ASSESSMENT OF THE DIMENSIONS OF CORPUS CALLOSUM USING 1.5 TESLA MRI IN WESTERN UP POPULATION: ORIGINAL ARTICLE

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Abstract

Background: Dimensional data are crucial for developing normative standards based on sex, and age.
Objectives: In this study, the size of the corpus callosum and the longitudinal as well as vertical dimension of the brain was measured using an MRI in healthy individuals, and the corpus callosum's size in relation to a person's age & gender.

Patient and methods: 100 healthy volunteers (44 men and 56 women) admitted to the Teerthanker Mahaveer Hospital, Moradabad, U.P, had their corpus callosum size on the midsagittal section measured by magnetic resonance imaging (MRI).The Corpus Callosum's lengthwise & horizontal measurements, the brain's lengthwise & horizontal dimensions, and others dimensions were also recorded. These dimensional parameters were compared by using independent sample "t" test, ANOVA test, tukey test, & Pearson correlation.

Results: Between males and females, there was a difference ($p<0.05$) in the frontal to occipital lobe (AB) in the age group of 21-30, the frontal pole to the genu (AE) in the age group of 51-60, the occipital pole to the splenium (BZ), and the brain's upper to lower border (CD) among the ages of 51-60. Frontal pole to genu (AE), Length of CC anterior up to distant end (EZ/3), CC's front to posterior-most end distance (EZ/5), & Length of CC (EZ) according to age groups were different ($p <0.05$).

Conclusion: Depending on how large the corpus callosum is, the size of brain can change. Despite the fact that this study shows age-related alterations, especially in older patients, sexual dimorphism is virtually absent.

Keywords: Sex, Magnetic resonance imaging**,** Corpus callosum**,** Brain.

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INTRODUCTION

The corpus callosum (CC), which has roughly 1.3 billion fibers, is the largest and most important inter-hemispheric commissure in the human brain both structurally & functionally. Mostly through Corpus Callosum, the left and right brain halves' activity coordinates. [1] The parameters of CC, including size, diameters, age structure, & sexual identity variations, were identified in various investigations utilizing MRI scans. [1, 2-8]. Gupta et al. did not find any differences between the sexes with in majority of the CC parameters in their research among Indians. As well, they mentioned CC's proximal portion shrinking with time. [3, 9]

PATIENT AND METHODS

The observational study was carried out on100 healthy volunteers (44 men and 56 women) admitted to the Teerthanker Mahaveer Hospital (TMU), Moradabad, U.P, from 20 march 2022 to 21 march 2023 had their corpus callosum size on the mid-sagittal section measured by magnetic resonance imaging (MRI). Inclusion criteria were Patients from IPD and OPD with MRI examination of the brain, Normal healthy Patients, Male and Female of both genders above 10 years. Patient with claustrophobia and are contraindicated as well as Patient with tumors, Neurocysticercosis, hydrocephalus, neurological sign, intracranial lesions, mass and head injury and Both gender below 10 years, were excluded.

The subjects were divided according to age and gender wise. The MRI measurements were made of the brain & cc by using (Siemens Magnetom Avanto, 1.5 T) scanner. MR image were obtained in a 1:1 ratio by utilizing T1 MP-RAGE sequence in mid-sagittal plane.

Using radiant software, the corpus callosum is measured in the following ways- (Fig-1)
AB: the brain's length, calculated from the frontal to the occipital regions. AE: from the frontal lobe of brain to the CC's splenium. EZ: corpus callosum's length from its anterior most end to its most posterior region. EZ is subdivided into three main parts which is:

- EZ/3 the anterior third of corpus callosum
- The middle body of corpus callosum
- EZ/5 posterior fifth of corpus callosum

BZ: length of corpus callosum's splenium to the brain's occipital pole. FG: thickness of the CC in the sagittal plane. CD: including the cerebellum, from the brain's superior surface to its inferior surface. Various dimension of corpus callosum which was (AB, AE, CD, BZ, EZ, EZ/3, EZ/5, and FG) had a correlation to mostly every parameter. The above measurement has been connected also with brain dimensions. (Fig-2) The results were therefore checked for any significant age & sex differences.

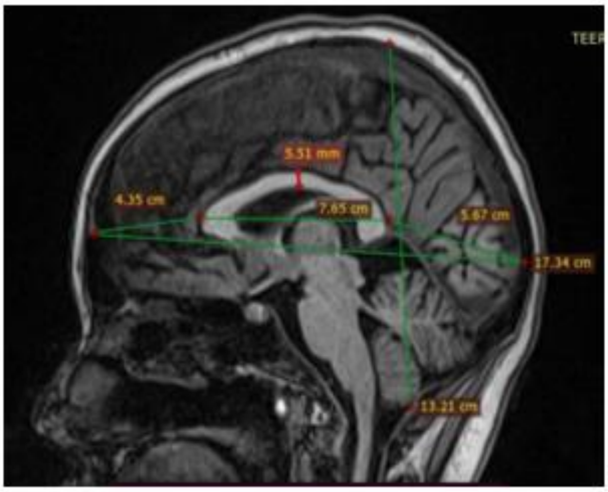

Fig 1: Measurement of corpus callosum on MR image by using T1 MP-RAGE sequence on sagittal plane

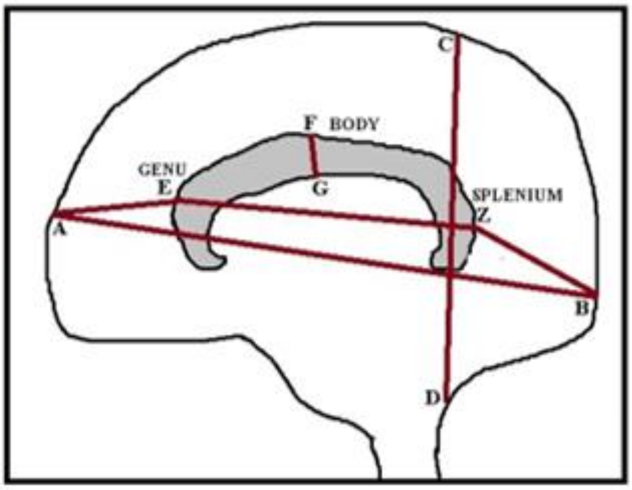

Fig 2: Measurement of corpus callosum

STATICAL ANALYSIS

SPSS software (statical package for the social services) version 23 was used to conduct the statistical analysis & ANOVA, tukey & t-test. P values less than 0.05 were regarded as significant including all evaluations. AB, EZ/3, EZ/5 was associated with EZ and hence they were considered as independent variables for multiple linear regression. The dependent variable was EZ for every unit (Cm) increment in AB, EZ/3, EZ/5.Total mean and different dimensions of corpus callosum were calculated. The independent sample "t" test, the ANOVA test, the Tukey test, and Pearson correlation were all used to compare these dimensional parameters.

RESULTS

The mean value of longitudinal dimension of the brain (AB) was 16.22± 0.59 cm, while the mean value for the longitudinal dimension of the CC (EZ) was 7.08 ± 0.41 cm, a ratio greater than 2:1.The mean value for the longitudinal dimension of the genu (EZ/3) and the splenium (EZ/5) was 2.36 ± 0.14 cm and 1.42 ± 0.08 cm, respectively.

The distance between the genu and the frontal pole (AE) had a mean value of 3.69 ± 0.21 cm, while the distance from the splenium to the occipital pole (BZ) was 5.79±0.47cm, an approximate ratio of 1:1.5.The mean value for the distance between the upper and lower surfaces of the brain (CD-vertical diameter) was 12.7 ± 0.60 cm.

AB, EZ/3, EZ/5 was correlated with EZ and hence they were considered as independent variables for multiple linear regression.

The dependent variable was EZ For every unit (Cm) increment in AB, EZ/3, EZ/5 contributes; 0.910, 0.477, and 0.180 respectively to the EZ. Regarding sex-related differences, the mean of the longitudinal dimensions and measured ratios tended to be smaller in women, and the inter-sex difference in mean value for AB (male; = 16.22 ± 0.59 cm, female; = 15.66 ± 0.91 cm; P < 0.001), AE (male; = 3.69 ± 0.21 cm, female; = 3.54 ± 0.31 cm, P < 0.005), BZ (male; = 5.79 ± 0.47 cm, female; = 5.58 ± 0.47 cm, P < 0.026) and CD (male; = 12.75 ± 0.60 cm, female; = 12.32 ± 0.71 cm, P < 0.002) was statistically significant. The CC's lengthwise measurements demonstrated a sharp increase with ageing. The one way ANOVA test was used to compare the length of CC (EZ) according to age for each gender. There was a difference (p > 0.05) in the EZ according to age group among females. Between the age groups: 10-20 and 41-50, 10-20 and 51-60; EZ/3, EZ/5, and EZ exhibited a difference.

The dimension of corpus callosum AE, AB, CD has shown significant result but other dimension of corpus callosum EZ/3, EZ/5, BZ, FZ, EZ they were statically non-significant. The Pearson correlation coefficient, “r” was used to find the relation between corpus callosum parameters. EZ was a positively correlated (p < 0.05) with AB, EZ/3, and EZ/5. Also, AB was a positively correlated (p < 0.05) with AE, EZ/3, EZ/5, BZ, and CD. Between AE and BZ, AE and CD, EZ/3 and EZ/5, there was a positive correlation.

Frontal to occipital lobe (AB)		Mean	S.D.	"t"	p value
10-20	Male	16.09	0.71	1.706	0.099
	Female	15.43	1.25		
21-30	Male	16.28	0.49	3.103	0.006*
	Female	15.59	0.55		
31-40	Male	15.98	0.68	0.713	0.499
	Female	15.59	0.81		
41-50	Male	16.36	0.56	0.410	0.689
	Female	16.21	0.85		
51-60	Male	16.28	0.69	1.629	0.127
	Female	15.70	0.69		
61-70	Male	16.33	0.40	1.247	0.253
	Female	15.77	0.81		

(* Significant)

Table 1: Frontal to occipital lobe (AB) according to gender for each age group

The Independent sample “t” test was used to compare the Frontal to occipital lobe (AB) according to gender for each age group. There was a difference (p < 0.05) in AB between males and females for the age group: 21-30 (Table-1). In the age group of 21-30 the males have higher AB dimension as compare to female.

Frontal pole to genu (AE)		Mean	S.D.	"t"	p value
10-20	Male	3.72	0.24	0.231	0.819
	Female	3.70	0.25		
21-30	Male	3.67	0.22	1.553	0.136
	Female	3.53	0.20		
31-40	Male	3.48	0.15	0.811	0.444

	Female	3.38	0.19		
41-50	Male	3.72	0.20	0.607	0.554
	Female	3.61	0.46		
51-60	Male	3.73	0.21	2.967	0.011*
	Female	3.33	0.30		
61-70	Male	3.71	0.24	1.618	0.150
	Female	3.42	0.27		

(* Significant)

Table 2: Frontal pole to genu (AE) according to gender for each age group

The Independent sample "t" test was used to compare the frontal pole to genu (AE) according to gender for each age group. There was a difference ($p < 0.05$) in the AE between males and females for the age group: 51-60 (Table-2). In the age group of 51-60 the males have higher AE dimension as compare to female.

Superior to inferior surface of brain (CD)		Mean	S.D.	"t"	p value
10-20	Male	12.65	0.62	1.270	0.214
	Female	12.32	0.76		
21-30	Male	12.84	0.54	1.247	0.227
	Female	12.57	0.47		
31-40	Male	13.19	0.23	1.928	0.095
	Female	12.31	0.76		
41-50	Male	12.38	0.56	-0.500	0.626
	Female	12.56	0.80		
51-60	Male	12.72	0.74	3.429	0.004*
	Female	11.58	0.54		
61-70	Male	13.17	0.39	2.195	0.064
	Female	12.48	0.52		

(* Significant)

Table 3: Superior to inferior surface of brain (CD) according to gender for each age group

The Independent sample "t" test was used to compare superior to inferior surface of brain (CD) according to gender for each age group. There was a difference ($p < 0.05$) in the CD between males and females for the age group 51-60 years (Table-3). In the age group of 51-60 the males have higher CD dimension as compare to female.

DISCUSSION

The study indicates that although the male corpus callosum is greater than the female corpus callosum, there is no noticeable sexual dimorphism in the Western U.P. Additionally there was a positive association between the longitudinal diameters of the brain and corpus callosum. The ideal size of the brain, on the other hand, is not statistically related to the horizontal measures of the corpus callosum. This suggests that while the various brain dimensions alter in concert with one another to maintain brain symmetry, they have no direct bearing on the position and size of the corpus callosum. In other words, while the corpus callosum occupies a certain place inside the cerebral hemispheres, the size of the corpus callosum is not proportional to the size of the brain. A study conducted by Sofia Mourgela et al. on 2007 thirty-five people was studied utilizing MRI Images. Every instance had a thorough review to confirm the lack of every illness. Following that, the measurements of the entire corpus callosum were measured using a mid-sagittal view of the cerebral hemispheres. To find sex-related differences, individuals studiedsplit according to their sex. They also divided by age group to assess for any age related differences. This research shows that although the corpus callosum and the brain have some developmental similarities, there is no link b/w them. [1] Eileen Luders et al. in their study of 60 patient selected from a database of high resolution anatomical MR images. They used cutting-edge artificial interface approaches to encode corpus callosum thickness and related gender effects, which are affected by alterations to brain structure that were made by scaling the data. With scaled data, there's no discernible gender disparity, but in unscaled data, men have notable cc thickness in a few areas. [5] A study conducted by T Gupta et al. on 2008 over a period of two year consisted of two groups first one was preserved cerebral samples as well as second was brain MRI images. At the mid-sagittal level, morphometric measures of the corpus callosum and its sub-regions were made in both groups. In the majority of the corpus callosum parameters examined, there was no sexual dimorphism found. Males are more likely than females to have atrophic cerebral alterations, which may explain the age-related thinning of the anterior part of the corpus callosum in men. [9]

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CONCLUSION

We came to the conclusion that, substantial relationship among brain size & corpus callosum length morphology in our investigation about the association among CC lengths as well as the brain. The numerous dimension measurements demonstrated that, in order to maintain the human brain's uniformity, the brain's size might change in accordance with the length of the corpus callosum. If the size of the corpus callosum changes, the width of the brain may expand or contract. Although there are age-related changes seen in this study, particularly in older subjects, sexual dimorphism is largely not found. A certain age group has also shown variations in brain dimensions, which may be the result of morphological changes that came on by ageing.

LIMITATIONS

This study having some limitation including-

1. Larger data sets allow for the possibility of even the slightest measurement error, which could lead to minute changes in the outcome.
2. Additional research is required to assess disparities between different ethnic backgrounds as well as to determine a typical pattern information for every demographic.
3. Our study includes a number of challenges, such as a lack of participants over 60, where more dimensional alterations are seen.
4. Additionally, the male candidates were smaller than the female candidates, which could have influenced the study's findings.

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