



A MORPHOLOGICAL STUDY OF CALCARINE SULCUS IN ADULT HUMAN BRAIN

Anatomy

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ABSTRACT

Introduction: Description of visual cortex and its blood supply requires a proper orientation of the calcarine sulcus.

Aim of the study: To study morphology of calcarine sulcus and compare the inter-individual and interhemispheric differences.

Materials and methods: The study was performed on 50 right and 50 left sided hemispheres of formalin fixed cadaveric brains which were collected from unclaimed and donated human cadavers from the Department of Anatomy and Forensic Medicine of Gauhati Medical College. All the specimens were photographed and data were recorded.

Results: Significant variations were found between right and left hemispheres in case of termination and length of the calcarine sulcus.

Conclusion: In cases where the Calcarine sulcus is found to terminate before reaching occipital pole macular sparing may not be possible.

KEYWORDS

Calcarine sulcus, Visual cortex, Cuneolingual gyrus.

Introduction:

Presence of calcar avis in variety of primates along with human brain was demonstrated by T. H. Huxley. In the course of his study of brain of spider monkey, he provided the first accurate description of calcarine sulcus. This sulcus produced the ridge "calcar avis" in the medial wall of occipital horn of the lateral ventricle hence Huxley termed it calcarine sulcus.¹

The parieto-occipital sulcus divides the calcarine sulcus in to anterior and posterior division. Anterior part of the calcarine sulcus is described as complete sulcus as it creates the calcar avis. The posterior part of the sulcus is considered an axial sulcus, as its axis runs along the visual cortex.² The peripheral parts of the retinae activate the most anterior parts in the visual cortex. The macular information is received by a disproportionately large posterior part around the posterior aspect of calcarine sulcus.³ At the level of the occipital pole, the calcarine sulcus usually branches in a T or Y shape. This branching is called the retrocalcarine sulcus.⁴

The aim of the present study was to identify variations of calcarine sulcus which may affect not only the area of visual cortex but also the arterial supply in visual cortex thus affecting the outcome of infarction or other pathologies in the posterior cerebral artery.

Material and Methods:

50 brain specimens obtained from unclaimed and donated bodies which were officially received by Head of the Department of Anatomy, Gauhati Medical College and also obtained from the unclaimed bodies in the Department of Forensic Medicine, Gauhati Medical College, Guwahati after fulfilment of all the official formalities from cases where autopsies were done within 6 hours following death.

Brains of adult human of both the sexes were included in the study. Those brains that exhibited any post mortem manipulation, obvious pathological changes and decomposition were excluded.

After collection, the brains were properly washed with normal saline and then fixed in 10% formalin solution and preserved. The cerebral hemispheres were separated by a midline sagittal section. The leptomeninges and blood vessels were carefully removed from the surfaces of occipital lobe. The calcarine sulcus was identified in each hemisphere according to standard anatomical criteria. Then the sulci were studied on the basis of following criteria:

1. Presence or absence of the sulci
2. Point of emergence of the sulci
3. Ramification or divisions of the sulci if any
4. Point of termination of the sulci
5. Lengths of the sulci

The length of the calcarine sulcus was taken with the help of thread and measuring scale. To measure the length of calcarine sulcus a thread is placed along the course of the sulcus to be measured from the point of emergence to the point of termination. Then the distance between the two points in the thread was measured with the help of a measuring scale. The measurements were taken in millimetres. Microsoft excel software was utilized to analyze the data obtained.

Result:

Presence, point of emergence and divisions:

Calcarine sulcus was found in all the 100 hemispheres, both right and left sided. In all the specimens (100%), the calcarine sulcus was found to emerge anteriorly underneath the splenium of the corpus callosum. Parieto-occipital sulcus was found to be arising from calcarine sulcus in all the 100 hemispheres thus dividing the sulcus into anterior and posterior division.

Point of termination of the sulcus:

In cases of point of termination of the calcarine sulcus, significant variations were found in between right and left sides.

Table-1 Showing variation in level of termination of calcarine sulcus.

Parameters	No. right hemispheres	No. of left hemispheres	Total no. of hemispheres	Percentage (%)
Termination before reaching occipital pole	10	4	14	14%
Termination after reaching occipital pole	15	16	31	31%
Termination after reaching superolateral surface	25	30	55	55%

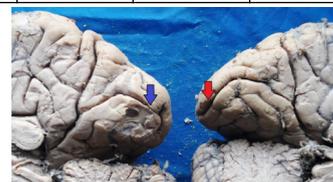


Figure-1: Photograph showing difference of calcarine sulcus termination in the hemispheres of same brain. Right hemisphere with calcarine sulcus not reaching occipital pole (blue arrow) and left hemisphere with calcarine sulcus reaching occipital pole (red arrow).

In the cases of termination of calcarine sulci before reaching the occipital poles and termination after reaching superolateral surface, the variations between right and left hemispheres differed significantly. As in these two cases 'p' values are found to be .013 and .024. In cases of termination of calcarine sulci after reaching the occipital poles, the variation between right and left hemispheres was found to be non-significant.

Ramification at the end:

In the present study 55 (55%) cases showed the calcarine sulci with ramification at the end. 45 (45%) cases did not show any ramification at the end. Ramifications were of T or Y shape. These ramifications are also called retrocalcarine sulcus. Interhemispheric difference of calcarine sulcus ramification in the same brain is shown in the table-2

Table-2: Showing interhemispheric difference of calcarine sulcus ramification in the same brain.

Parameters	No. of brains	Percentage (%)
Presence of CS with ramification in both hemispheres	23	46%
Presence of CS with ramification in one hemisphere	9	18%
Presence of CS without ramification in both hemispheres	18	36%

However the difference between right and left in the case of ramification of calcarine sulcus at the end is non-significant as the "p" value was found to be 0.083.



Figure-II: Photograph showing difference in ramification of calcarine sulcus in the hemispheres of same brain. Right hemisphere with bifurcation (blue arrow) and left hemisphere without ramification (red arrow).

Presence of cuneolingual gyrus:

In the present study 12 hemispheres (12%) from both right and left sides were found to have cuneolingual gyrus. Thus the middle part of the calcarine sulcus was separated from the posterior part by the small bridge like cuneolingual gyrus which connected the cuneus and lingual gyrus. The difference between right and left hemispheres in this case was non-significant as "p" value was found to be .159.

Difference of cuneolingual gyrus presence in the same brain is shown in table-3.

Table-3: Showing interhemispheric difference of cuneolingual gyrus presence in the same brain.

Parameters	No. of brains	Percentage (%)
Presence in both hemispheres	5	10%
Presence in one hemisphere	2	4%
Absence in both hemispheres	43	86%



Figure-III: Photograph showing cuneolingual gyri (red arrows) in both hemispheres of the same brain.

Length of calcarine sulcus :

The mean lengths of calcarine sulcus in the right and left sided hemispheres were found to be 100.24 mm and 103.12 mm respectively. It was found that the difference of length in right and left hemispheres is highly significant as "p" value was found to be .000 (p<0.01).

Discussion:

Extent of calcarine sulcus posteriorly may be related to the outcome of occlusion of the posterior cerebral artery. In 41st edition of Grays Anatomy-The Anatomical Basis of Clinical Practice, it is described "When the posterior cerebral artery is occluded, a phenomenon known as 'macular sparing' may occur, in which vision with the central part of the retina is preserved. Collateral circulation of blood from branches of the middle cerebral artery into those of the posterior cerebral artery may account for this phenomenon."³ According to Swayam Jothi. S. *et al.* when the calcarine sulcus fails to reach the occipital pole it is the macular area that will suffer not only by the size of the area of representation but also because of lack of dual blood supply.⁵ Thus in this case macular sparing is doubtful.

In present study 14 hemispheres (14%) showed calcarine sulcus not reaching occipital pole and difference between right and left side hemispheres was found to be significant.

Ananth C.⁶ found in his study that in 73 out of 99 hemispheres, calcarine sulcus terminated at occipital pole. Alves R.V. *et al*⁷ identified calcarine sulcus extending along superolateral surface in 8 specimens (40%) out of 20 hemispheres. Swayam Jothi S. *et al.*⁵ found in their study that in 8 hemispheres (24.1%) out of 33 hemispheres calcarine sulcus did not reach the occipital pole. 6 of these hemispheres were of right side and 2 hemispheres were of left side.

Table-4 Shows different studies on calcarine sulcus ramification at the end.

Studies	Hemispheres studied	No. of hemispheres with CS ramification at the end (%)
Malikovic A. <i>et al.</i> (2011)	30	24 (79.9%)
Mandal L. <i>et al.</i> (2014)	106	63 (59.43%)
Present study	100	55 (55%)

Malikovic A. *et al.*⁸ in their study described that posterior part of calcarine sulcus was separated from the middle part by small bridge like cuneolingual gyrus in 4 hemispheres i.e. in 13.3% of cases out of 30 hemispheres studied. In the present study, the percentage is 12% (i.e. 12 hemispheres). Out of these hemispheres, 7 were of right side and 5 were of left side.

Malikovic A. *et al.* (2011) also found significant difference between lengths of calcarine sulcus in right and left hemispheres like that of present study.

Table -5: Showing comparison between studies describing the length of calcarine sulcus.

Studies	Mean distance	
	Right side	Left side
Malikovic A. <i>et al.</i> (2011)	99.7 mm	109.5 mm
Present study	100.24 mm	103.12 mm

Conclusion:

The study revealed wide variability of the calcarine sulci not only among two different brains but also between two hemispheres of the same brain. Significant differences found in case of length and point of termination of calcarine sulcus in this study along with other similar studies. These variations should be established radiologically too. Knowledge of significant or non-significant variations present in calcarine sulcus will help neurosurgeons to properly interpret the lesions occurring in the occipital lobe due to CVA or any other pathology.

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