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Original Article

Anatomy Section

Cadaveric and Radiological Evaluation of Artery of Percheron: A Cross-sectional Study

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ABSTRACT

Introduction: The Artery of Percheron (AOP) is a thalamoperforating arterial trunk that provides blood supply to the paramedian thalami and the rostral midbrain. Occlusion of the AOP results in atypical ischaemia.

Aim: To determine the morphology of the AOP and identify the type of AOP in cadaveric and radiological studies.

Materials and Methods: The present cross-sectional study was conducted on 60 standard embalmed and formalin-preserved adult cadaveric brains obtained from the Department of Anatomy, Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India from October 2023 to April 2024. The brain was dissected to identify the AOP, and its type was determined. Origin and course of the vessel were observed, and measurements were made from the point of its origin to its termination. In addition, the radiological study was done on 60 patients who were referred for Magnetic Resonance Angiography (MRA) to determine the circle of Willis, identify and categorise the type of AOP. Descriptive statistics were used to express categorical variables as frequencies and percentages continuous data was expressed as mean±standard deviation.

Results: In the cadaveric study, out of 60 specimens, the AOP was seen in 21 specimens (35%), and the mean distance was 3.5±0.3 mm from the point of origin to its termination. Out of four types, Type I was observed in 12 cadavers (57.14%), Type IIA in 5 (23.81%), Type II B in 4 (19.04%), and Type III was not seen in any cadavers. However, in the radiological study, out of 60 cases, MRA imaging has shown the presence of the AOP in 14 patients (23.33%). Type I bilateral was observed in 9 (64.28%) and Type II B in 5 (35.71%), whereas Type IIA and Type III were not observed in any of the patients.

Conclusion: Occlusion of the AOP results in a unique ischaemic pattern, typically affecting the bilateral paramedian thalami, with or without involvement of the midbrain. Because this condition is infrequently documented, cadaveric and radiologic studies are essential for increasing awareness and understanding of this anatomical variant.

Keywords: Stroke, Thalamic infarct, Thalamic vasculature, Thalamus

INTRODUCTION

The AOP is a thalamoperforating arterial trunk, provides blood supply to the paramedian thalami and rostral midbrain. [1]. The thalamoperforating arteries usually arise from the superior surface of the P1 and P2 segments of the posterior cerebral artery and rarely from the posterior communicating artery [2]. Posterior cerebral artery is a terminal branch of the basilar artery. Posterior cerebral artery has cortical and central branches; central branches supply subcortical structures by piercing the posterior perforated substance [3]. Sub-cortical structures are the anterior thalamus, sub-thalamus, and globus pallidus [4]. The thalamus acts as a relay station for all sensory and motor functions and also plays a crucial role in regulating sleep, alertness, and consciousness [5]. Blood supply to the thalamus is classified into four categories: anterior, paramedian, inferolateral, and posterior. Paramedian area of thalamus receives its blood supply from the thalamoperforating arteries, which arise from the P1 segment of the posterior cerebral artery [6].

Occlusion of AOP results in a characteristic pattern of ischaemia: bilateral paramedian thalamus with or without midbrain involvement [4]. AOP infarcts are often missed on initial Computed Tomography (CT) scan in stroke patients, due to diverse clinical features. The exact prevalence of AOP remains unknown, however, study shows that it can be present in 7 to 11.7% of subjects [7]. This rare anatomical variant can lead to ischaemic stroke if compromised, affecting cognitive and sensory functions. Knowledge of this artery is essential for accurate diagnosis and effective management of related neurological conditions. With this background, the present study was done to identify the type of artery of the percheron in cadaveric and radiological studies.

MATERIALS AND METHODS

The present cross-sectional study was conducted on 60 well-embalmed, formalin-preserved adult cadaveric brains obtained from the Department of Anatomy, Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India, from October 2023 to April 2024. The radiological study was done on 60 patients who were referred for MRA to the Department of Radiodiagnosis from October 2023 to April 2024 at Rajarajeswari Medical College and Hospital. Informed consent had been taken. Ethical clearance has been taken from the Institution (IEC- 234/2023).

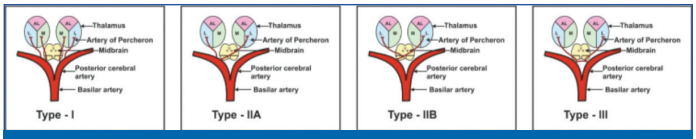
Inclusion criteria: Cadavers of age group 30-70 years, irrespective of gender, were included in the cadaveric study. All patients undergoing MRA in Rajarajeshwari Medical College and Hospital, regardless of age and gender, were included in the radiological study.

Exclusion criteria: Cadavers with major congenital anomalies or those damaged during dissection were excluded from the study. Patients whose MRA showed neoplastic, infectious, or inflammatory aetiology were excluded.

Study Procedure

Cadeveric study: Brain was dissected to identify the AOP, and its type (Classification by Percheron) was determined [1]. AOP is an anatomic variant of paramedian artery and arises from the posterior cerebral artery. There are four major variants in paramedian artery, first described in 1973 by Gerard Percheron, a French medical scientist [1].

The AOP arises from the posterior cerebral artery. There are four types as depicted in [Table/Fig-1]. Type I: Characterised by paramedian arteries originating bilaterally from their corresponding P1 segment;



[Table/Fig-1]: Anatomy demonstrating thalamic and midbrain perforating arteries. Four anatomical types of Artery of Percheron (AOP).
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Type IIA: has both paramedian arteries originating from either the left or right P1 artery; Type IIB: Originates from P1 unilaterally and then bifurcates to supply bilateral paramedian thalamus and rostral midbrain; Type III: characterised by an arterial arcade connecting the left and right P1 segments and giving rise to paramedian arteries.

Origin and course of the vessel were observed, and measurements were made from the point of its origin of AOP to its termination in the base of brain using slide calipers. This radiological study was done on 60 patients who were referred for MRA to the Department of Radiodiagnosis from October 2023 to April 2024 at Rajarajeswari Medical College and Hospital. Informed consent had been taken.

Radiological study: For evaluation of the circle of Willis, images were obtained in three slabs each containing 40 slides with 3-dimensional time-of-flight MRA technique (TR: 25 ms, TE:7 ms, number of acquisitions: 2; flip angle: 20"; 0.7 mm slice thickness; matrix size: 242°256, FOV: 180*180 mm). MRA images were automatically reconstructed in the maximum intensity projection algorithm and AOP was identified and categorised.

STATISTICAL ANALYSIS

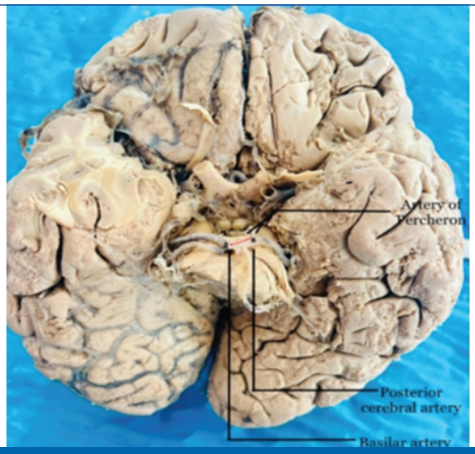
Data was analysed using licensed version of Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics was used to express categorical variables as frequency and percentages, continuous data was expressed as mean± standard deviation.

RESULTS

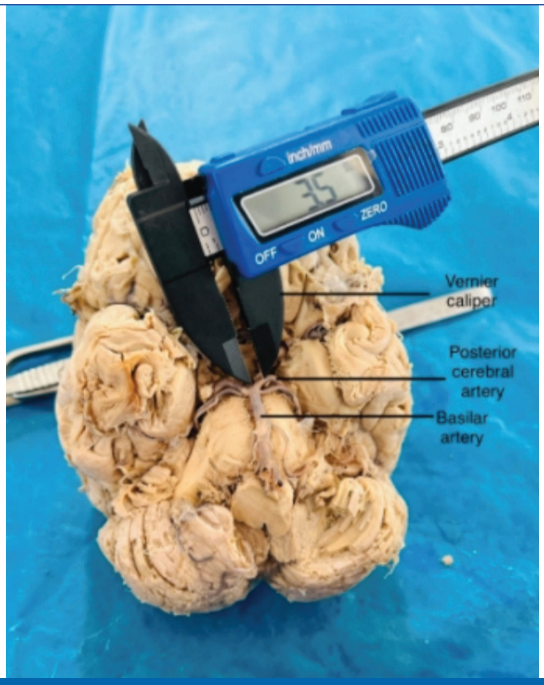
In cadaveric study, out of 60 specimens, AOP was seen in 21 specimens (35%) as tabulated in [Table/Fig-2]. Mean distance was 3.5±0.3mm from the point of origin to its termination [Table/Fig-3,4]. Percentage of Type I was observed in 12 cadavers (57.14%) as shown in [Table/Fig-5], Type IIA in 5 (23.81%) [Table/Fig-6], Type IIB in 4 (19.04%) and Type III was not seen in any cadavers.

Type of AOP	Cadaveric (n=60)	Percentage (%)	Radiographic (n=60)	Percentage (%)
Type I	12	57.14	9	64.28
Type IIA	5	23.81	Nil	Nil
Type IIB	4	19.04	5	35.71
Type III	Nil	Nil	Nil	Nil
Total	21	35	14	23.33

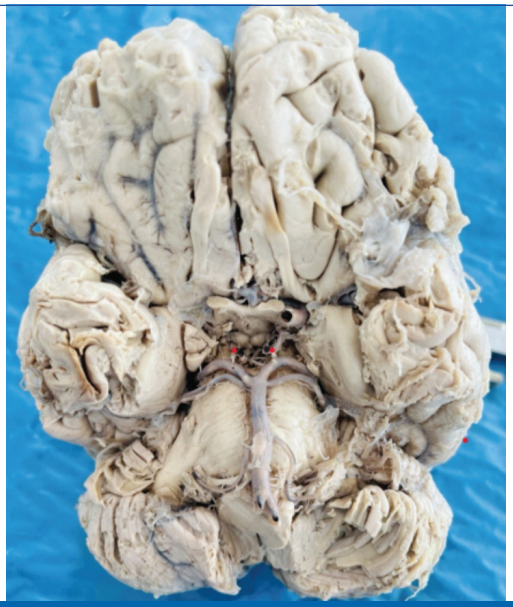
[Table/Fig-2]: Incidence and Types of Artery of Percheron (AOP).



[Table/Fig-3]: A: basilar artery dividing into 2 posterior cerebral arteries; B: point of origin of AOP; A-B: is the measurement from point of origin of posterior cerebral artery to the origin of AOP.



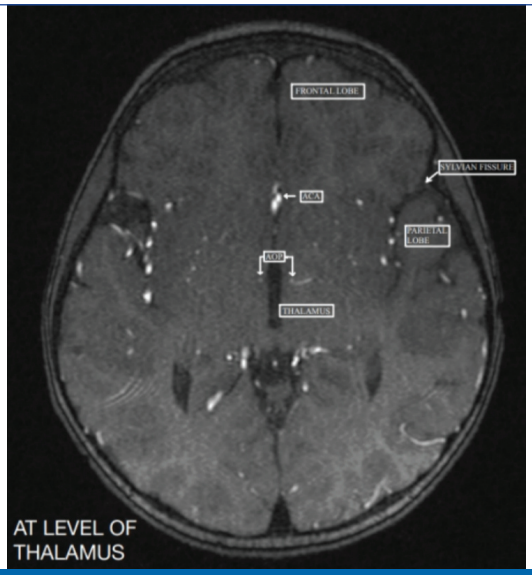
[Table/Fig-4]: Measurement taken using slide calipers.



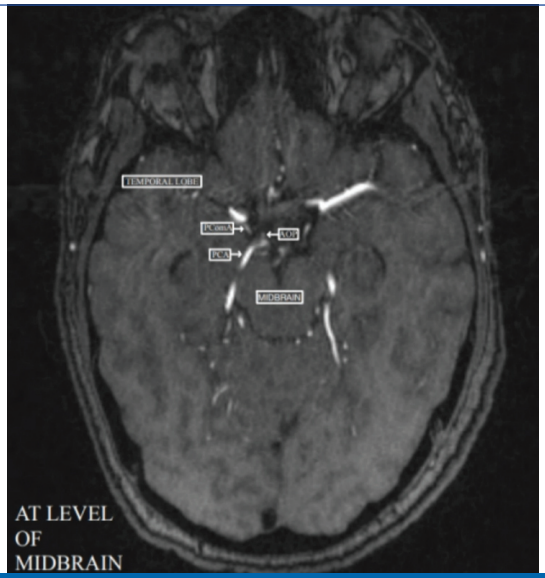
[Table/Fig-5]: Red dot indicates Type I AOP.

[Table/Fig-6]: Red dot indicates Type IIA AOP.

In the radiological study, out of 60 cases of cerebrovascular aetiology, MRA imaging has shown the presence of the AOP in 14 patients (23.33%). Type I bilateral seen in 9 (64.28%) [Table/Fig-7] and Type II B in 5 (35.71%) [Table/Fig-8], whereas Type IIA and Type III were not seen in any of the patients.



[Table/Fig-7]: Radiographic image showing Type I AOP.



[Table/Fig-8]: Radiographic image showing Type IIB Artery of Percheron (AOP).

DISCUSSION

The present study is similar to the cadaveric study by Kocaeli H et al., which was done on 34 formalin-fixed cadaveric brains in which Type I was seen in 55.8%, Type IIA was seen in 11.7%, Type IIB was observed in 20.5%, and Type III was seen in 11.7% [2]. The mean distance of the artery was 1.87 mm from the basilar apex and entered through the posterior perforated substance.

The present results align with those reported in previous studies, as seen in the study done by Lazzaro NA et al [4], Type I AOP was observed in 25 out of 37 patients who underwent radioimaging [Table/Fig-9] [2,4]. In contrast to CT imaging, Magnetic Resonance Imaging (MRI) is usually diagnostic. In a retrospective study of 18 cases of AOP stroke, using Magnetic Resonance Imaging (MRI), 100% of cases were detected, unlike Computed Tomography (CT) scan, in which only 50% were detected [5].

Infarction of the thalamus results in diverse clinical manifestations, while ischaemic strokes in common locations like the middle cerebral artery typically lead to predictable focal deficits and syndromes. AOP infarcts, however, present with varied symptoms, including altered mental status, coma, transient loss of consciousness, memory impairment, psychosis, aphasia, dysarthria, and oculomotor dysfunction [8-12].

Brain removal and microdissection were performed on twenty-five latex-injected adult cadaveric heads, with particular focus on identifying the AOP. When the AOP was identified, measurements were taken, and observations were made regarding its origin and course. AOP was observed in 3 specimens (12%), occurring on the right side in 2 specimens and on the left side in 1 specimen (1 male and 2 female specimens). AOP typically originate about 8 mm lateral to the basilar artery bifurcation, with an average diameter of 2.1 mm and a mean length of 1.5 cm from its origin to its point of entry into the brain [13].

Due to the limited resolution of imaging modalities to detect AOP infarct, few patients experiencing this type of stroke may not receive a timely diagnosis during the initial hours. The patient's nonspecific symptoms and absence of abnormalities in the brain CT scan, consequently, lead to a delay in both diagnosis and subsequent treatment [7]. Typical clinical features of AOP infarct are unconsciousness and delayed recovery despite all the critical and intensive measures, with or without cranial nerve involvement. MRI with diffusion-weighted imaging is the investigation of choice and shows bilateral thalamus with paramedian midbrain infarct [4]. Though the AOP is rare, but is a significant cause of stroke. Hence, early diagnosis and timely intervention are essential for positive patient outcomes. Further studies can be done on biomarkers for the early detection of AOP infarction.

Limitation(s)

The sample size is small, and findings cannot be generalised. The preparation, preservation, and storage of cadavers might not be available in all medical colleges.

CONCLUSION(S)

Clinical presentation of AOP infarction is varied and often non-specific, leading to potential delays in diagnosis. However, timely recognition is critical, as prompt treatment can substantially reduce morbidity. Since this condition is infrequently documented, cadaveric and radiologic studies are essential for increasing awareness and understanding of this anatomical variant.

Acknowledgement

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Author	Year published	Radiographic study/ Cadaveric study	Type I (%)	Type IIA (%)	Type IIB (%)	Type III (%)	No. of cases/specimens
Kocaeli H et al., [2]	2012	Cadaveric study	55.8	11.7	20.5	11.7	34
Lazzaro NA et al., [4]	2009	Radiological study	43	38	14	5	37
Our study	2024	Cadaveric study	57	23	19	Nil	60
		Radiologic study	64	Nil	36	Nil	60

[Table/Fig-9]: Incidence of Artery of Percheron (AOP) done by various authors [2,4].

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