

ORIGINAL ARTICLE

MEASURING AND COMPARING CORTICAL SURFACE AREA OF PARACENTRAL LOBULE IN A TERTIARY CARE HOSPITAL, BANGLADESH

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Abstract

Background: The paracentral lobule is the area on medial surface of the cerebral cortex which extends from precentral sulcus to postcentral sulcus. Any trauma, tumor, or cerebral ischemia cause lesions of motor and sensory cortex of paracentral lobule. The result of this study is very important to the radiologists and neurosurgeons for diagnosis of above mentioned diseases and the practice of safe neurosurgery. This study was carried out to observe the cortical surface area of paracentral lobule in adult male and female Bangladeshi population, may help for future research. **Methods:** This cross-sectional study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, during the period of January 2017 to December 2017. Total 70 adult Bangladeshi male & female people were selected, among them 35 male and 35 female, age ranging from 20-65 years. CT scan image of brain in mid sagittal view was used for this study. Data were analyzed by Unpaired Student's 't' tests. **Results:** The surface area of motor cortex of right and left paracentral lobule was significantly higher ($p < 0.01$) in male. Surface area of sensory cortex of both paracentral lobule was significantly higher ($p < 0.05$) in male than female. **Conclusion:** The present study reveals significant difference in morphological measurements of right and left paracentral lobule between male and female of adult Bangladeshi population.

Key words: Paracentral lobule, motor cortex, sensory cortex, morphometric measurement.

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Introduction

The paracentral lobule is located on the medial surface of cerebral hemisphere.¹ This specific area of cerebral cortex are concerned with specific parts of the body with specific types of input and activities.² This lobule extends from precentral sulcus to

postcentral sulcus on superomedial border. On the medial surface of cerebral hemisphere, the paracentral lobule is bounded anteriorly by the paracentral sulcus, an ascending branch of the cingulate sulcus which is anterior to precentral sulcus. Posteriorly it is bounded by the pars

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marginalis, which is the ascending termination of the cingulate sulcus, inferiorly by the cingulate sulcus.^{3,4} Its superior boundary corresponds to the superior margin of the hemisphere. The paracentral sulcus which is anterior to the precentral sulcus containing the supplementary motor area did not consider as a potential anterior boundary of the paracentral lobule.⁴ In case of segmented cingulate sulcus there is a short transitional lobulo-limbic gyrus, which may complicate definition of the paracentral lobule boundaries.⁵

By the indentation of central sulcus, this lobule is divided into anterior and posterior parts.⁶ The anterior part is continuous with the precentral gyrus and posterior part is continuous with the postcentral gyrus.⁷ The anterior part contain primary motor area representing the muscles of leg and foot⁴ and the perineal region of the opposite side. It is responsible for voluntary control of defecation and micturition.⁶ The posterior part contains the primary somatosensory area, representing the leg and foot⁽⁷⁾. Ischemia and infarction occurs in cerebrovascular disease which causes lesions of motor cortex and produce contralateral lower limb weakness or paralysis and urinary incontinence.^{8,1} This area may be a primary site for tumors and focal seizures making its surgical access of great importance for neurosurgery.³ Thickness of cortex (gray matter volume) of paracentral lobule decreases with age and also in many diseases such as in Alzheimer's disease,⁹ chronic Schizophrenia, and multiple sclerosis.¹⁰

Due to advances in the endoscopic neurosurgery, which has decreased the incidence of morbidity in conventional surgery, it has become extremely necessary to better understand the detailing of the paracentral lobule's anatomy and its location with surroundings.³

This study was an attempt to contribute to the current knowledge regarding anatomy of the paracentral lobule, conducting an analysis of morphological measurements of this region in both cerebral hemispheres between adult Bangladeshi male and female population. For this study Computed tomography (CT) Scan of brain in mid sagittal view was used because it provided more detailed information about structure of brain than regular radiographs (x-ray).¹¹

Methods:

This Cross sectional study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, during the period from January 2017 to December 2017. Seventy adult Bangladeshi people, among them 35 male and 35 female, age ranging from 20-65 years were included in this study. The subject of this study were selected from the Radiology & Imaging Department of Dhaka Medical College & Hospital attending for CT scan of brain advised by their physicians. This study was carried after

permission from Ethical Committee. Subject were selected purposively. The study subjects were assured of confidentiality of the study. Personal information of the subjects were recorded on questionnaire by the author. Informed written consent was taken. Those CT scan images of brain in mid sagittal view of both cerebral hemispheres were collected which were normal reported by the radiologists. For this study, reconstructed mid sagittal view of both cerebral hemispheres were taken since the paracentral lobule was visible in this way and these images were viewed on a computer monitor for editing and magnifying. Different dimensions of paracentral lobule were measured from these images by using computer with image measuring software program named DICOM (Digital Imaging and Communications in Medicine) version 4.0.3. (64-bit).

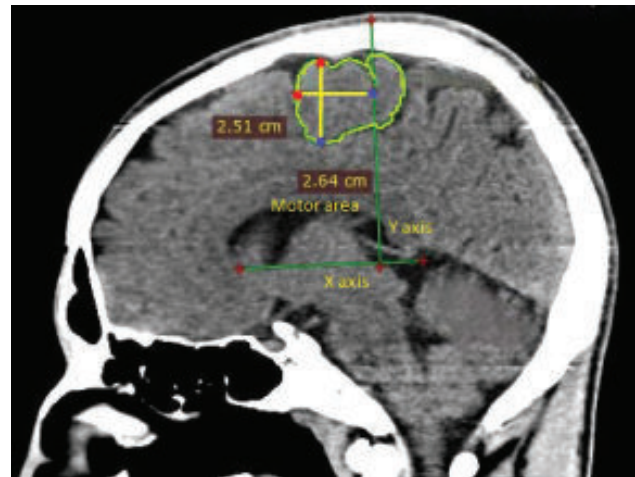


Figure: Photograph showing surface area of motor cortex of paracentral lobule.

Due to a total absence of clear morphological landmarks, measurement was standardized by using intercommissural or CA-CP line (CA- anterior commissure, CP- posterior commissure) line system in order to increase precision of data⁴.

Statistical analysis:

Unpaired student's 't' test was done for statistical analysis of the results. P value <0.05 was taken as of significance.

Results:

In male, mean surface area of motor cortex of the right paracentral lobule was $6.17 \pm 0.85 \text{ cm}^2$ & the left paracentral lobule was $6.47 \pm 0.74 \text{ cm}^2$. In female, mean surface area of motor cortex of the right paracentral lobule was $5.52 \pm 0.81 \text{ cm}^2$ & the left paracentral lobule was $5.97 \pm 0.72 \text{ cm}^2$. From Table I found statistically significant difference in mean surface area of motor cortex of right ($p=0.002$) and left ($p=0.005$) paracentral lobule between male and female.

Table I

Surface area of motor cortex of right & left paracentral lobule between male and female

Variables	Male (n=35)	Female (n=35)	p value
Right motor cortex (cm ²) (Mean±SD)	6.17±0.85	5.52±0.81	0.002**
Left motor cortex (cm ²) (Mean±SD)	6.47±0.74	5.97±0.72	0.005**

Comparison of values between male and female was done by Unpaired Student's 't' test,

** = significant at p<0.01.

In male, mean surface area of sensory cortex of the right paracentral lobule was 2.21±0.43 cm² & the left paracentral lobule was 2.07±0.37 cm². In female, the mean surface area of sensory cortex of the right paracentral lobule was 1.94±0.41 cm² & the left paracentral lobule was 1.88±0.41 cm². Table II showing statistically significant difference in mean surface area of sensory cortex of right (p=0.010) and left (p=0.047) paracentral lobule between male and female.

Table II

Surface area of sensory cortex of right & left paracentral lobule between male and female

Variables	Male (n=35)	Female (n=35)	p value
Right sensory cortex (cm ²) (Mean±SD)	2.21±0.43	1.94±0.41	0.010*
Left sensory cortex (cm ²) (Mean±SD)	2.07±0.37	1.88±0.41	0.047*

Comparison of values between male and female was done by Unpaired Student's 't' test,

* = significant at p<0.05, ** = significant at p<0.01.

Discussion:

In this study, mean surface area of motor cortex (right (p=0.002) and left (p=0.005)) and sensory cortex (right (p=0.010) and left (p=0.047)) of the right & left paracentral lobule were found significantly higher in male than female. Statistically significant difference was also observed between male and female. Surface area of motor cortex of left paracentral lobule was significantly larger than right both in male and

female. Mean surface area of sensory cortex was larger in right paracentral lobule than the left both in male and female. Spasojevic⁴ recorded the surface area of right and left paracentral lobule and revealed that mean surface area of left paracentral lobule was significantly larger (p<0.05) both in male and in female than the right paracentral lobule in their study subjects which corresponds to the predominance of right handed people (90-95%). After comparing the surface area of paracentral lobule between male and female, they did not find statistically significant sex differences (p>0.05). The findings of the present study were almost within normal range and also similar to the findings of that study.

Review of existing literature reveals that few works have been done on this topic in other countries. The studies concerning measurements of the paracentral lobule did not carried out in our country previously. So, the result of the present study was compared with the findings of other researchers of abroad. Some dissimilarities were noticed among the findings of present study and the studies conducted by other researchers. This dissimilarities may be due to mixture of different age and races, different geography, use of cadaveric brain instead of CT scan image from living subject, variation in the radiograph and taking the measurement in different technique.

The adult paracentral lobule study is very important to the radiologist and clinicians for the diagnosis and treatment of related diseases. The result of the present study can be used as a baseline anatomical normative data for future researches and the findings of this study might be useful in providing data for the anatomists, radiologist, neurosurgeons, and forensic experts.

Conclusion:

The study findings suggest that there are significant difference in cortical surface area of right and left paracentral lobule between adult Bangladeshi male and female subject that may have anatomical and clinical importance.

Limitations:

In this study, the samples were not distributed into age groups. The present study was conducted in a single center, may not be fully representative of whole community of Bangladesh. So far known, no published article was available on the paracentral lobule among Bangladeshi people, so comparison could not be done here. Few numbers of publications of similar study were available done by researchers of other countries to compare with the findings of present study. So, morphological parameters could not be compared

properly with the present study. The result of this study might be more accurate if correlation could be done with some other variables such as age, height, race, education and occupation etc.

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Conflict of Interest:

The authors stated that there is no conflict of interest in this study

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Authors' Contributions:

Mahfuza Chowdhury were responsible for conception and design, obtaining funds, data interpretation, manuscript drafting and manuscript editing, and final approval data acquisition, data interpretation and critical revision for important intellectual content conception and design, obtaining funds, data interpretation, manuscript editing, and final approval. Ferdausi Rab was responsible for data analysis and statistical analysis. Mahfuza Chowdhury Tunajjina Kawsar and Aminur Rahman were responsible manuscript writing and editing. Mahfuza Chowdhury was responsible for data collection. All authors have read and approved the final version of the manuscript.

Data Availability:

The datasets analysed during the current study are not publicly available due to the continuation of analyses but are available from the corresponding author on reasonable request.

Conflict of Interest:

The authors stated that there is no conflict of interest in this study

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Ethical consideration:

The study was conducted after approval from the ethical review committee. The study was approved by the Ethical Research Committee of Dhaka Medical College. The confidentiality and anonymity of the study participants were maintained.

References:

1. Snell R. S., THE CEREBRUM, In: Clinical Neuroanatomy. 7th edition. Philadelphia: Lippincott Williams and Wilkins, 2008; p.261-295.
2. Gyton, A.C., Hall, J.E., Textbook of medical physiology. 12th ed. New Delhi: Elsevier, 2013; pp.677-728.
3. Neto, M.O., Nascimento, P.A., Rodrigues, R.B., Oliveira, W., Oliveira, L.S. & Silva, A.R., Morphometric analysis of the Paracentral lobe. Health Biology. Science; vol 2, number 2014;2(1): pp.19-22.
4. Spasojević, G., Malobabic, S., Spasojević, O., Macut, N.D. & Maliković, A., Morphology and digitally aided morphometry of the human paracentral lobule. Folia Morphol (Warsz) [Internet]. [access 2017 April 10]; 2013;72(1): pp.10-16.
5. Woessner, H., Vibhute, P. & Barrett, K., Acute Loss of Bladder Control in a Stroke of the Frontal Cortex. The Neurohospitalist. 2012;2(4): pp. 129-131. <https://doi.org/10.1177/1941874412450715> PMID:23983877 PMCID:PMC3726109
6. Crossman, A.R., 2008, Cerebral Hemisphere, In : S. Standring, 40th ed., Gray's Anatomy - The Anatomical Basis of Clinical Practice, London: Churchill Livingstone, 2008; pp.335-357.
7. Duvernoy, H.M., The human brain; surface, three-dimensional sectional anatomy and MRI. Springer-Verlag, Wien-New York, 1991; pp.28-29
8. Stanczyk, L.J., Variation of the gyrus and sulcus cinguli in phylo and ontogenesis. Folia Morphol, 1983; 42: pp.243-259
9. Ohnishi, T., Matsuda, H., Tabira, T., Asada, T. & Uno, M., Changes in brain morphology in Alzheimer disease and normal aging: is Alzheimer disease an exaggerated aging process. AJNR Am J Neuroradiology. 2000;22: pp.1680-1685.
10. Sailor, M., Fischl, B., Salat, D., Templemann, C. & Busa, E., Focal thinning of the cerebral cortex in multiple sclerosis. Brain. 2003; 126: pp.1734-44. <https://doi.org/10.1093/brain/awg175> PMID:12805100
11. Haaga, J.R., CT and MRI of The Whole Body, 5th edition. 2003; pp.5-8, 2612-2633.