

Medical Science

The Morphmetric Study of Fourth Ventricle by Computerized Tomography

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ABSTRACT

The structure of human brain is complicated and not yet fully understood. As the human brain ages, characteristic structural changes occur that are considered normal. Thus the thorough knowledge of the normal changes that occur in the brain with age is critical before abnormal findings are analyzed. The normal ventricular size during life was previously unknown. In the past pneumoencephalogram was the most valuable test for determining ventricular size during life, but this method was not practical due to discomfort and morbidity. Advances in sophisticated and sensitive imaging techniques like the computerized tomography scan helps in dramatic expansion of our understanding of the normal structure of brain without the use of contrast media as well as it helps to understand the changes taking place in brain in normal individuals. CT scan provided a revolutionary means for morphologic study of the brain in vivo. The first purpose of this study was to examine the different dimensions of fourth ventricle. Many studies report a strong relationship between age and different measures of ventricular system. The study was carried out in adult individuals with age group 20-60 years and in ageing individuals above 60 years.

Keywords:- Computerized Tomography, Fourth Ventricle, Brain stem, Cerebellum, Medulla oblongata, Pons.

1. INTRODUCTION

As aging occurs the brain undergoes many gross and histopathologic changes with regression of the brain tissue leading to the enlargement of ventricles. Both imaging and autopsy studies suggest that cerebrospinal fluid spaces increases and cerebral volume reduction accompany normal human aging. Due to these changes which occur normally with aging the diagnosis of diseases in elderly patients is often complicated. So, two major changes that may occur in elderly individual without neurologic deficits is enlargement of ventricles and cortical atrophy. However there is surprising lack of clinical, radiologic and pathologic information regarding these changes in humans. According to

corsellis and Hughes CP an increase in the CSF spaces in dementia especially in Alzheimer's disease and Parkinson's disease was due to reduction in size of nerve cells. Hagga 1994 reported that, enlargement to be more sensitive indicator of cortical atrophy due to increasing age and dementias. To understand these changes the knowledge of normal morphometry and size of normal fourth ventricle of brain is important.

2. AIMS AND OBJECTIVES

1. To analyze the size of fourth ventricle.
2. To compare the fourth ventricle size of males and females.
3. To correlate the changes in the fourth ventricle size and corresponding changes in the dimension of fourth ventricle during ageing.
4. To compare the result of this study with previous study.

3. MATERIAL AND METHOD

Material: Computer tomography of these patients was performed on Siemens somatom volume zoom multislice (4 slice) multi detector spiral CT scanner with a scan time of 1-10 sec and slice thickness of 5 mm.

Method: The study was carried out on 200 patients who had been advised brain CT scan by various clinical departments. The patients were between 20 to 85 age groups who had been advised CT scan. The patients who have local mass lesion in brain, cerebral infraction, hydrocephalus, alcoholism, drug abuse, and trauma or previous history of intracranial surgery were excluded from study. Computed Tomography of these patients was performed on Siemens somatom volume zoom multislice (4 slice) multidetector Spiral CT scanner with a scan time of 1 to 10 seconds with slice thickness of 5 mm. A constant 120 KVP station was used. Routine scanning was done on 350° standard scan.

Scanning parameters:

1. Position: Supine.
2. Scanner Setting KVP: 12
(May vary according to patient age and size)
3. mAS: 260
4. Slice thickness – 5 mm.
5. Feed / Rotation- 12.5 mm
6. Rotation time – 0.5 sec.
7. Slice collimation- 5X2.5
8. Kernel-H40s
9. Reconstruction interval – 2.5 sec.
10. Direction – Cranial to caudal
11. Increment – 5 mm

The patient was placed on the CT table in supine position. The table was adjusted in required position using the push button to manipulate the table position, the patient head was centralized and supported for correct alignment and to reduce blurring images. Head was centered to the criss cross point of the light beam at external auditory meatus. The vertical light beam was made to coincide with the orbitomeatal line. This position represents the 0 table position. Then gauze pads were kept on either side of the head and the head band was placed across the forehead to immobilize the head. The total 8 to 10 sections were obtained without any overlap. The 4th ventricle was seen as an oval area at the centre of the posterior fossa between the cerebellum and the pons⁹. The CT scan images of the fourth ventricle were studied and following measurements were made.

1. Measurement of the fourth ventricle and brain stem cerebellum, from upper margin of pons to lower limit of open part of medulla oblongata.
2. Greatest height in cms, for fourth ventricle was measured as the greatest distance between the roof and the floor of the fourth ventricle for brainstem cerebellum from upper margin of pons to lower limit of open part of medulla oblongata.
3. Greatest vertical distance (length) of fourth ventricle from upper margin of pons to lower limit of open part of medulla oblongata.
4. Greatest Anterior posterior extent in cms for brainstem and anterior posterior extent was measured from anterior margin of pons to posterior margin of cerebellum.
5. Greatest transverse diameter in cms maximum transverse distance along the horizontal axis.

Table 1

Age Distribution among the study sample

Group(n=200)	Minimum	Maximum	Mean	Standard Deviation
Age (Years)	20	85	51.492	16.42

Table 2

Age Distribution in groups among the study sample

Type	Sample Size	Percentage
Age 20-60 years	127	63%
Above 60	73	27%
Total	200	100%

Table 3

Sex Distribution among the study sample

SEX	SAMPLE SIZE	PERCENTAGE
MALE	102	51%
FEMALE	98	49%
TOTAL	200	100%

males and females (Tables 4 & Figures 4).

Correlation of age with vertical distance of fourth ventricle for all male and female samples

The greatest vertical distance of the fourth ventricle showed negative correlation with age of males and of females which was statistically not significant in both (Table 5).

Table 4

Correlation of age with greatest height of fourth ventricle for all male and female samples

SEX	Mean Age (yrs)	Mean Greatest Height (cms)	Standard Deviation	Pearsons Correlation	P-Value
MALE	50.23	1.12	0.152	0.1430	0.0028
FEMALE	50.82	1.01	0.207	0.2946	0.0010

Table 5

Correlation of age with vertical distance of fourth ventricle for all male and female samples

SEX	Mean age (yrs)	Mean Vertical distance (cms)	Standard Deviation	Pearsons Correlation	P VALUE
MALE	50.23	1.41	0.297	-0.04213	0.7230
FEMALE	50.82	1.37	0.239	-0.00092	0.8912

Table 6

Correlation of age with transverse diameter of fourth ventricle for all male and female samples

SEX	Mean Age (yrs)	Mean Transverse Diameter (cms)	Standard Deviation	Pearsons Correlation	P VALUE
MALE	50.23	1.28	0.219	0.06348	0.0310
FEMALE	50.82	1.21	0.186	0.00325	0.0407

Table 7

Correlation of age with vertical distance of fourth ventricle for all male and female samples

SEX	Mean age (yrs)	Mean Vertical distance (cms)	Standard Deviation	Pearsons Correlation	P VALUE
MALE	50.23	4.91	0.396	0.00461	0.8715
FEMALE	50.82	4.39	0.481	-0.02188	0.7139

4. RESULTS

Age Distribution among the study sample

Youngest Patient of study sample was 20 years old and the oldest patient was of 85 years age. The mean age of the sample was 51.492 years with standard deviation of 16.42 (Tables 1-2 & Figures 1-2).

Sex Distribution among the study sample

There were 102 Male patients and 98 Female patients among the study sample (Table 3 & Figure 3).

Correlation of age with greatest height of fourth ventricle for all male and female samples

The greatest height of the fourth ventricle showed low positive correlation with age of males and females which was statistically significant in both. The trend line shows increase in height of the fourth ventricle with age in both

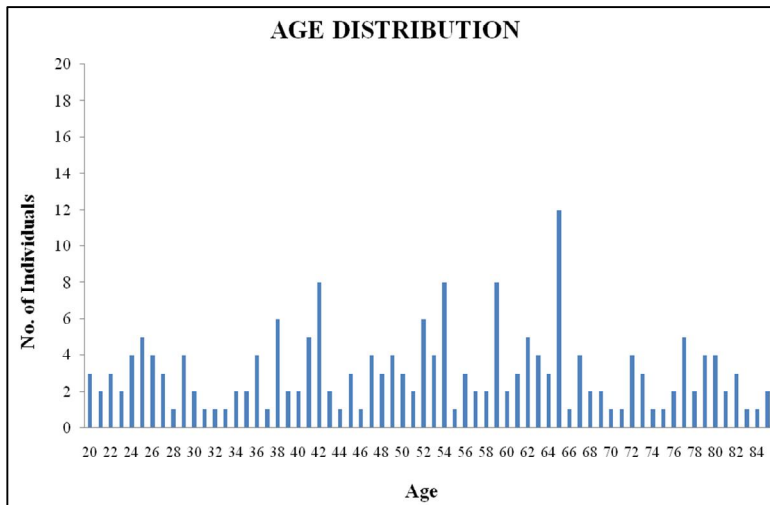


Figure 1

Age Distribution among the study sample

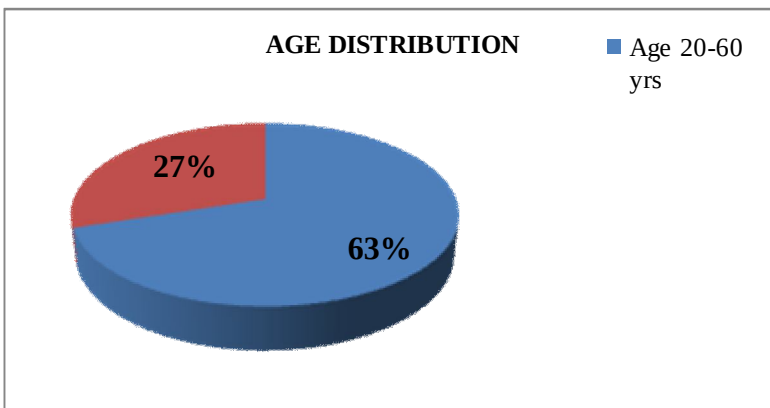


Figure 2

Age Distribution in groups among the study sample

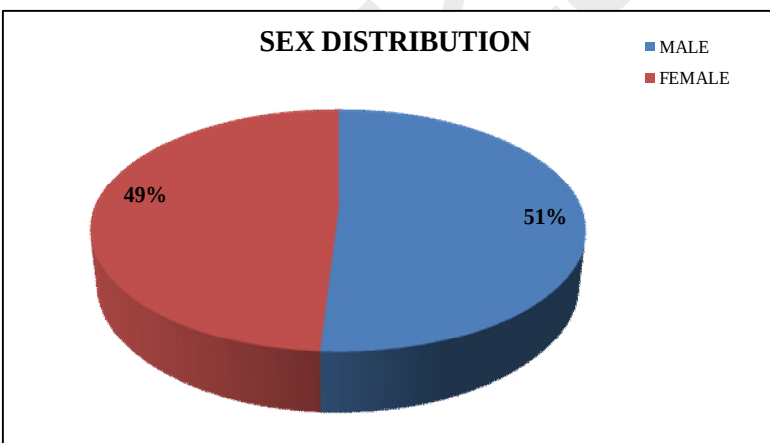


Figure 3

Sex Distribution among the study sample

Correlation of age with transverse diameter of fourth ventricle for all male and female samples

The greatest diameter of the fourth ventricle showed low positive correlation with age of males and females which was statistically significant in both. The trend line shows increase in transverse diameter of the fourth ventricle with age in both males and females (Tables 6 & Figures 5-6).

Correlation of age with greatest height of Brain Stem and Cerebellum for all male and female samples

The greatest height of the brain stem and cerebellum showed low positive correlation with age of males and of females which was statistically not significant in both (Table 7).

5. DISCUSSION

For many years the diagnosis of cerebral atrophy was demonstrated by the enlargement of ventricles by autopsy and pneumoencephalography. In an autopsy study of 28 previously hospitalized patients without neurologic symptoms, Tomlinson et al. (1970) found that 17 patients had mild ventricular enlargement with prominent cortical atrophy in the frontal and parasagittal regions. Bernard Messert et al. (1971) did autopsy study of 225 adult brains. The variation of ventricular size at death and after fixation was studied. It was found that there was significant reduction in size of the ventricular system from the living state to that found at autopsy. Thus frequently very small ventricles found at death are not representative of a normal ventricular system. Thus it was suggested that the size of ventricles cannot appreciate by autopsy study.

In 1976, Barron et al., studied 135 normal volunteers by CT scan and their ventricular size was measured. It was observed that there is gradual progressive increase in ventricular size from 1st to 6th decades followed by a dramatic increase in the 8th and 9th decades. Samuel D Brinkman et al., (1981) compared CT scan images of 28 patients with dementia and 30 normal elderly persons. The study suggests that CT scan could differentiate from normal ageing changes based on a significantly higher ventricular brain ratio or ventricular size in the demented patients. In 1981 Hughes and Gado studied 47 subjects of 65-80 years. This study shows that atrophy on CT scan correlates with age. Gomari et al., (1983) studied 148 patients aged 28 to 84 years without evidence of any nervous system disorder by computed tomography. These included size of lateral, third and fourth ventricles, width of the sylvian and interhemispheric fissures and cortical sulci. Various parameters indicated decrease in brain mass with age and

dilation of the ventricles. In 1984 Takeda et al., measured brain volume of 1045 subjects with no brain damage using X-ray computed tomography and investigated brain atrophy of ageing. This study shows that brain atrophy increases exponentially with increased age from thirties in both sexes.

In 1992 Coffy et al., reported an age related of brain volume of 2.8 ml/year from ages 65 to 95 years and also found age related brain changes are greater for ventricular volume (about 3% per year) than for brain tissue (about 0.5% per year). He suggested that ventricular enlargement is more sensitive indicator of the ageing brain than brain

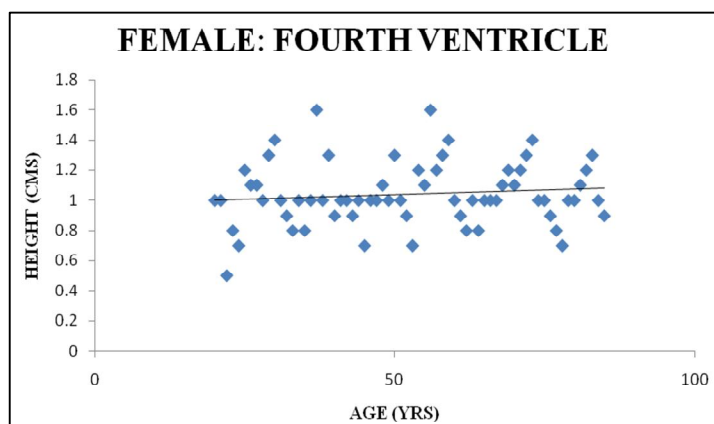


Figure 4

Correlation of age with greatest height of fourth ventricle for all male and female samples

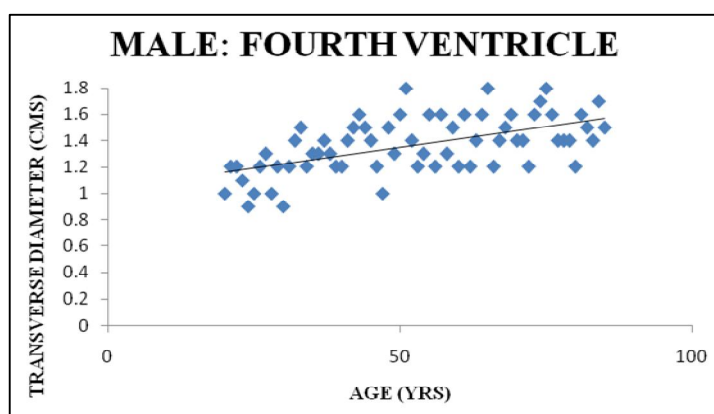


Figure 5

Correlation of age with greatest transverse diameter of fourth ventricle for all male samples

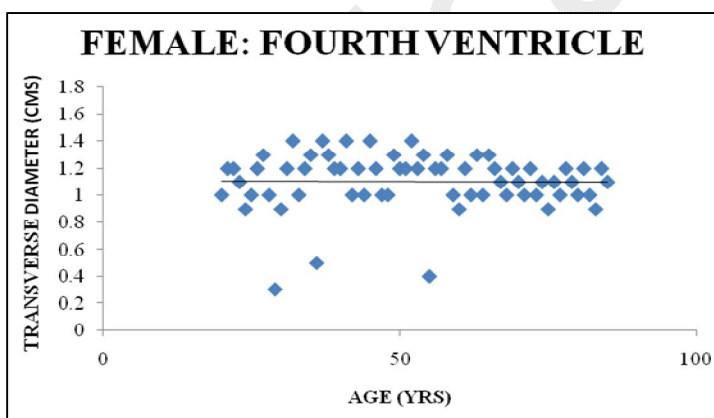


Figure 6

Correlation of age with greatest transverse diameter of fourth ventricle for all female samples

atrophy. With the advent of computed tomography radiologist now have a non invasive, safe method to study ventricular system without complication. In present study brain CT scan images of 200 patients were studied from these images the dimensions of ventricles and brain was measured and the range of change in ventricular size and brain was studied. Studies by Gawler et al., (1976) revealed that the greatest distance between the roof and the floor of the fourth ventricle was 1.08 cm. D'souza and Natekar et al., studied 1000 patients by CT scan for the various morphometric measurements of the ventricles of the brain. It was observed that the height of fourth ventricle was significantly larger in males (1.18 +/- 0.27 cms) than females (1.11 +/- 0.24 cms). The width of fourth ventricle was found to be greater than the height in both gender and was more in males (1.31 +/- 0.23) than in females (1.21 +/- 0.22).

In present study the mean greatest height of the fourth ventricle of males was 1.12 cm and of females was 1.01 cm. When correlated with age, the mean greatest height of fourth ventricle of males was 1.12 cms with standard deviation (SD) of 0.152 and females was 1.01 with standard deviation (SD) of 0.207, which was statistically significant in both. The height of fourth ventricle was greater in males as compared to females. The mean greatest transverse diameter of males was 1.28 cms, and of females was 1.21 cms. When correlated with age the mean transverse diameter in males was 1.28 cms with standard deviation (SD) of 0.219 and in females was 1.21 cms with standard deviation (SD) of 0.186 which was statistically significant in both. Transverse diameter of fourth ventricle was greater in males than in females. In addition vertical distance of fourth ventricle was also measured (Figures 7 & 8). The mean greatest vertical distance of males was 1.41 cm, and females were 1.37 cm. When correlated with age the mean greatest vertical distance of fourth ventricle for males was 1.41 cm with standard deviation (SD) of 0.297 and 1.37 cm with standard deviation (SD) of 0.239 in females, which was statistically not significant in both. Thus it was seen that the dimension of fourth ventricle increases with age (Table 8).

6. SUMMARY AND CONCLUSION

The present study was done at our Government, Municipal and private hospitals after due consent of patients from city to study changes in the size of fourth ventricle during ageing. The CT scan images of the fourth ventricle were studied and we found following measurements. The mean greatest height of fourth ventricle of males was 1.12 cms (SD 0.152) and female was 1.01 cms (SD 0.207). The height of fourth ventricle was greater in males as compared to females which was statistically significant in both. The mean transverse diameter of males was 1.28 cms (SD 0.219) and in females was 1.21 cms (SD 0.186) which was statistically significant in both. Transverse diameter of fourth

ventricle was greater in males than in females. The mean greatest vertical distance of fourth ventricle for males was 1.41 cms (SD 0.297) and 1.37 cms (SD 0.239) in females which was statistically not significant in males and females. The conclusion of present study is, "The dimensions of fourth ventricle increases with age. This change was more in age above 60 years".

Table 8

Parameters		Gawler et al	D'souza & Natekar		Present Study	
			Males	Females	Males	Females
Height	Mean	1.08	1.18	1.11	1.12	1.01
	SD	--	+ 0.27	+0.24	+0.152	+0.207
Vertical Distance	Mean	--	--	--	1.41	1.37
	SD	--	--	--	+0.297	+0.239
Transverse Diameter	Mean	--	1.31	1.21	1.28	1.21
	SD	--	+0.23	+0.24	+0.219	+0.186



Figure 7

Transverse measurement of fourth ventricle

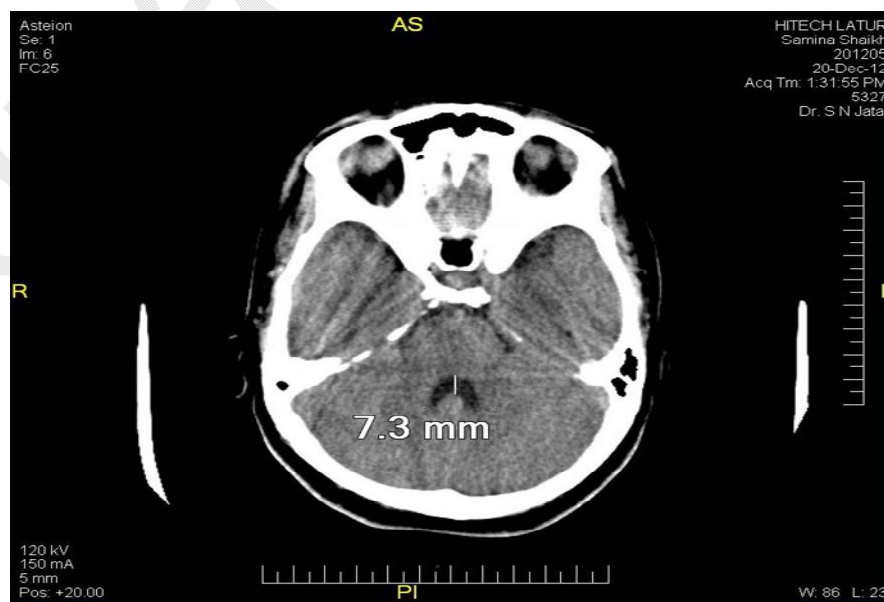


Figure 8

Anterio-posterior measurement of fourth ventricle

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