

Sex-related differences in the morphology of the corpus callosum among adult Bangladeshi population: A CT-scan based study

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Abstract

Context: The activities of the left and right cerebral hemispheres correlate via the corpus callosum. Its morphology has importance to diagnose and treatment for many neuropsychiatric diseases. The purpose of this study was to measure the different parameters of the corpus callosum in healthy adult Bangladeshi population to standardize the morphology of the human corpus callosum as well as to estimate the potential morphological sex difference which can provide a useful assessment of disease progression with implications on treatment planning.

Methods: A cross sectional, analytical study was conducted on 35 adult male and 35 adult female Bangladeshi people aged ranging from 20-65 years in the Department of Anatomy, Dhaka Medical College, Dhaka from January 2017 to December 2017. CT scans of the brain in midsagittal view of both cerebral hemispheres were taken for this study. Then the maximum width of the genu and width of the body at the midpoint of the corpus callosum were measured from CT scan images by using a image measuring software program named RadiAnt DICOM Viewer, Version 4.0.3(64 bit). Data were analyzed by Unpaired student's 't' test.

Results: The results revealed that the mean maximum width of genu of corpus callosum was 11.05 ± 0.97 mm and 10.48 ± 1.16 mm in male and female respectively. The mean maximum width of genu of corpus callosum ($p < 0.05$) was significantly higher in male. The mean width of body at midpoint of corpus callosum was 5.79 ± 0.55 mm and 4.93 ± 0.61 mm in male and female respectively and mean width of body at midpoint of corpus callosum ($p < 0.001$) was significantly higher in male.

Conclusion: The present study reveals a significant difference in morphological measurements of the corpus callosum between male and female of adult Bangladeshi population.

Keywords: Corpus callosum, genu, body, morphometric measurement, RadiAnt DICOM.

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Introduction

About 300 million finely myelinated fibers are contained in the corpus callosum of a human brain. It connects both cerebral hemispheres and facilitates interhemispheric communication.¹ It's an arched shape object in the midsagittal view, which consists of four parts; Rostrum, Genu, Body and Splenium.² The anterior part of the frontal lobes is communicated via genu, while the rest of the frontal lobes and parietal lobes are connected by the body of corpus callosum, Splenium connects the anterior parts of temporal lobes and occipital lobes together.³

Studies reveal that the corpus callosum is affected in conditions such as schizophrenia, Alzheimer's,

dyslexia, autism, attention deficit hyperactivity disorders, etc.⁴⁻⁷ The thickness of the corpus callosum is reduced in autism, with the most significant effects in the genu, midbody and splenium.⁸ Attention deficit-hyperactivity disorder (ADHD) children have a smaller corpus callosum, particularly in the region of genu and splenium.⁶ As such, knowledge of the size of the corpus callosum in normal adults is essential baseline information necessary for interpreting data from diseased brains.

Corpus callosum morphology and sex-related differences have been of interest to scientists because they influence the performance of callosotomies in patients with intractable epilepsy.⁹ And also gender differences have been reported in the width of the genu, trunk and splenium.¹⁰⁻¹³ Thus, the corpus callosum plays a critical part in a variety of integrative and cognitive functions and recent years has become a major area of cerebral research.¹⁴

CT-scan based imaging is a convenient and cost-effective method to study the living corpus callosum without the risk of invasive procedures or ionizing radiation. In the mid-sagittal plane the corpus callosum can be depicted in great detail.^{15,16}

This study aimed to document the normal values of subregions of corpus callosum using CT-scan in healthy adult females and males in our population to identify the gender differences and to provide baseline data for the diagnosis of the presence and progression of diseases.

Materials and Methods

A cross sectional, analytical study was conducted on 35 adult male and 35 adult female Bangladeshi people age ranging from 20-65 years in Department of Anatomy, Dhaka Medical College, Dhaka, from January, 2017 to December, 2017. The subject of this study was selected from the Radiology & Imaging Department of Dhaka Medical College & Hospital attending for CT scan of brain advised by their physicians. Informed written consent was taken from each study subject and they were

assured of the confidentiality of the study. Personal information of the subject was recorded on questionnaire and datasheet. People with intracranial mass lesions, head injury or brain pathology were excluded from the study. CT-scan images were collected which were normal reported by the radiologists.

For this study reconstructed midsagittal view of both cerebral hemispheres were taken since corpus callosum is visible in this way. These images were viewed on a computer monitor for editing and magnifying of images. It was magnified at 100%. Then these images were transferred to CD and different dimensions of corpus callosum was measured by using image measuring software named RadiAnt DICOM Viewer, Version 4.0.3(64 bit).

Methods of measurements:

Measurement of maximum width of genu of corpus callosum:

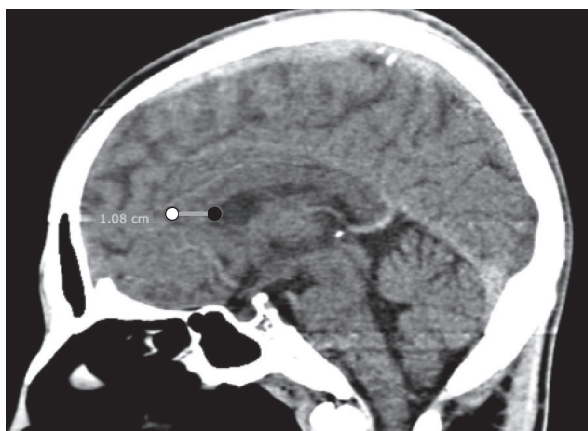
The maximum width of genu of corpus callosum was measured by drawing a line from anterior most point of genu to the anterior most point of inner concavity of the anterior part of the corpus callosum (Figure 1).¹⁷ This procedure was done by using measurement tool box of DICOM software with length option. Measurement was taken in cm which is converted into mm by calibration.

Measurement of width of body at midpoint of corpus callosum:

The dorso-ventral width at the midpoint of the corpus callosum is the width of body at midpoint of corpus callosum (Figure 2).¹⁷ The distances of these two points was measured by using measurement tool box of DICOM software with length option. Measurement was taken in cm which is converted into mm by calibration.

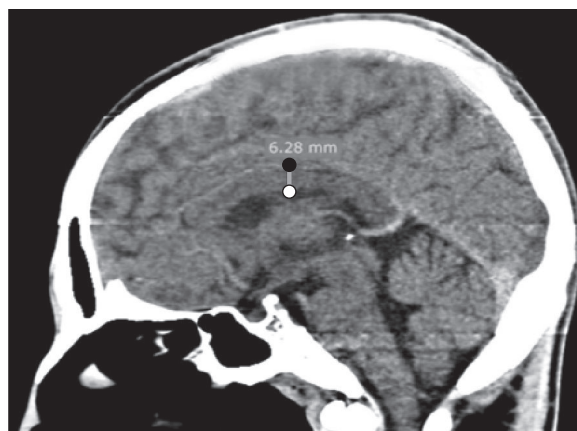
Unpaired student's t test was done for statistical analysis of the results. P value <0.05 was taken as of significance.

Ethical Clearance: This study was approved from the Ethical Review Committee (ERC) of Dhaka Medical College, Dhaka.



- Anterior most point of genu of corpus callosum
- Anterior most point of inner concavity of the anterior part of the corpus callosum
- Maximum width of the genu

Fig.-1: Photograph of maximum width of genu of corpus callosum



- Indicates width of body at midpoint of corpus callosum

Fig.-2: Photograph of width of body at midpoint of corpus callosum

Results

Mean maximum width of genu of corpus callosum was 11.05±0.97 mm and 10.48±1.16 mm in male and female respectively. The maximum width of genu of corpus callosum was ranged from 8.83 mm to 12.89 mm in male and 7.38 mm to 12.57 mm in female.

Mean width of body at midpoint of corpus callosum was 5.79±0.55 mm and 4.93±0.61 mm in male and female respectively. The width of body at midpoint of corpus callosum was ranged from 4.89 mm to 6.99 mm in male and 3.99 mm to 6.69 mm in female.

Statistically significant higher value was observed in male than female in the mean maximum width of genu and mean width of body at midpoint of corpus callosum (Table - I).

Table I

Comparison of maximum width of genu of corpus callosum and width of body at midpoint of corpus callosum between male and female

Variables	Male (n=35) Mean±SD (Range)	Female (n=35) Mean±SD (Range)	p value
Maximum width of genu of corpus callosum (mm)	11.05±0.97 (8.83-12.89)	10.48±1.16 (7.38-12.57)	0.029*
Width of body at midpoint of corpus callosum (mm)	5.79±0.55 (4.89-6.99)	4.93±0.61 (3.99-6.69)	0.0001***

Figures in parentheses indicate range SD = Standard deviation.

Comparison of values between male and female was done by unpaired Student's 't' test, *significant at p<0.05, *** = significant at p<0.001.

Discussion

There have been a number of studies in the past to collect morphological data on human corpus callosum. These studies are both on autopsy specimens of brain or in vivo magnetic resonance imaging (MRI) measurements of various corpus callosum indices and ratios.¹⁷⁻²² Most of the studies have been performed in Caucasian population.^{9,13,23} However, there are very few studies, on the size and shape of corpus callosum in the Asian or Bangladeshi population. So, the results of the present study were compared with the studies carried out by other researchers.

In the present study, statistically significant differences were observed between male and female in the mean maximum width of genu and mean width of body at midpoint of corpus callosum where the mean maximum width of genu of corpus callosum was significantly higher ($p < 0.05$) in male than female. And the mean width of body at midpoint of corpus callosum was significantly higher ($p < 0.001$) in male than female. According to Suganthy et al¹⁷ there was statistically no significant ($p = 0.81$) gender difference in the width of genu and the width of trunk of corpus callosum in Indian population. But they also stated that the width of the genu and trunk decreased with age in males. This change was not seen in females. Junle et al²⁴ in their study on Chinese people stated that width of genu and width of body of corpus callosum were larger in female than male but statistically significant sex difference was not found. Puthanveetil et al²⁵ found that difference was not statistically significant ($p = 0.626$) between male and female in the mean width of genu and width of body of corpus callosum. Oishi et al²⁶ did a study on Japanese people and stated that the width of genu was significantly ($p < 0.05$) higher in healthy control group than chronic alcoholic group and also mentioned that the width of body was significantly ($p < 0.01$) higher in healthy control group than chronic alcoholic group.

Vidal et al⁸ used the tensorbased morphometry to show reduced callosal thickness in the genu, midbody and splenium in autistic children. Estruch et al²⁷ conducted a study on alcoholics reveals that

thickness of the genu decrease due to chronic alcoholism and causes visual impairment.

Witelson et al¹³ studied sex differences in the isthmus and genu and concluded that total callosum, genu and anterior mid-body were greater in absolute area in males. On the other hand, isthmus was significantly larger in females.

The researchers recorded differences in different dimensions of corpus callosum between male and female which were found to be similar to the present study.

The dissimilarities of finding between the present study with other studies may be due to the mixture of different age and races, use of cadaveric brain instead of CT scan image from living subject, variation in the radiograph and taking the measurements in different techniques. Some study was done in formalin fixed preserved cadaveric brain which may cause shrinkage of viscera resulting lower values than present study and MRI based study.²² In addition, in fresh autopsy brain, all parameters of corpus callosum were significantly larger due to the removal of brain from its support of dural processes of skull which causes flattening of brain and distortion of corpus callosum.²¹

Conclusion:

In the present study, morphometric measurements of corpus callosum showed that there were statistically significant differences between male and female of Bangladeshi population. The values of maximum width of genu and width of body at midpoint of corpus callosum were significantly higher in male than female. Findings of the study might be useful in providing data for the anatomists, radiologists, neurosurgeons, forensic experts.

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