ORIGINAL ARTICLE

# Morphometric Variation of Paracentral Lobule in Relation to the Hemisphere of Human Brain

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*Abstract*

***Introduction:*** *The paracentral lobule is the area on the medial surface of the cerebral cortex which surrounds the indentation produced by the upper end of central sulcus on the superior border. The human paracentral lobule is an important center for micturition and defecation and control lower limb muscular activity below the knee. Any trauma, tumor, or cerebral ischemia can cause lesions of motor and sensory cortex of paracentral lobule. Size of the paracentral lobule varies from person to person. So, the adult paracentral lobule study is very important to the radiologist and clinicians for the diagnosis and treatment of related diseases. This study was carried out to observe the morphometric pattern between right and left paracentral lobule in adult male and female Bangladeshi population to establish a baseline anatomical data for future studies.*

***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 were male and 35 were female, age ranging between 20-65 years. CT scan images of brain in mid sagittal view were used for the study. Data were analyzed by Paired Student's 't' test.*

***Results:*** *The length of the motor and the sensory area and the width of the sensory area of the left paracentral lobule was significantly higher ($p<0.01$) than the right paracentral lobule. Only the width of the sensory area was found significantly higher in the right paracentral lobule.*

***Conclusion:*** *The present study reveals significant difference in morphological measurements between right and left paracentral lobule in adult male and female Bangladeshi population.*

***Key words:*** *Paracentral lobule, Central sulcus, Motor cortex, Sensory cortex, Morphometric Measurement, Pars marginalis*

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**Introduction:**

The paracentral lobule extends from precentral sulcus to postcentral sulcus on superomedial border.[1] 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, separates the paracentral lobule from the medial frontal gyrus.[2] Posteriorly the paracentral lobule is bounded by the pars marginalis, which is the ascending termination of the cingulate sulcus and separates the paracentral lobule from the precuneus. Inferiorly the paracentral lobule is bounded by the cingulate sulcus which separates it from the cingulate gyrus.[3]

A study was done comparing the right and left areas of the paracentral lobule and found the mean extrasulcal surface of the left paracentral lobule was significantly larger both in male and female which corresponds to the predominance of right handed people (90-95%).[2]

The central sulcus usually cuts into the posterior part of the paracentral lobule on the superomedial border and subdivides the lobule into anterior and posterior parts. The anterior part is continuous with the precentral gyrus (motor cortex) and posterior part is continuous with the postcentral gyrus (sensory cortex).[4] The precentral gyrus

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controls the movement of lower limb below the knee [5] and perineal region of the opposite side[1] and is concerned with the voluntary control over defecation and micturition reflexes.[6] Damage of paracentral lobule occurs from occlusion or lesion of anterior cerebral artery which causes contralateral lower limb muscle weakness or paralysis and urinary incontinence.[7,6]

Thickness of cortex (gray matter volume) of paracentral lobule decreases with age and also in many diseases such as in Alzheimer's disease[8], chronic Schizophrenia and multiple sclerosis.[9] Lesion of the primary somesthetic area of paracentral lobule results in contralateral sensory disturbances.[6]

In interstitial cystitis or painful bladder syndrome increase in gray matter thickness in primary somatosensory area (paracentral lobule) occur.[10] Increased volume and cortical thickness in the somatosensory and motor regions including bilateral paracentral lobule develops trigeminal neuralgia,[11] and migraine.[12] This lobule might be a primary site for tumors and focal seizures.[3]

So, anatomy of the paracentral lobule has a great importance. The present study was an effort in that issue using data collected as Computed Tomography (CT) scan images of brain through Compact Disc (CD) from Radiology and Imaging Department of Dhaka Medical College and Hospital. CT scan provided more detailed information about structure of brain than regular radiographs (x-ray).[13]

**Methods:**

This cross sectional study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, during the period between 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 and informed written consent was taken. Normal CT scan images of brain in mid sagittal view of both cerebral hemispheres were collected. 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. It was magnified at 100%. These images were transferred to a CD. Different dimensions of paracentral lobule were measured from these images by using computer with image measuring software program (DICOM version 4.0.3.).

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 data [2]. Paired student's 't' test was done for statistical analysis of the results. P value <0.05 was taken as of significance.

**Results:**

In this study, mean maximum length of motor area of the right paracentral lobule was 25.91±1.84 mm & the left paracentral lobule was 26.52±1.68 mm in male. In female, mean maximum length of motor area of the right paracentral lobule was 24.56±1.98 mm & the left paracentral lobule was 25.55±1.80 mm. In male, mean maximum width of motor area of the right paracentral lobule was 23.78±2.30 mm and the left paracentral lobule was 24.39±2.01 mm. Mean maximum width of motor area of the right paracentral lobule was 22.43±2.00 mm and the left paracentral lobule was 23.34±1.81 mm in female. The maximum length of motor area was higher in left paracentral lobule than right both in male and female and the result was statistically significant (p<0.001). The maximum width of motor area of left paracentral lobule was significantly higher than right both in male and in female and the result was statistically significant (p<0.001). (Table I).

**Table I**

*Maximum length and maximum width of motor area between right and left paracentral lobule in male and female*

| Variable | Right (Mean±SD) | Left (Mean±SD) | p value |
|---|---|---|---|
| Maximum length of motor area of male (mm) (n=35) | 25.91±1.84 (23.12 30.24) | 26.52±1.68 (23.12 30. 1) | 0.0001*** |
| Maximum length of motor area of female (mm) (n=35) | 24.56±1.98 (21.01 27.74) | 25.55±1.80 (21.93 28.61) | 0.0001*** |
| Maximum width of motor area of male (mm) (n=35) | 23.78±2.30 (18.76 29.65) | 24.39±2.01 (20.61 30.52) | 0.001** |
| Maximum width of motor area of female (mm) (n=35) | 22.43±2.00 (17.22 25.76) | 23.34±1.31 (18.84 27.40) | 0.0001*** |

Comparison between right and left paracentral lobule was done by Paired Student's 't' test.
** = significant at p<0.01, *** = significant at p<0.001.

**Table II**

*Maximum length and maximum width of sensory area between right and left paracentral lobule in male and female*

| Variable | Right (Mean±SD) | Left (Mean±SD) | p value |
|---|---|---|---|
| Maximum length of sensory area of male (mm) (n=35) | 20.79±2.54 (16.34-27.33 | 21.32±2.41 (16.51-28.28) | 0.003** |
| Maximum length of sensory area of female (mm) (n=35) | 19.33±2.66 (15.24 -24.37) | 20.06±2.47 (16.45-24.83) | 0.0001*** |
| Maximum width of sensory area of male (mm) (n=35) | 10.62±1.47 (6.36-15.31) | 9.73±1.14 (7.63-13.30) | 0.0001*** |
| Maximum width of sensory area of female (mm) (n=35) | 10.06±1.43 (7.00-14.01) | 9.33±1.36 (6.58-12.31) | 0.004** |

Comparison between right and left paracentral lobule was done by Paired Student's 't' test.
** = significant at p<0.01, *** = significant at p<0.001.

In male, mean maximum length of sensory area of the right paracentral lobule was 20.79±2.54 mm and the left paracentral lobule was 21.32±2.41 mm. Among female, mean maximum length of sensory area of the right paracentral lobule was 19.33±2.66 mm and the left paracentral lobule was 20.06±2.47 mm. In male, mean maximum width of sensory area of the right paracentral lobule was 10.62±1.47 mm and the left paracentral lobule was 9.73±1.14 mm. In female, mean maximum width of sensory area of the right paracentral lobule was 10.06±1.43 mm and the left paracentral lobule was 9.33±1.38 mm. It was found that the length of sensory area of left paracentral lobule was significantly higher than right both in male & female and the result was statistically significant (p<0.01). The maximum width of sensory area was significantly higher in right paracentral lobule than left both in male and in female and the result was statistically significant (p<0.001). (Table II).

**Discussion:**

In the present study, the length of motor area of left paracentral lobule was higher than right both in male and female. Statistically significant difference was observed between right and left paracentral lobule. The width of motor area of the left paracentral lobule was higher than the right both in male and female. Statistically significant difference was also observed between right and left paracentral lobule. Neto [3] (2014,) carried out a study in Brazil on postmortem brain of 42 hemispheres, 22 from the right and 20 from the left hemispheres. Information as to age and sex was not available. Using a digital caliper rule, they recorded length and width of motor and sensory area of right and left paracentral lobule and did not find any significant difference between the lengths of the regions analyzed in the paracentral lobule in their study subjects. They measured the width of paracentral lobule in transverse axis and significant difference was not found in their study subjects. They found that average width of motor area was larger in left than right paracentral lobule but did not publish separate data regarding male and female. The findings of the present study were almost within normal range and also similar to the findings of that study.

In the present study, the length of sensory area of left paracentral lobule was higher than right in male and female. Statistically significant difference was also observed between right and left paracenyral lobule. In this study, the width of sensory area was significantly higher in right paracentral lobule than the left both in male and female. Statistically significant difference was also found between right and left. On the other hand, similar observation were found by Neto[3] and recorded the length of paracentral lobule in the sagittal axis. But they did not publish any data regarding the length of sensory area. They stated that the motor area showed larger length in relation to the sensory area in the analysis of two hemispheres. Neto[3] mentioned no significant difference in width of sensory area of the right and left paracentral lobule in their study subjects.

Review of existing literature reveals that few works have been done on this topic in other countries. As there is no available published work concerning measurements of the paracentral lobule in our country. 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, 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 result of the present study can be used for future researches and the findings of this study might be useful in providing data for the anatomists, radiologist, neurosurgeons, and forensic experts.

**Conclusion:**

From this study, it can be concluded that there are mostly significant difference between right and left paracentral lobule in male and female. The maximum length of motor and sensory area and maximum width of motor area has been found significantly higher in left paracrntral lobule both in male and female. This may be due to left dominance of brain [2]. Maximum width of sensory area have shown significantly higher in right paracrntral lobule both in male and female. The study findings suggest that morphological measurements of the paracentral lobule dimensions reveal significant difference between right and left in adult Bangladeshi male and female people that may have anatomical and clinical importance.

**Limitations:**

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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