LPChA), and cortical branches (Fig. 5, 6). In our study, however, we mainly examined vessels originating from P-2 & P-3 segments, that is, mainly those giving branches to the hippocampus.

The cortical branches of the PCA are divided into four segments: (a) inferior temporal artery, (b) parieto-occipital artery, (c) calcarine artery, and (d) splenial artery.

The inferior temporal arteries include: (a) hippocampal artery, (b) anterior, (c) middle, (d) posterior and (e)common temporal arteries (5) (Fig. 43).

In our study the PCA supplied the hippocampus by cortical branches that include the hippocampal artery, the anterior and middle temporal arteries, and the lateral posterior choroidal arteries (LPChAs).

The hippocampal artery, which supplies the uncus, the cornu ammonis, and the dentate gyrus, was present in 82.8% of specimens examined. This artery arose from the P-1 segment in 2.8%. in 48.6% from P-2A, in 20% from P-2P, in8.6% from P-3 (from the calcarine artery) and in 2.8% from the common temporal artery (Table 1, Fig. 4.5).

Anterior temporal artery was present in 80% of hemispheres. It arose from P-2A in 40% of specimens, P-2P in 37.2, and P-3 in 2.8% (Fig. 4,5,6). It supplies the hippocampus and the inferior surface of the temporal lobe.

Middle temporal artery was present in 80Y0 of hemispheres. It arose from P-2A in 25.7%, from P-2P in 45.7%, and from P-3 in 8.6% (Fig. 4.5).

The posterior temporal artery (Fig.5) supplied the inferior temporal and occipital surface, including the occipital pole and lingual gyrus. It did not supply the hippocampus. It was present in 77.1 % of hemispheres. It originated from P-2A segment in 2.8% of specimens, from P-2P in 17%, from P-3 in 54%, and from the calcarine artery in 2.8%. The common temporal artery was present in only 16% of the specimens. It arose from P-2P segment in 14.3%, and from P-3 in 5.7%. It supplied the inferior surface of the temporo-occipital lobes with no obvious contribution to the arterial supply of the hippocampus.

Lateral posterior choroidal arteries (LPChAs)

The PCA gave origin to 2-4 Lateral posterior choroidal arteries (LPChAs) in one hemisphere (average 3) (Fig. 2, 4), with no difference in number being observed between right and left LPChAs.

There were two LPCMs in 43%, three in 40%, four in 17%. When more than one LPChA were present, they were divided into two branches, that is, anterior and posterior (Fig. 3) (4). The posterior branches arose from P-2P, P-3, or their cortical branches, and coursed posteriorly around the pulvinar, supplying the choroids plexus of the trigone of the lateral ventricle.

LPChAs arose from the P-2P segment in 44.8%, from the P-2A in 19.5%, from the P-3 in 9.2%, and from the cortical branches of PCA in 26.5%. The anterior branches of LPChAs arose from P-2A or its cortical branches coursed laterally to enter the choroid fissure, and supplied the choroid plexus of the temporal lobe.

In our study, the anterior branches of LPChA anastomosed with AChA in 31% of the specimens (Fig. 2). There were no obvious relationship between the size of the anterior choroidal and the LPChAs arteries except in 6% of the LPChAs which were definitely smaller than the AchA (Fig. 1). Along its course, the LPChA supplied the crus, commissure, body and part of the anterior columns of the fomix, the dorsomedial thalarnic nucleus, pulvinar, and the lateral geniculate body (6). The contributions of the arteries that supply the hippocampus are summarized in Table 1.

Table 1: Arterial Supply of the Hippocampus in 30 Hemispheres

Arteries	**Branches Present (% of hemispheres)**	**Site of origin (% of hemispheres)**					**No. branches pesent per hemisphere**
AchA	100.0	Supraclenoid segment of ICA					1-2
Branches from PCA		P-1	P-2A	P-2P	P-3	Cortical Branches	
***HiA**	82.2	2.8	48.6	20.0	8.6	2.8	1
***ATA**	80.0	0.0	40.0	37.2	2.8		1
***MTA**	80.0	0.0	25.7	45.7	8.6		1
***PTA**	77.1	0.0	2.8	17.2	54.3	2.8	1
***CTA**	16.0	0.0	0.0	14.3	5.7	0.0	1
LPChA	100.0		19.5	44.8	9.2	26.5	2-4

AchA, anterior choroidal artery; **HiA**, hippocampal artery, **ATA**,anterior temporal artery; **MTA**, middle temporal artery; **PTA**, posterior temporal artery; **CTA**, common temporal artery. Neither PTA nor CTA contributed to the supply of hippocampus; **LPCHA**, lateral posterior choroidal artery, **PCA**, posterior cerebral arteiy.

* **denotes cortical branches of posterior cerebral artery**

Discussion

It is apparent from this study that 1-2 hippocampal branches of the AchA (anterior choroidal artery) supplies mainly the proximal (rostral) and middle portions of the hippocampus, whereas branches from P-2A and P-2P segments of PCA supply mainly the middle and distal (caudal) regions of the hippocampus. The results confirm previous observations (7, *8)*, but differed somewhat in the variations made by the branches of PCA.

There were variations in the contribution of these two sets of branches to the arterial vascularization of the hippocampus. In our study, the distribution of the AChA varied with that of the hippocampal cortical branches of PCA: in the absence the latter, the AChA supplied the major part of the hippocampus (Fig. 6). This is in accordance with the previous study by Erdem *et* al (9). The hippocampal branches of PCA were present in 82.2% of specimens examined, as compared to 64% reported by Zeal and Rhoton *(5).*

The anterior branches from LPChA usually arose from P-2A or its cortical branches. In our study, the anterior branches of the LPChA anastomosed with the AchA (Fig. 2) in 3 1% of specimens.

According to Carpenter, et al., anastomoses were found between AchA and LPChA in 93%. A numerous inter-territorial anastomosis between these vessels was found inside the temporomesial region that a selective presurgical Wada test is needed to evaluate its functions (10, 11).

Although it has been reported that the size of the LPChA was usually inversely proportional to the size of AchA (3,6, 12), in our study there was no obvious relationship between the size of these two arteries.

According to Marinkovic el al.(l3) there are two to seven hippocampal arteries, arranged in three sets: (a) the anterior hippocampal arteries originated from AchA, from the ATA, and from the main trunk of PCA; (b) the middle hippocampal arteries, originated from the common temporal artery and the main trunk of PCA; (c) the posterior hippocampal arteries arose from the main trunk of PCA and the splenial artery. In our study the common temporal and the posterior temporal arteries did not contribute to the arterial supply of the hippocampus.

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