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Sexual dimorphism of splenial thickness of corpus callosum

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Abstract

There are disputed claims about the differences of the size of the human corpus callosum in men and women and the relationship of any such differences to gender differences in human behaviour and cognition. There is scientific dispute not only about the implications of anatomical difference, but whether such a difference actually exists. The corpus callosum is the largest commissure of the brain. It is seen as a thick, curved white band on medial surface of sagittaly bisected brain. The Corpus callosum is 10 cm long, and has 4 parts i.e. rostrum, genu, trunk and splenium. The present study was carried out on 120 individuals (78 males & 42 females) between the age group of 1-85 years of age who visited the OPD of Department of Radio-diagnosis, Sardar Vallabh Bhai Patel Hospital and NMC Sky Imaging Centre, LLRM Medical College, Meerut. MRI scans were studied for splenial thickness of corpus callosum in mid-sagittal plane & comparison was done in males & females by using two way ANOVA procedure. No significant sexual dimorphism in splenial thickness was found in the present study.

Key words: Corpus callosum, Splenium, MRI, Sexual Dimorphism, Thickness of splenium.

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Introduction

Our limited knowledge about the human brain can be attributed to its complex nature. Basically, the brain is divided into two halves also known as hemispheres, - the right brain and the left brain. Each of these hemispheres of the brain is assigned for particular tasks related to various human body functions. The right brain characteristics differ from the left brain characteristics to a significant extent. Yet another interesting fact on the human brain is that the right brain is concerned with the left side of the body, while the left brain is with the right side of our body so there has to be some link between these two hemispheres of the brain, and corpus callosum acts as this link which facilitates communication between two.

Corpus callosum is a wide, flat bundle of nerve fibers located at the longitudinal fissure beneath the cortex. The term 'corpus callosum' means tough body in Latin. With approximately 200-250 million contra lateral axonal projections, corpus callosum is the largest among the various white matter structures in the central nervous system. The anterior portion of this structure is referred to as the '*genu*', while the posterior portion is referred to as '*splenium*'. In between the anterior and posterior portions of corpus callosum lies the body of the structure which is referred to as the '*truncus*'. While the functions of the right hemisphere differ from that of the left hemisphere, there has to be some connection between the two halves of the brain in order to facilitate proper functioning of the nervous system as a whole. This is where the corpus callosum comes into the picture, as it facilitates this connection by acting as a bridge between the two hemispheres, and transmitting information from one hemisphere to the other. There are disputed claims about the difference in the size of the human corpus callosum in men and women and the relationship of any such differences to gender differences in human behaviour and cognition. A Philadelphia anatomist [1], suggested in 1906 that the "exceptional size of the corpus callosum may mean exceptional intellectual activity" and claimed differences in size between males and females and between races, although these were refuted by the director of his own laboratory in 1909 [2]. Of much more substantial popular impact was a 1982 *Science* article claiming to be the first report of a reliable sex difference in human brain morphology, and arguing for relevance to cognitive gender differences.

Magnetic resonance (MR) imaging enables the in vivo study of cerebral structure and function. Several

neuroimaging studies have used the midsagittal area of the corpus callosum to show differences in morphology related to sex, handedness, aging and pathologic states. The corpus callosum has been shown to be altered in conditions such as schizophrenia, dyslexia, even when visual assessment of the MR images reveals normal findings.

In pathologic states such as multiple sclerosis and Alzheimer disease, quantitative measures of the corpus callosum have been proposed as useful indicator of disease progression. Several studies indicate that the size and shape of the corpus callosum (CC) in human brain are correlated to sex, age, brain growth and degeneration, handedness, and to various types of brain dysfunction. MRI is regarded as the best method to obtain cross-sectional area and shape information of corpus callosum. In addition, MRI is fast and safe, without any radiation exposure to the subject such as with X-ray, CT. Since manual tracing of corpus callosum in MR images is time consuming, operator-dependent.

Material and Methods

This study was conducted in the Department of Anatomy in collaboration with the Department of Radio-diagnosis, LLRM Medical College and NMC Sky Imaging Centre, Meerut. The patients who attended OPD of Radio-diagnosis of Sardar Vallabh Bhai Patel Hospital, Meerut and visited NMC Sky Scanning centre were included. This study included individuals of different age groups ranging from 1 to 85 years. A total of 120 individuals (78 Males and 42 females) were studied by Magnetic Resonance Imaging (Mid-sagittal imaging).The subjects of the MRIs were patients referred for suspected or known central nervous system diseases.

Exclusion Criteria

Patients were excluded only when the pathologic process affected, or theoretically could affect, the corpus callosum (e.g., hydrocephalus or tumor) and when the entire corpus callosum was not on a single slice as a consequence of an oblique imaging plane. Magnetic resonance images were eliminated if there was any visible evidence of deviation from the mid-sagittal plane. Thus, although small deviations probably escaped detection, these errors would not be consistent in any direction by sex or age but rather would be a random error across the entire population studied. Such errors could be expected to be of no greater magnitude than those introduced randomly by the pathologist's knife in samples of autopsy specimens. The machine used for this purpose was a 1.5 Tesla Machine of G. G. company with LCD projector in NMC Sky Imaging Centre, LLRM Medical College; Meerut The splenium has received more attention than any other part of corpus callosum in studies of sexual dimorphism. In this study, thickness of splenium was measured at the level of its maximum thickness horizontly & compared. The data has been placed into groups depending on age and sex of patients and analyzed by two way ANOVA procedure with age and sex as the two factors. The data was measured in millimeter.

Observations and Results

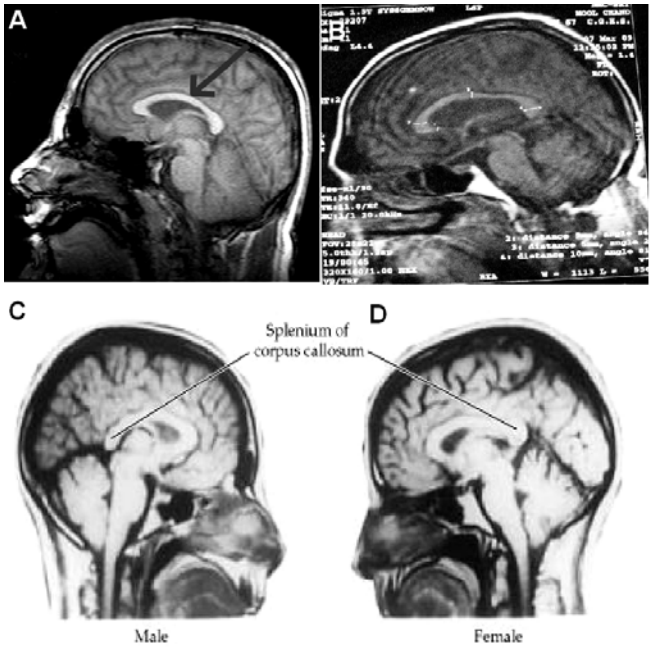

Figure 1. *Showing position of corpus callosum in mid-sagittal view of MRI (arrow) (**A**),and thickness of its different parts (**B**) and position of splenium in male (**C**) and female (**D**).*

Table 1. *Shows splenial thickness (in mm) in males and females in different age gro*ups in mid-sagittal view of MRI.

Age group (years)	**Male** {78} (Mean ±S.D.)	**Female** {42} (Mean ± S.D.)
01-20	8.33 ± 1.94 [18]	9.43 ± 1.13 [07]
20-40	10.73 ± 1.70 [22]	10.55 ± 1.21 [11]
40-60	10.57 ± 1.78 [23]	10.14 ± 2.07 [14]
60-80	10.09 ± 1.22 [11]	8.60 ± 1.35 [10]
>80	9.25 [4]	NIL

On the basis of the findings in the present study, one can conclude that there is no significant difference in thickness of splenium as far as age and sex is concerned. Variations observed are more likely to be due to

individual difference. Sexual dimorphism of the corpus callosum has remained controversial for several reasons- (1) Measurement have been performed in a variety of ways in different laboratories, in part because published reports frequently do not describe the methodology in detail. (2) Despite known age-related changes during both

Table 2. *Shows comparison of splenial thickness with its significance by ANOVA procedure (NS- Nonsignificant)*

Variation due to	**D.F.** (Degree of freedom)	**S.S.** **(**sum of square)	**M.S.S.** (Mean sum of square)	**F-test**	**Remark**
Age	4	75.87	18.96	0.23	NS
Sex	1	1.09	1.09	0.01	NS
Error	4	324.63	81.1		
Total	9	407.59			

childhood and adulthood, investigators have not taken age-matched subjects; (3) The size and shape of corpora callosa vary considerably among individuals, requiring large sample sizes to demonstrate significant sex differences.

Discussion

Corpus callosum has been the focus of fair amount of research and debate, especially its morphology in relation to various aspects of cerebral function. In recent years, most of the available studies have been carried out on MRI scans, and few studies are based on formalin- fixed autopsy brain specimens.

This was concluded on the basis of 19 independent studies of human CC, that there is insufficient evidence to support the presence of sex related differences in the size or shape of the splenium [3]. The effect of individual variations in callosal size was large enough to out range any effect of splenial size differences between males and females [4]. Any sex related differences were not reported in splenial areas either in absolute size or size proportional to brain weight [5]. There was no gender related difference of splenium in the Japanese [6] and in the Indians [7, 8]. No significant difference in splenial width was found between males and females [9]. In the present study, there was no significant gender related differences in the thickness of splenium. Possibly more refined measure of splenial shape and size may be necessary to finalize the question of gender differences in splenial morphology. However, on the basis of the findings in the present study, one can conclude that there is no significant sexual dimorphism in splenium. Variations observed are more likely to be a function of individual differences regardless of sex.

Corpus callosum, being the major structure connecting both the hemispheres, is likely to be affected by the physiologic as well as pathological changes occurring in the cortical and sub cortical regions of brain. Therefore different sub regions of the CC may be affected depending upon the region of the brain involved, as fiber systems connecting corresponding hemispheric regions pass through specific callosal sub regions. Therefore, alteration in CC morphology may give a clue towards diagnosis of specific disease processes. A knowledge of CC morphology and the gender as well as age related changes, thus is likely to be helpful in providing baseline data for the diagnosis of presence and progression of disease.

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References

1. Bean RB (1906): Some racial peculiarities of the Negro brain. Am J Anat 5: 353-432.
2. Mall FP (1909): On several anatomical characters of the human brain, said to vary according to race and sex, with especial reference to the weight of the frontal lobe. Am J Anat 1909; 9: 1-32.
3. Bishop KM, Wahlstein D (1997): Sex differences in the human corpus callosum: myth or reality? Neurosci Biobehav Rev 1997; 21: 581-601.
4. Luders E, Rex DE, Narr KL, Woods RP, Jancke L, Thompson PM, Mazziotta JC and Toga AW (2003): Relationships between sulcal asymmetries and corpus callosum size, Gender and handedness effects. Cereb Cortex 2003; 13: 1084-1093.
5. Witelson SF. Hand and sex differences in the isthmus and genu of the human corpus callosum. A postmortem morphological study. Brain 1939; 112: 799-835.

6. Takeda S, Hirashima Y, Ikeda H, Yamamoto H, Sugino M, Endo S. Determination of indices of the corpus callosum associated with normal aging in Japanese individuals. Neuroradiol 2003; 45 (8): 513-518.
7. Banka S, Jit I. Sexual dimorphism in the size of the corpus callosum. J Anat Soc of India 1996; 45: 77-85.
8. Suganthy J, Raghuram L, Antonisamy B, Vettivel S, Madhavi C, Koshi R. Gender and Age related differences in the morphology of the corpus callosum. Clin Anat 2003; 16: 396-403.
9. Gupta T, Singh B, Kapoor K, Gupta M, Kochhar S.. Normative Data of Corpus Callosal Morphology in a North-West Indian Population- An autopsy and MRI study. J Nepal Med Assoc 2009; 48: 46-51.

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