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The Morphometric Study of Lateral Ventricle (Anterior Horn) and Cerebrum by Computerised Tomography

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A B S T R A C T

INTRODUCTION: The two major changes that may occur in elderly individual without neurologic deficits is enlargement of ventricles and cortical atrophy. Aim of this morphometric study was to statistically analyze the dimensions of lateral ventricle (anterior horn) in relation to the dimension of surrounding cerebrum (frontal cortex) in humans and also to study the changes that occur during ageing. Ventricular size of males and females was compared. The symmetry of lateral ventricle (anterior horn) on the left and right side was studied. **METHOD**: The CT images of 112 adult individuals (Age Group 21-60) and 88 ageing individuals (Age above 61) was studied in both males and females. Measurements like greatest height, anterior-posterior diameter and transverse diameter of lateral ventricle (anterior horn) and surrounding cerebrum (frontal cortex) was made by using dicom works software. **RESULT**: This study suggests that there is positive co-relation of age with dimensions of lateral ventricle and the volume of the lateral ventricle is enlarged with physiologic ageing. When the symmetry of lateral ventricle (Anterior horn) on the left and right side, it was seen that the dimensions of left were larger than the right. Also there is negative co-relation of age with dimensions of cerebrum and cerebral volume is reduced with age. **CONCLUSION**: Our study is expected to serve as a guide for proper interpretations of brain images using various imaging modalities. It will also be useful to the clinicians while diagnosing conditions like hydrocephalus, schizophrenia and other psychotic disorders.

KEY WORDS: Cerebrum, CT images, Lateral ventricle, anterior horn, frontal cortex.

INTRODUCTION

Man has long been fascinated with workings of human mind.The structure of human brain is complicated and not yet fully understood. According to Schochet [1] (1988) and various imaging and autopsy studies as ageing occurs the brain undergoes many gross and histopathologic changes with regression of the brain tissue leading to the enlargement of the ventricles which are considered normal and are expected. Thus the thorough knowledge of the normal changes that occur in the brain with age is critical before abnormal findings are analyzed. Due to these changes that occurs normally with aging the diagnosis of diseases in elderly patients is often complicated. There is more shrinkage with age in the frontal cortex and lateral ventricles are enlarged [2]. Also the left lateral ventricle is normally larger than the right in both sexes and the linear measurements of the lateral ventricles has positive correlation to cranial size [3].The CT studies showed a positive correlation between ventricular enlargement and age with greater degree of ventricular enlargement and cortical atrophy in men as compared to women[4,5,6,7]. To understand these changes the knowledge of normal morphometry and size of normal lateral ventricle and surrounding cerebrum is important. Therefore the aims of this morphometric study were to analyze the size of lateral ventricle (anterior horn) and the dimension of surrounding cerebrum (Frontal cortex) in humans. The lateral ventricular size of males and females was compared. The changes in normal lateral ventricular size and corresponding changes in the dimension of Cerebrum during ageing was studied. Also the symmetry of lateral ventricle (anterior horn) on the left and right side was compared.

MATERIALS AND METHODS

The study was carried out on 200 normal individuals in the age group of 20 to 60 years and above 60 years of either sex attending the department of Radio diagnosis who has been advised brain CT. Brain CT scan images required for this study were obtained from the Radiodiagnosis department of BYL Nair and LTMMC General Municipal Hospital. The study was

done on the patients whose CT images were reported to be normal by the radiologist. The study was done in two age groups of 112 adults in age Group of 21-60 and 88 ageing individuals age above 61 of either sex. There were 106 Male patients and 94 Female patients among the study sample. CT scanner used in the study was "SIEMENS SOMATOM VOLUME ZOOM MULTI SLICE (4 SLICE) MULTI DETECTOR SPIRAL CT SCANNER" with a scan time of 1-10 sec and slice thickness of 4mm. Patients were given detailed information about the study and written informed consent was obtained from them for the use of their CT scan images. Measurement of lateral ventricle (anterior horn) (Fig 1) and surrounding cerebrum (frontal cortex) (Fig 2) was made by using dicomworks software [8]. The procedures followed were in accordance with the ethical standards of experimentation (institutional or regional) and with the Helsinki Declaration of 1975.

Exclusion Criteria:

1) Individuals below 20 years of age. In this study along with morphometry the age changes in the morphometry were studied and the past studies have shown that the changes are seen beyond 20 years. Thus individuals below 20 years were not included.
2) Any history of local mass lesion in brain, cerebral infarction, hydrocephalus, drug abuse and trauma or previous history of intracranial surgery

Analysis of Image: These CT scan images were studied and the following measurements were made:
Statistical analysis was performed using SPSS software version 16.

RESULTS

In the present study all the three dimensions of frontal horn of lateral ventricle of left and right side and cerebrum (frontal cortex) were studied. The Comparison of morphometry of anterior horns of lateral ventricles and cerebrum (Frontal Cortex) in males (M) and females (F) in age group 20-60 years and above 60 was shown in table I and II respectively.

Lateral Ventricle (Frontal Horn): The mean greatest height of frontal horn of lateral ventricle in individuals (age 20-60 years), was more on left side (F-1.620 cms, M-1.58 cms) than right side (F-1.60 cms, M-1.58 cm) (table I). In individuals (age above 60 years) the height was same in both females and males on both sides (1.5 cms) (table II). The greatest anterior-posterior diameter in individuals (age 20-60) was more on left side (F-2.58 cms, M-2.81cms) than right side (F- 2.48 cms, M-2.71 cms) (table I). In individuals(age above 60),the anterior-posterior diameter was more on left side(F- 2.92 cms ,M-3.2 cms) than right side (F- 2.80 cms, M- 3.07 cms)(table II)..When the greatest transverse diameter in individuals (age20-60) was measured,it was more on left side (F- 0.54cms, M-0.74 cms) thanon right side (F- 0.49cms, M-0.65 cms)(table I). In individuals (age above 60) on left side (F- 0.89 cms, M-1.05 cms) it was more than on right side (F- 0.81 cms, M-0.97 cm) (table II). When correlated with age the mean height of frontal horn of lateral ventricle increases on both sides and was larger in females and not significant in both whereas the anterior-posterior diameter and transverse diameter of frontal horn of lateral ventricle increases and were more in men than in femaleswhich were statistically significant ($p<0.05$) and both increases with age.

Cerebrum (Frontal Cortex): The mean greatest height in individuals(age 20-60 years) on left (F-8.71 cms, M-8.27 cms) and right side (F- 8.71 cms, M- 8.27 cms) (table 3) was more than the left (F-8.69 cms, M- 8.65 cms) and rightside(F-8.69 cms, M-8.65 cms) in individuals (age above 60 years) (table 4). The greatest anterior-posterior diameter of cerebrum (frontal cortex) in individuals (age20-60) on left side (F- 6.02 cms, M- 6.33 cms) and right side (F- 5.99 cms,M- 6.30 cms)(table I) was more than the left side (F- 6.01 cms, M - 6.05 cms)and right side(F- 5.77 cms,M- 6. 04 cms) (table II) in individuals (age above 60) .

The greatest transverse diameter of cerebrum in individuals (age 20-60 years) on left side (F- 5.41cms , M- 5.70 cms) and on right side (F- 5.39cms, M-5.56 cms) (table I) was more than left side (F- 5.30 , M- 5.60 cms) and right side (F- 5.22 cms,M-5.49 cms) (table II) In individuals (age above 60 years). When correlated with age the height of cerebrum decreases with age in females was found to be lesser than in males which was not statistically significant in both whereas anterior-posterior diameter and transverse diameter of cerebrum decreases and was larger in males than in females which was statistically significant ($p<0.05$) in both.

TABLES

Table I: Comparison of morphometry of anterior horns of lateral ventricles and cerebrum (Frontal Cortex) in males and females age 20-60 years

Samples	Female Aged 20-60 yrs				Male Aged 20-60 yrs			
Type	**Mini**	**Maxi**	**Mean**	**P value**	**Mini**	**Maxi**	**Mean**	**P value**
LL1	1	2.5	1.625	0.3223	1	2	1.583	0.2055
LL2	1.87	3.31	2.584	0.0001	1.85	3.57	2.81	0.0001
LL3	0.16	1.26	0.546	0.0001	0.2	1.5	0.741	0.0001

LR1	1	2.5	1.605	0.3027	1	2	1.583	0.2055
LR2	1.82	3.25	2.481	0.0001	1.81	3.45	2.711	0.0001
LR3	0.16	1.2	0.49	0.0001	0.22	1.5	0.655	0.0001
CL1	7	11	8.711	0.5265	6	10.5	8.275	0.1162
CL2	5.24	6.87	6.027	0.0291	5.68	7.18	6.337	0.0052
CL3	4.65	6.64	5.412	0.0338	4.96	6.9	5.706	0.0108
CR1	7	11	8.711	0.5265	6	10.5	8.275	0.1162
CR2	5.3	6.87	5.996	0.0446	5.64	7.16	6.309	0.0266
CR3	4.61	6.17	5.399	0.0332	4.19	6.27	5.569	0.0352

Statistically significant value:p<0.05

Table II: Comparison of morphometry of anterior horns of lateral ventricles and cerebrum (Frontal Cortex) in males and females age above 60 years

Samples	**Female Aged Above 60 yrs**				**Male Aged Above 60 yrs**			
Type	**Mini**	**Maxi**	**Mean**	**P value**	**Mini**	**Maxi**	**Mean**	**P value**
LL1	1	2.5	1.595	0.3223	1	2	1.5	0.2055
LL2	2.11	3.72	2.928	0.0001	2.55	3.72	3.202	0.0001
LL3	0.2	1.69	0.89	0.0001	0.45	1.91	1.054	0.0001
LR1	1	2.5	1.595	0.3027	1	2	1.5	0.2055
LR2	2.06	3.53	2.807	0.0001	2.35	3.72	3.078	0.0001
LR3	0.3	1.44	0.81	0.0001	0.45	1.81	0.976	0.0001
CL1	6	11.2	8.695	0.5265	7	10	8.652	0.1162
CL2	5.27	7.1	6.01	0.0291	5.65	7.48	6.05	0.0052
CL3	4.64	6.23	5.306	0.0338	4.64	6.46	5.606	0.0108
CR1	6	11.2	8.695	0.5265	7	10	8.652	0.1162
CR2	5.3	5.95	5.77	0.0446	5.5	6.44	6.04	0.0266
CR3	4.41	6.02	5.227	0.0332	5.05	6.27	5.498	0.0352

Statistically significant value:p<0.05

Lateral ventricle (frontal horn):
Left side: LL1-height,LL2-anterior-posterior diameter, LL3- transverse diameter.
Right side-LR1-height,LR2- anterior-posterior diameter,LR3- transverse diameter.
Cerebrum (frontal cortex):
Left side: CL1-height,CL2-anterior-posterior diameter, CL3- transverse diameter.
Right side: CR1-height,CR2- anterior-posterior diameter,CR3- transverse diameter.

Table III: Measurement of Frontal Horn of Lateral Ventricle

Parameters	**D'souza& Natekar[14]**				**Present Study**			
Height(Cms)	**Males**		**Females**		**Males**		**Females**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**
Mean	--	--	--	--	1.54	1.54	1.61	1.61
SD	--	--	--	--	± 0.32	± 0.32	± 0.345	± 0.345
A-P Diameter								
Mean	2.78	2.74	2.58	2.55	2.98	2.87	2.73	2.62
SD	± 0.37	± 0.36	± 0.35	± 0.33	± 0.385	± 0.385	± 0.362	± 0.362
Transverse Diameter								
Mean	--	--	--	--	0.87	0.79	0.7	0.63
SD	--	--	--	--	± 0.358	± 0.339	± 0.322	± 0.291

FIGURES

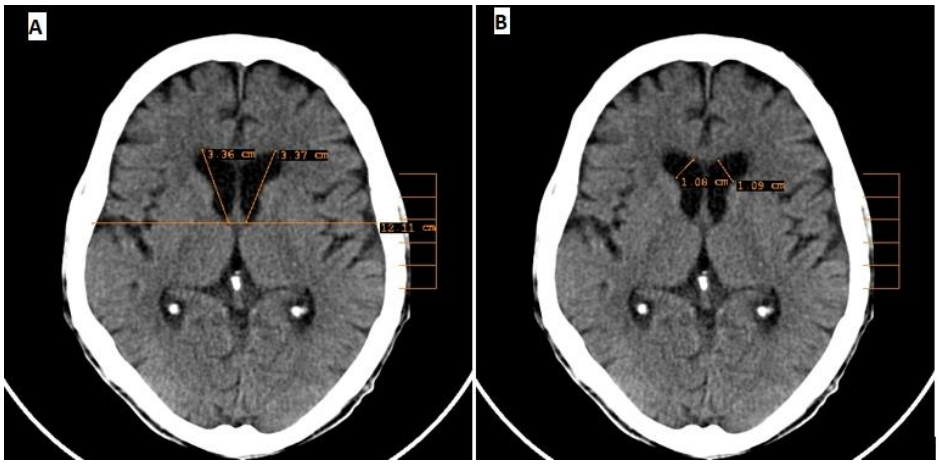

Figure 1:
A Measurement of anterior horn of right and left Lateral ventricle: Anterior-posterior diameter B Measurement of anterior horn of right and left Lateral ventricle: Transverse diameter

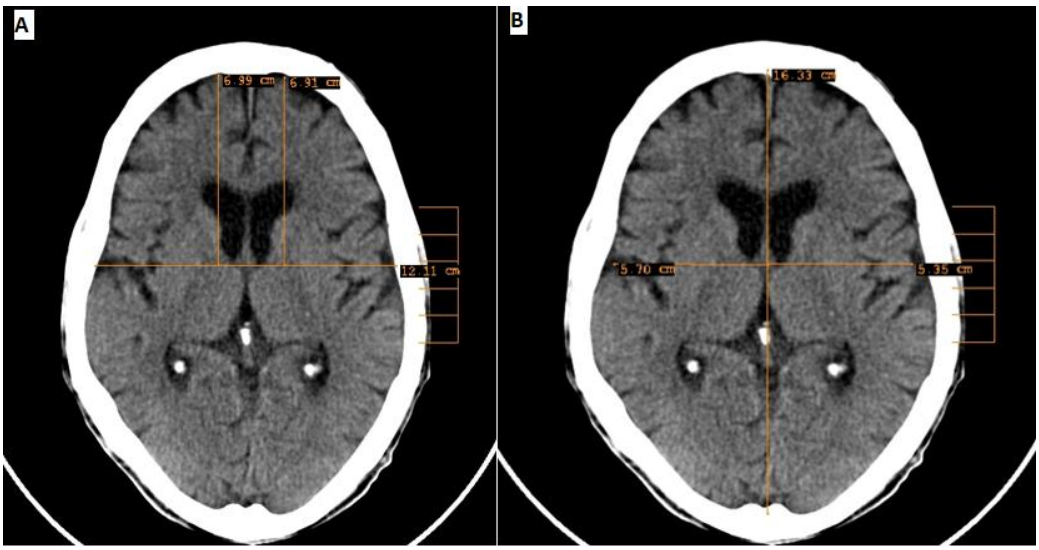

Figure 7:
A Measurement of Anterior-posterior diameter of right and left Cerebrum(frontal cortex) from frontal pole to horizontal line passing through interventricular foramen

Figure 8:
B Measurement of Transverse diameter of right and left Cerebrum at the level of interventricular foramen

DISCUSSION

Haaga[9] (1994) reported ventricular enlargement to be a more sensitive indicator of cortical atrophy due to increasing age and dementias. In the present study all the three dimensions of frontal horn of lateral ventricle of left and right side were studied and it was found that the dimensions of frontal horn of left and right lateral ventricle increases with age except the height**.** In the past studies it was observed that there is gradual progressive increase in the ventricular size from 1 st to 6th decades followed by a dramatic increase in the 8th and 9th decades [7].In the present study it was found that the dimensions of the frontal horn of lateral ventricle increases with age and the increase was more in individuals with age above 60 years than individuals with age 20-60 years and more in males than in females. According to Glydensted[3], Gomori et al [10], Takeda and Matsuzawa [11] the left lateral ventricle was larger than the right one and both were larger in males. In the present study when the symmetry of lateral ventricle on the left and right side for all dimensions was compared, it was seen that the dimensions of left lateral ventricle were larger than the right. Some studies suggest that there is more shrinkage with age in the frontal cortex [12] and also it was found that subjects aged 80 to 99 had more atrophy and large ventricles [13].

LATERAL VENTRICAL (FRONTAL HORN) :CT scan studies by D'souza and Natekar[14]showed that the anterior-posterior extent of frontal horn of lateral ventricle in males was 2.78 ± 0.37 and in females was 2.58 ± 0.35 which was

greater than that of the right horn in which the anterior-posterior extent in males was 2.74 ± 0.36 and in females was 2.55 ± 0.33. In the present study the mean greatest anterior-posterior diameter of the frontal horn of left lateral ventricle was larger in males 2.98 cms (SD 0.385) than in females 2.73 cms (SD 0.362) and of right lateral ventricle was larger in males 2.87 cms (SD 0.385) than in females 2.62 cms (SD 0.362) which was statistically significant. Coffey [15] suggested that ventricular enlargement may be a more sensitive marker of the aging process than brain tissue atrophy.

CEREBRUM (FRONTAL CORTEX)**:** Regression of the brain with aging is a normal process [16]. A cross-sectional analysis of brain volumes demonstrated a significant correlation between age and total brain, left hemisphere, right hemisphere, frontal lobe [,17,18,19,20]. The volume measurementsin brain tissue appear to vary with sex as well[21,22]·In the present study all the three dimensions of left and right cerebrum (frontal cortex) were studied. When correlated with age the mean greatest anterior-posterior diameter of cerebrum on left side [F-6.07 cms (SD 0.382), M- 6.43 cms (SD 0.391)]and on right side [F-6.03 cms (SD 0.382),M-6.37 cms (SD 0.375)] decreases with age which was statistically significant in both. When correlated with age the mean greatest transverse diameter on left side was [F-5.36 cms (SD 0.389), M-5.66 cms (SD 0.372)] and on right side [F-5.32 cms (SD 0.387) M- 5.53 cms (SD 0.364)] decreases with age and which was statistically significant.

Thus the dimensions of right and left cerebrum decreases with age in both males and females and the decrease was more in individuals with age above 60 years thanin individuals with age 20-60 years and more in males than in females.

LIMITATIONS OF THE STUDY

The study was done on the patients whose CT images were reported to be normal. There were many cases had been excluded from the study due to minor pathological changes in the brain which could influence the measurement? So, we tried as far as possible to find images with normal brain appearance. The detailed study of changes in the ventricular size and cerebrum in Parkinsons and Alzheimer's disease should be done. The extent to which Alzheimer's disease and aging are truly different processes remains to be determined.

CONCLUSION

Thus the present study has defined the morphometric measurements of the anterior horn of lateral ventricles and cerebrum (frontal cortex) surrounding it. In conclusion, this study highlights the frequent occurrence of morphometric changes in dimensions of lateral ventricle and cerebrum with age. The findings of the study may be gainfully utilized by imaging specialists and surgeons, to respectively avoid possible errors in interpretations and subsequent misdiagnosis, and to assist in planning appropriate surgical procedures.

Conflict of Interest: None

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