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Original Research Paper

Anatomy

AGE RELATED CHANGES IN CORPUS CALLOSUM

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ABSTRACT

INTRODUCTION:- This quantitative MRI study done on 100 healthy adult individuals between 20-60 years of age reports measurement of different dimensions of corpus callosum and any changes in the dimensions with ageing.

METHODS: MRI of corpus callosum of adult healthy individuals aged between 20-60 years were done and morphometric measurements of different parameters i.e. length, width, height and subregions of corpus callosum were noted and compared.

RESULTS: In our study it was found that-

1. Thickness of splenium, thickness of posterior part of corpus callosum & shortest distance from posterior most point of corpus callosum to cortical surface (P-S) increased with age.
2. Length of corpus callosum, length of corpus callosum/length of brain increased upto 39 years and thereafter declined.
3. Height of corpus callosum, thickness of body at mid-point, maximum thickness of the body and minimum thickness started to decrease after 50 years.

CONCLUSION: The results of this study indicate that ageing effects are more pronounced in genu and anterior part of corpus callosum.

KEYWORDS : Corpus callosum, MRI, Normal Ageing

AIMS AND OBJECTIVES:

To study the variation in the size of corpus callosum with advancing age.

INTRODUCTION:

The corpus callosum is a prominent body of white matter that connects the two cerebral hemispheres in a homotropic manner with reference to cortex. Corpus callosum is readily visualised on MRI[1] .The midsagittal section of corpus callosum on MRI can be used to measure its dimensions in different subregions & this procedure can be employed to estimate normative ageing process. Most cross-sectional MRI studies proves corpus callosum to be a relatively immune to age-related shrinkage upto seventh decade of life [2-7] on the contrary, some studies have shown senescent effects. [8-11]

MATERIAL AND METHODS

This study was carried out in deptt of Anatomy, Surgery and Radiology at Dr.RKGMC, Hamirpur and Dr.RPGMC, Tanda. A total of 100 healthy individuals aged between 20-60 years were included in the study and their dimensions of corpus callosum and its subregions on MRI Scans were noted. Individuals were further subdivided into 4 age groups i.e. 20-29 years, 30-39 years, 40-49 years and 50-59 years for comparasion.

THE FOLLOWING SETS OF MEASUREMENTS WERE TAKEN

1. Length of corpus callosum (Lc).
2. Thickness of body of corpus callosum at mid point (T).
3. Maximum thickness of rostrum (Tr).
4. Maximum thickness of splenium (Ts).
5. Height of corpus callosum (Hc).
6. Maximum and minimum thickness of body of corpus callosum (Tmax and Tmi).
7. Maximum thickness of anterior half of corpus callosum body (TBA).
8. Maximum thickness of posterior half of corpus callosum body (TBP).
9. Genu-Fornix Length (G-F): Distance between anterior edge of genu to anterior edge of columns of fornix.
10. Genu-Anterior Commisure Length (G-C): Distance between anterior edge of genu to anterior edge of anterior commissure.
11. Shortest distance from anterior most point of corpus callosum to cortical surface (A-S)
12. Shortest distance from top most point of corpus callosum to cortical surface (T-S).
13. Shortest distance from posterior most point of corpus callosum to cortical surface (P-S).
14. Length of brain (LB): From frontal pole to occipital pole of brain in midsagittal section.
15. Distance from frontal pole of brain to anterior most point of corpus callosum (F-A).
16. Distance from occipital pole of brain to posterior most point of corpus callosum (O-P).

RATIOS

17. Length of corpus callosum /Length of brain (Lc/LB).
18. Splenial thickness /Length of corpus callosum (Ts/Lc).
19. Splenial thickness /Length of brain (Ts/LB).
20. Thickness of body at mid point/Length of corpus callosum (T/Lc).
21. Thickness of body at mid point/Height of corpus callosum (T/Hc).

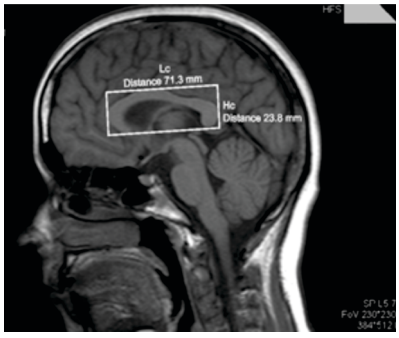

Fig.1.MEASURMENT OF CALLOSUM (MIDSAGITTAL MRI)
Lc: Length of corpus callosum
Hc: Height of corpus callosum

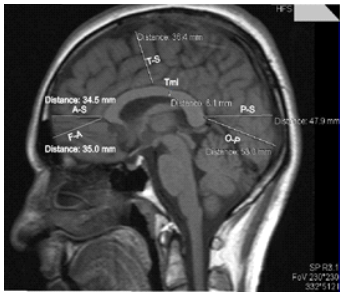

Fig. 2: MEASURMENT OF CORPUS CALLOSUM (MIDSAGITTAL MRI)

A-S: Shortest distance from anterior most point of corpus callosum to cortical surface

F-A: Distance from frontal pole of brain to anterior most point of corpus callosum

T-S: Shortest distance from top most point of corpus callosum to cortical surface

Tmi: Minimum thickness of body of corpus callosum

P-S: Shortest distance from posterior most point of corpus callosum to cortical surface

O-P: Distance from occipital pole of brain to posterior most point of corpus callosum.

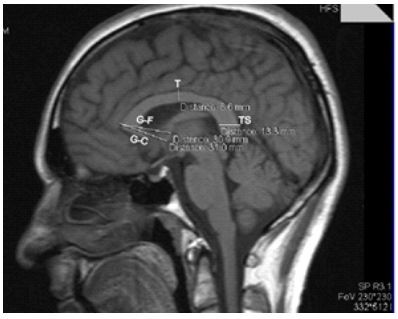

Fig. 3: MEASURMENT OF CORPUS CALLOSUM (MIDSAGITTAL MRI)

G-F: Genu-Fornix Length

G-C: Genu-Anterior Commisure Length

T: Thickness of body of corpus callosum at mid point

Ts: Maximum thickness of splenium

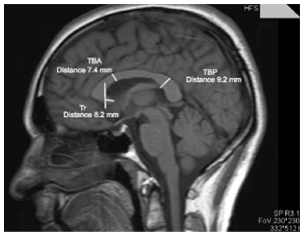

Fig. 4: MEASURMENT OF CORPUS CALLOSUM (MIDSAG ITTAL MRI)

TBA: Maximum thickness of anterior half of corpus callosum body

Tr: Maximum thickness of rostrum

TBP: Maximum thickness of posterior half of corpus callosum body

STATISTICAL ANALYSIS-

Post-Hoc test, a variant of ANOVA test was used to do the comparasion between these age groups. ANOFA was applied to do comparison amongst all groups.

RESULTS-

In our study following results were observed:

1. Ts, P-S and Tp increased with increase in age.
2. Hc and thickness of anterior part of corpus callosum(Tba) declined after 50 years of age.
3. Length of corpus callosum(Lc) decreased steadily after 40 years of age.
4. Mean difference of Tba between age groups 40-49 years and 50-60 years was 0.17143± 0.058 which was statistically significant with a 'p' value of 0.020.
5. Mean difference of Tp between 40-49 yrs and 50-60 yrs was 0.1560±0.05572 which was statistically significant with a 'p' value of 0.031.
6. Mean difference of G-F between age groups 20-29 yrs and 50-60 yrs was -0.44033 with a 'p' value of 0.006 which was statistically significant.
7. Mean difference of P-S between age groups 20-29 yr and 40-49 yr was -0.33548± 0.11616 with a 'p' value of 0 .024 which was statistically significant.
8. Mean difference of P-S between age groups 20-29 years and 50-60 years was -0.38300±0.14764 with a 'p' value of 0.053 which was statistically significant.

COMPARISON BETWEEN VARIOUS AGE-GROUPS

CC Para Meter	20-29 (N= 30)		30-39 (N= 20)		40-49 (N= 35)		50-60 (N= 15)		F; P value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Lc	7.039	0.5667	7.3085	0.4930	7.0977	0.4909	7.012	0.6042	1.279; 0.286
Hc	2.310	0.6649	2.4235	0.6248	2.5566	0.6540	2.442	0.5297	0.817; 0.488
T	0.6043	0.1359	0.601	0.1451	0.6723	0.1582	0.6227	0.1102	1.636; 0.186
Tmax	0.8227	0.1409	0.811	0.1609	0.894	0.1855	0.7433	0.0789	3.629; **0.016****
Tmi	0.4197	0.0862	0.4705	0.1298	0.4869	0.1091	0.4587	0.0472	2.510; 0.063
-'[Tr	3.5273	0.2687	1.078	0.1671	1.0823	0.2170	1.1013	0.2043	0.712; 0.547
Ts	1.087	0.1851	1.095	0.1914	1.0991	0.1975	1.128	0.2169	0.150; 0.929
Tba	0.7903	0.1671	0.7305	0.1243	0.8394	0.2496	0.668	0.1121	3.420; **0.020****
Tp	0.7193	0.1307	0.7195	0.2286	0.806	0.2133	0.65	0.0821	3.018; **0.034****
G-F	2.4317	0.4122	2.665	0.3565	2.5563	0.4628	2.872	0.3403	4.130; **0.008****
G-C	2.6683	0.3252	2.8275	0.2345	2.7331	0.3164	2.7293	0.2774	1.133; 0.340
A-S	3.3157	0.3366	3.464	0.4157	3.3214	0.3393	3.2953	0.2347	1.039; 0.379
P-S	4.1757	0.3602	4.4185	0.5137	4.5111	0.4707	4.5587	0.5742	3.558; **0.017****
T-S	3.568	0.3470	3.7505	0.5660	3.7246	0.4395	3.5273	0.2687	1.535; 0.210
LB	15.4223	0.7792	15.8365	0.8177	15.5151	0.9041	15.768	1.1277	1.151; 0.333
F-A	3.5107	0.3679	3.436	0.4278	3.5426	0.4055	3.4793	0.4894	0.303; 0.823
O-P	5.3643	0.5763	5.535	0.6627	5.6486	0.5358	5.552	0.6234	1.275; **.0287****
Lc/LB	0.4567	0.0331	0.4614	0.0181	0.4583	0.0338	0.4454	0.0345	0.836; 0.477
Ts/Lc	0.1543	0.0222	0.1497	0.0230	0.1546	0.0239	0.1626	0.0391	0.705; 0.551
Ts/LB	0.0706	0.0122	0.0691	0.0114	0.0710	0.0129	0.0718	0.0144	0.148; 0.931
T/Lc	0.0862	0.0197	0.0820	0.0184	0.0950	0.0224	0.0899	0.0210	1.949; 0.127
T/Hc	0.2796	0.0942	0.2530	0.0474	0.2737	0.0765	0.2639	0.0662	0.548; 0.651

DISCUSSION-

Results of different studies done on the size changes of coprus callosal with ageing are equivocal. Studies conducted by Pffefferbaum et al [6], Pozzilli et al [12] Johnson SC et al [5] concluded that age related thinning of copus callosum is modest whereas Sullivan et al [13], Weis et al [9] and Doraiswamy et al [8] reported statistically significant changes. Salat D et al [11] and Weis et al [9] reported greater vulnerability in size changes with advancing age in anterior than posterior regions of corpus callosum that is similar to our findings. Weis et al [9] reported significant decrease in size of genu and anterior part of trunk of copus callosum with age suggesting alteration in frontal and temporal interhemispheric fibre system. Corpus callosum is located adjacent and superior to lateral ventricle, these changes may be attributed to expansion of lateral ventricle in elderly.[11,13] Decrease in corpus callosal size may reflect histological changes in cerebrum, such as the loss of synaptic connections and callosal collaterals.

Study conducted by Mori et al [14] in 2005 concluded that MR Diffusion Tensor Imaging(DTI) enables examination of white matter tracts and markers of white matter microstuctural integrity at macroscopic resolution in living human beings by measuring Water Diffusion. Assaf and Pasternak [15] in 2008 conclude that Fractional Anisometry (FA) and Diffusivity (D) are useful in measuring microstuctural integrity.

Advanced age is associated with increased occurrence of myelin sheath deformations[16,17] fewer small-diameter myelinated fibers [18,19] expanded extra-axonal spaces, and loss of anterior commiussral fibres, but not with axonal degeneration [20,21] . Age related white matter differences like increased axonal diameter and reduced packing density could result in increased diffusitivity and reduced FA. Altough myelin influences both FA and RD [22,23] these indices are poor proxies for local myelin content [24,25,26,27]). Axonal diameter, independent of myelination, appears the strongest anatomical correlate of AD [24].

In 2007, Sullivan and Pfeefferbaum [28] found that advancing age is associated with reduction in FA on DTI studies. Study conducted by O'Sullivan et al [29] in 2001 concluded that integrity of Corpus callosal white matter reduces with advancing age which is usually greater in anterior compared to posterior brain regions. Study conducted by Bastin et al [30] supported the "Frontal Aging Hypothesis" as there was significant positive correlation between Mean Diffusivity (D) and age in genu and negative correlation between FA and age in splenium. These results are similar to our finding where thinning of anterior part of corpus callosum was observed after 50 years of age. Some changes in shape of splenium were mediated by age related global brain atrophy and ventricular enlargenment. In 2016, Vanessa et al [31] found age related metabolic and microstructural vulnerability of splenium as there was decrease in N-Acetylaspartate and T2 and increase in T2'with advancing age. On the contrary, in our study it was found that splenium thickness increased with age upto 60 years. In contrary study conducted by Bender et al [32] in 2015 observed no significant differences in size change for genu or splenium with advancing age.

CONCLUSION

The results of this study indicate more pronounced ageing effects in genu and anterior part of corpus callosum with advancing age.

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