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Original Article

Radiology Section

Age and Gender Related Changes in the Dimensions of Corpus Callosum by MRI-In South Indian Population

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ABSTRACT

Introduction: Corpus callosum is the largest and most important commissural white matter tract connecting the two cerebral hemispheres. MRI helps in assessment of variation in its size and shape with respect to age and gender and possible implications on treatment planning.

Aim: To evaluate the changes in the thickness of various parts and bending angle of corpus callosum with relation to age and gender.

Materials and Methods: The thickness of various parts (rostrum, genu, body and splenium) of corpus callosum, the distance of genu from frontal pole, the distance of splenium from occipital pole and bending angle of corpus callosum were measured in 121 normal subjects (72 males and 49 females) in T1 mid sagittal images on 1.5 tesla MRI in M S Ramaiah hospitals, Bengaluru. The data was analysed using unpaired 't'-test.

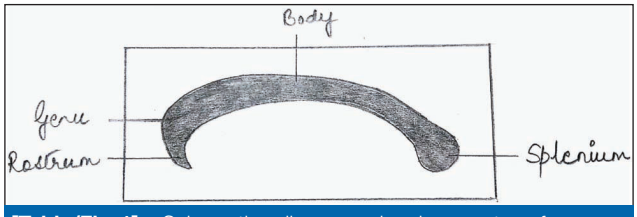
Results: Thickness of various parts of corpus callosum (rostrum, genu, body and splenium) was found to be significantly more (p-value < 0.05) in the younger age group (20 – 60 years) than the older age group (>60 years). The bending angle, however was found to be significantly more (p-value < 0.05) in the older age group (> 60 years) as compared to the younger group (20 – 60 years). There was no significant difference in the above parameters with respect to gender. Also, distance of genu from the frontal pole and splenium from the occipital pole were not statistically different.

Conclusion: This study showed that there was significant decrease in the thickness of different parts and increase in the bending angle of corpus callosum with age. There was however, no significant difference in relation to gender. Normative values thus obtained help in early detection and follow-up of disease processes.

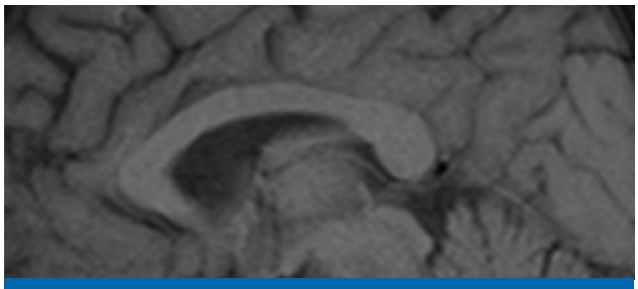
Keywords: Bending angle, Genu, Rostrum, Splenium

INTRODUCTION

The corpus callosum is the largest and most important anatomical and functional commissural white matter tract that crosses the midline and topographically connects the two cerebral hemispheres. Much of the inter hemispheric communication is conducted through it. It consists of the rostrum, genu, body and the splenium [Table/Fig-1,2] [1]. Studies reveal that there is variation in size and shape of corpus callosum with age, gender and in conditions like bipolar disorders, vascular dementia, Alzheimer's disease,



[Table/Fig-1]: Schematic diagram showing parts of corpus callosum.



[Table/Fig-2]: T1 sagittal MRI brain.

William's syndrome and various other diseases processes [2]. Quantitative measurements of the thickness of the various parts and bending angle of corpus callosum can be accurately performed on MRI and provide useful assessment of disease progression with implications on treatment planning.

MATERIALS AND METHODS

This study was designed as a retrospective review of 121 patients referred for MRI brain from June 2015 to October

2015 for a period of five months, to the Department of Radiodiagnosis, M.S Ramaiah Hospitals, Bengaluru, India. During the study period all patients aged between 20 to 87 years who underwent MRI Brain for various suspected or known CNS disorders were included, except in those with alteration of corpus callosum morphology by disease processes like significant trauma, hydrocephalus or space occupying lesions.

Subjects were divided into two groups - Adult (20-60 years) and Senile group (> 60 years). Total number of males were 72 and females 49 [Table/Fig-3]. Patients less than 20 years of age were not included in the study, due to insufficient number of patients in this age group and also there was a wide variability in corpus callosum morphology at this age.

Informed consent was taken from all the patients with clearance from the institutional ethics committee.

Demographic Data – Age and Gender Distribution			
Gender/Age	20-60 years	>60 years	Total
Male	54	18	72
Female	39	10	49
Total	93	28	121

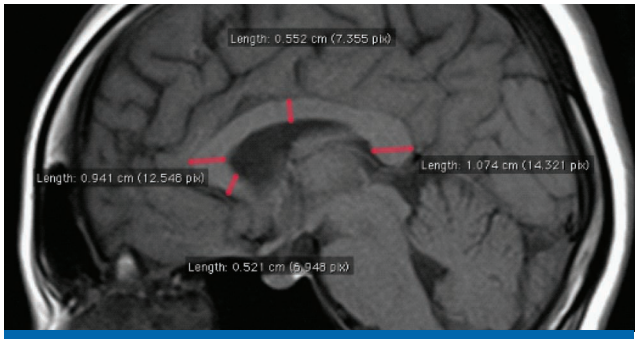
[Table/Fig-3]: Age and gender distribution of patients.

Image Analysis: Study was performed on T1 mid sagittal sequences (TR - 450ms and TE-8.7ms) taken on a 1.5 Tesla MRI (Siemens Magnetom Avanto) scanner in M S Ramaiah Hospitals, Bengaluru.

T1 sagittal sequences show excellent visualization of the entire corpus callosum. Hence, the various parameters of corpus callosum measured on it were - Maximum thickness (width) of various parts of corpus callosum; rostrum (Maximum thickness of rostrum just below the genu), genu, body (maximum thickness at centre of the corpus callosum at the vertex of bending angle as described below), splenium (maximum thickness starting at posterior most part of corpus callosum). All measurements were taken by drawing a line perpendicular to the long axis of the corpus callosum in different parts respectively [Table/Fig-4] [3].

Maximum distance from the genu of corpus callosum to the frontal pole of brain (BF) and of splenium to the occipital pole (CO) was also measured [Table/Fig-5] [4]. All parameters were measured in millimetres (mm) and the results were tabulated.

For measuring the bending angle of corpus callosum, a straight line was first drawn at the inferior most level of corpus callosum joining the most anterior point of corpus callosum (B) to the most posterior part (C). Then, a rectangular bounding box of corpus callosum was drawn and a third landmark was placed on the superior line of the rectangle at the midpoint (A).



[Table/Fig-4]: Measurement of thickness of various parts of corpus callosum.

[Table/Fig-5]: Measurement of distance of genu from frontal pole and splenium from occipital pole.

An angle was drawn through these three points [Table/Fig-6]. The angle at vertex is the so called bending angle (BAC) [5].The point A was also taken to measure the maximum thickness of the body of corpus callosum.

STATISTICAL ANALYSIS

Comparison of each of these parameters was done according to age, in adults (20-60 years) and senile (>60 years) age groups and according to gender.The results were statistically analysed by using unpaired student's 't' test correction. Probability 'p' value ≤ 0.05 and 't' value ≥ 1.96 was considered significant.

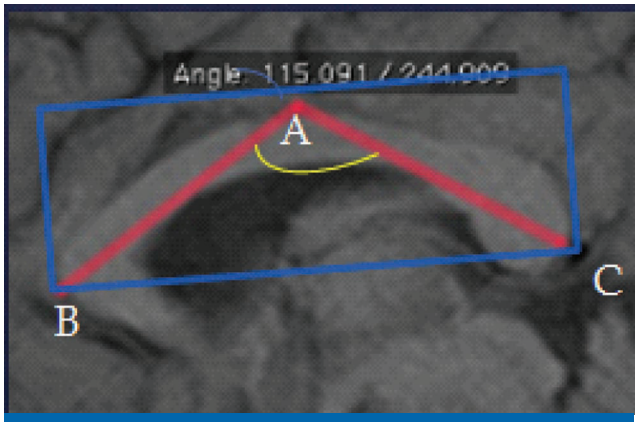
RESULTS

Thickness of various parts of corpus callosum (rostrum, genu, body and splenium) was found to be significantly more (p-value < 0.05) in the younger age group (20-60 years) than the older age group (>60 years). The mean thickness of the rostrum was 5.8 mm in the younger age group and 4.4 mm in the older age group, genu 11.5 and 9.9 mm, body 5.6 and 4.7mm and splenium 10.6 mm and 9.9 mm respectively.

The bending angle of corpus callosum was found to be significantly more (p-value < 0.05) in the older age group (> 60 years) compared to the younger age group (20-60 years). There was no significant difference in thickness of various parts of corpus callosum or bending angle of corpus callosum in relation to gender in either age group [Table/Fig-7].

	Age Group 1 (20-60)	Age Group 2 (>60)	p-value	t-value	Result
Rostrum	5.8	4.4	0.0001	4.8	Very significant
Male	5.1	4.2			
Female	5.24	4.8			
Genu	11.5	9.9	0.0001	4.4	Very significant
Male	11.5	9.8			
Female	11.48	9.6			
Body	5.6	4.7	0.0001	4.8	Very significant
Male	5.7	4.7			
Female	5.64	4.5			
Splenium	10.6	9.9	0.02	2.3	Significant
Male	10.7	10.1			
Female	10.6	9.58			
Distance from frontal pole	33.3	32.5	0.17	1.3	Not significant
Male	33.7	32.65			
Female	32.7	32.36			
Distance from occipital pole	48.8	50.6	0.14	1.3	Not significant
Male	51.5	48.86			
Female	49.3	48.8			
Bending Angle	120.6	128.4	0.03	2.12	Significant
Male	119.7	128.8			
Female	121.9	128.2			

[Table/Fig-6]: Different parameters of corpus callosum.



[Table/Fig-7]: Measurement of bending angle of corpus callosum.

DISCUSSION

Corpus callosum is the largest commissural tract that connects the two cerebral hemispheres, both anatomically and functionally, exchanging both sensory and motor information. It is likely to be affected by physiologic and pathological changes occurring in the cortical and subcortical regions of brain. White matter fibers in the corpus callosum are arranged topographically, prefrontal cortex of both the sides connecting via genu and rostrum, primary motor and sensory cortex via body and parieto-temporal and occipital fibres through the splenium [2]. So, depending on the part of brain affected by the disease process that part of corpus callosum is affected, hence need for normative data of different parts.

Prominence of sulci, ventricles, basal cisterns and sylvian fissures are commonly used to suggest age related atrophy. Similarly, altered morphology (changes in thickness and bending angle) of corpus callosum can also contribute to diagnosis of age related atrophy. Corpus callosum has a role in affective behaviour so it can also be altered in either size and shape or both in various conditions including schizophrenia, Niemann-Pick disease, bipolar disorders, William's disease, multiple sclerosis, Alzheimer's disease and dyslexia. Knowledge of variability in size and shape of corpus callosum with age and gender helps in detecting possible focal and diffuse changes in disease processes and correcting the target areas on stereotactic surgery [2].

There are few studies on normative data of corpus callosum in Indian population including, one on preserved brain [6], another on MRI scans [3,7] and the third including both methods [8]. One study has been done, only in females [4]. Ours seems to be the only study in South India measuring both the thickness of corpus callosum and the bending angle.

Corpus callosum consists of the rostrum, genu, trunk and the splenium. Rostrum is the narrowest part and is situated anteriorly. The trunk (body) is the main part. Genu is the most anterior part and lies about 4 cm from frontal pole and splenium, the thickened posterior end lies about 6 cm from occipital pole [9].

In this study the mean distance from the anterior pole of brain to the genu (BF) is 3.3 cm (male 3.37, female 3.26) in adult age group and 3.25 cm (male 3.26, female 3.23) in senile age group and from the occipital pole to splenium (CO) 4.8 (male 5.15, female 4.93) and 5.06 cm (male 4.8, female 4.8) respectively and was not statistically significant by age or gender.

However, in another study in North-West India mean values from ages 20-60 years in males were 3.6 and 5.8 cm and females 3.2 and 4.9 cm respectively and was more in males and was statistically significant by gender [3]. Study in Iranian population, the mean values from ages 30 to 45 years and above was males 3.7 (BF) and 5.8 cm (CO) and in females 3.6 and 5.4 cm respectively. Hence our population study showed lesser values as compared to above two studies.

In another study in females in North India [4] comparing the mean values in adults and senile groups were 4.4 cm and 4.38

cm of distance from frontal pole to genu respectively and 5.9 cm and 6 cm distance from occipital pole to splenium and was not statistically significant by age.

Changes in callosal size and thickness with increasing age in adults have been extensively studied. Studies have shown ageing effects over 3rd-8th decades [10]. A study reported that among elderly subjects (age range 65-95 years) age related atrophy of the anterior and middle sectors of the corpus callosum occurred in women but not in men [11].

In the present study the thickness of various parts of corpus callosum decreased with age with a statistically significant difference between the adult and senile age groups. This decrease in thickness with age was seen in all the parts of corpus callosum especially the anterior and mid aspect.

In this study, the mean thickness of rostrum, genu, body and splenium in adult age group in females were 5.2, 11.4, 5.6 and 10.6 mm respectively and in senile age group 4.4, 9.6, 4.5 and 9.5 mm, showing significant decrease in thickness. Similar study in females in North India [4] compared the thickness in adult and senile age groups respectively in different parts of corpus callosum i.e., rostrum, genu, body and splenium as 3.9, 11.04, 5.8, 10.6 mm and 3.1, 8.8, 5.1, 8.6 mm and found significant decrease in width with ageing especially of genu and splenium. In our population the decrease was more marked in the anterior and mid part of corpus callosum as opposed to splenium and also overall the thickness of different parts was more as compared to their measurements.

Splenium thickness in our study in the adult population in males and females was 10.7 and 10.6 mm respectively as compared to other two Indian studies 11.5 mm and 11.7 mm and 11.2 mm and 11.4 mm [7,8], Japanese study [12] 9 mm for both males and females and Caucasian study 19 and 17 mm [13]. So splenium thickness on our study was less than other Indian studies and caucasian study but more than the Japanese study.

In this study there was no statistical difference in thickness of the corpus callosum between both genders. This was similar to a previous study in Japanese population [12] as opposed to Canadians [14].

In this study the bending angle in the adult group and the senile group was 128.4 and 120.8 respectively and it was statistically significant. The changes with gender were not significant. A study comparing bending angle in patients with William's syndrome and normal controls revealed that the bending angle was larger in WS than in normal control subjects 119.1 mm and 111.9 mm respectively [5]. Our study seems to be one of the few studies studying the relationship of ageing on bending angle.

LIMITATION

Patients less than 20 years were not taken up for study. Unequal distribution of subjects in each category.

CONCLUSION

This study showed variability of thickness of various parts of corpus callosum with age and gender with significant decrease in thickness and increase in the bending angle (becomes more flattened) with age. The normative data thus obtained ,can help in detection of morphological changes in corpus callosum in various diseases states which can in turn lead to early detection and monitoring progression. Treatment options like correcting the target zones of corpus callosum via stereotactic brain surgery and callostomies are increasing being employed and hence the need for further population wise baseline data.

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