

Morphometric Study of the Lateral Ventricles of Brain by Imaging Using Computerized Tomography

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Conflict of interest: Nil

Abstract:

Introduction: The human brain has four connected ventricles which form the ventricular system of brain – two lateral ventricles, a third ventricle and a fourth ventricle. Knowing the normal measurements of the cerebral ventricles in the living human has great significance in diagnosing and monitoring several pathologies. The aim of the present study is to determine the average dimensions and variations of the different parts of the normal lateral ventricles of brain by imaging using Computerized tomography.

Materials and Methods: The study was conducted by the Department of Anatomy in association with the Department of Radiodiagnosis, Government Medical College, Thiruvananthapuram. A total of 200 CT brain of individuals which included 100 males and 100 females, in the age group 10 – 90 years, with normal radiological findings, were taken for the study.

Results: The measurements of the different parts of the lateral ventricle, except inferior horn, were more in males compared to females and more on the left side than right side. Measurements of the inferior horn showed that the transverse diameter was more in females than males on both the sides. Height of inferior horn was found to be 0.23 mm more on the right side in males and 0.12 mm more on the right side in females.

Conclusion: From the present study, the different parts of the left lateral ventricle was found to be larger than the right side in both genders. The size of the ventricular system was seen to be varying with age, that is, it increased with an increase in age. This study has defined the morphometric measurements of the different parts of the lateral ventricles of brain by CT scans in South Kerala population. This can be useful to many clinicians and would aid in the diagnosis and management of many neurological conditions.

Keywords: Morphometry, Lateral Ventricles, Computerized Tomography, Interventricular Foramen, Brain.

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Introduction

The cavity within the brain forms the ventricular system which is filled with cerebrospinal fluid. The lateral ventricles are the largest paired ventricles present within the cerebrum; the third ventricle is located in the diencephalon of the forebrain between the thalami; and the fourth ventricle is located posterior to the pons and the open part of the medulla oblongata of the hindbrain. The cerebral ventricular system consists of a series of interconnecting spaces and channels which originate from the central lumen of the embryonic neural tube. The ventricular system which is filled with cerebrospinal fluid (CSF), is an important part of the brain [1]. Understanding the normal anatomy and the variations of the ventricular system of brain is helpful for clinicians, neurosurgeons and radiologists in their day-to-day clinical practice [2].

As ageing progresses, the brain undergoes changes, leading to the enlargement of the ventricles [3]. Both imaging and autopsy studies have revealed that there is a correlation with increase in cerebrospinal fluid spaces and reduction in cerebral volume accompanying normal human ageing [4,5]. Enlargement of cerebrospinal fluid spaces during ageing is generally diffuse [6]. There is regression of thalamic nuclei after 50 years of age [7]. There is more shrinkage with age in the frontal cortex, brain stem and diencephalic structures [8]. Also, it has been found from many other studies that the left lateral ventricle is normally larger than the right side. This reflects that usually the ventricular system is larger in the dominant hemisphere [9]. Various studies clearly show an increase in the CSF spaces in dementia, especially in neurological

conditions such as Alzheimer's disease and Parkinson's disease [10].

The present study was done to analyse the morphometric measurements of the different parts of the lateral ventricles of brain by imaging using CT scan method. It is intended to provide information regarding the average size of the normal lateral ventricles of brain in the population of South Kerala. Also, the gender-wise and the side-wise changes in values of the ventricular size on both sides was determined.

Materials and Methods

The present study was a descriptive cross-sectional study conducted in Department of Radiodiagnosis, Government Medical College, Thiruvananthapuram. Two hundred (200) CT scans of brain were selected for the study which included individuals in the age group 10 to 90 years. The number of males and females included in the study were 100 each. Data for the study was collected randomly from CT scans which were reported as normal by the radiologists. Those patients who came with history of head injuries, previous intracranial surgeries or showing local mass lesion and cerebral infarctions, were not included in the

study. Informed consent was taken from each patient for the purpose of the conduct of the study. For those patients between 10 to 18 years of age, informed consent was taken from the parents or local guardian.

From the CT scan of brain of the study group, 3-4 slices of the CT films in which the lateral ventricles are seen were studied. Measurements were taken at three levels:

- At the level of interventricular foramen of Munro
- Above the level of interventricular foramen of Munro
- Below the level of interventricular foramen of Munro

Study variables

- Length of frontal horn of lateral ventricle
- Length of body of lateral ventricle
- Length of posterior horn of lateral ventricle
- Transverse diameter of inferior horn of lateral ventricle
- Height of inferior horn of lateral ventricle



Figure 1: CT scan at the level of interventricular foramen showing frontal horn, body and posterior horn of lateral ventricle

- 1-2 (A) = Length of frontal horn of lateral ventricle
(From interventricular foramen to the tip of frontal horn)
- 2-3 (B) = Length of body of lateral ventricle
(From interventricular foramen to collateral trigone)
- 3-4 (C) = Length of posterior horn of lateral ventricle
(From collateral trigone to the tip of posterior horn)

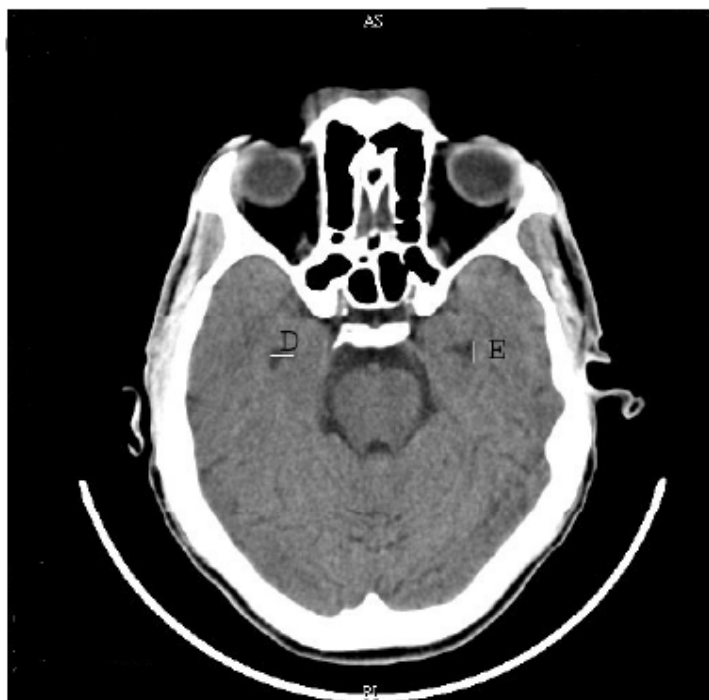


Figure 2: CT scan of brain below the level of interventricular foramen showing inferior horn of lateral ventricle

D = Transverse diameter of inferior horn
 E = Height of inferior horn

(Statistical Presentation System Software, SPSS) for windows version 16.

Statistical Analysis

All the data collected were entered as mean and standard deviation. It was analysed and expressed in tables. The side-wise and gender-wise comparison of the different parts of the lateral ventricles of brain was performed using independent Student’s t-test and p-value was calculated. All the statistical calculations were done using the software SPSS

Ethical Clearance

Before the conduct of the study, approval was obtained from the Institutional Ethics Committee of Government medical college, Thiruvananthapuram.

Results

In the present study, 200 CT scans of brain in individuals from 10 to 90 years of age, were studied and analysed.

Table 1: Length of the frontal horn of lateral ventricle

	Side	Female				Male			
		Number	Mean(mm)	SD	p value	Number	Mean(mm)	SD	p value
Length of Frontal Horn	Right	100	29.16	2.440	0.000	100	30.05	2.516	0.000
	Left	100	30.20	2.433		100	31.41	2.637	

The length of the frontal horn is more in males and is also found to be more on the left side in all age groups.

Table 2: Length of the body of lateral ventricle

	Side	Female				Male			
		Number	Mean (mm)	SD	p value	Number	Mean (mm)	SD	p value
Length of Body of Lateral Ventricle	Right	100	47.40	2.601	0.000	100	49.66	2.641	0.000
	Left	100	48.77	2.693		100	50.81	2.842	

The length of the body is more on the left side than the right side in both sexes.

Table 3: Length of the posterior horn of lateral ventricle

	Side	Female				Male			
		Number	Mean (mm)	SD	p value	Number	Mean (mm)	SD	p value
Length of Posterior Horn	Right	100	26.20	1.995	0.000	100	27.12	2.297	0.000
	Left	100	27.44	2.479		100	28.52	2.529	

The length of posterior horn is more in males. Length of left posterior horn is more than right in both sexes.

Table 4: Transverse diameter of the inferior horn of lateral ventricle

	Side	Male				Female			
		Number	Mean (mm)	SD	p value	Number	Mean (mm)	SD	p value
Transverse Diameter of Inferior Horn	Right	89	8.11	2.652	0.822	87	8.54	2.710	0.410
	Left	89	8.07	2.672		87	8.37	2.688	

The transverse diameter is more in females than males on both the sides.

Table 5: Height of the inferior horn of lateral ventricle

	Side	Female				Male			
		Number	Mean (mm)	SD	p value	Number	Mean (mm)	SD	p value
Height of Inferior Horn	Right	89	3.25	1.161	0.325	87	3.60	1.351	0.091
	Left	89	3.13	1.036		87	3.37	1.152	

The height of inferior horn is more in males on right and is almost equal in both sexes on left side.

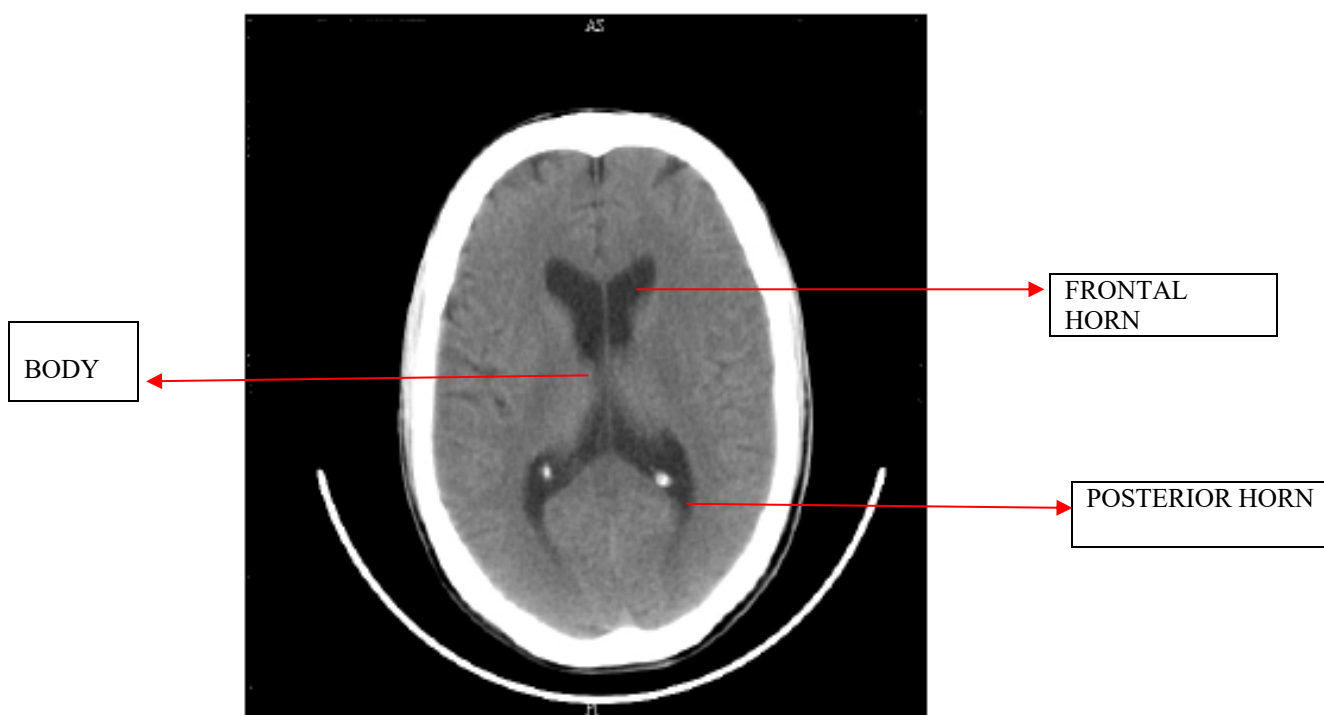


Figure 3: CT scan of the brain of 23 years old male showing frontal horn, part of body and posterior horn of lateral ventricle



Figure 4: CT scan of the brain of 67 years old male showing section of the inferior horn of lateral ventricle

Discussion

Table 6: Comparison of the length of frontal horn of lateral ventricle

	Mean Length of Frontal Horn			
	Males		Females	
	Right	Left	Right	Left
D'Souza et al [11]	27.4±3.6	27.8±3.7	25.5±3.3	25.8±3.5
Brij et al [12]	25±3.18	26.2±2.94	25.3±3.5	26.5±3.3
Gameraddin et al [13]	28.53±3.88	28.53±3.88	26.16±4.21	26.17±4.23
Present study	30.05±2.51	31.41±2.63	29.16±2.44	30.20±2.43

In the present study, the length of the frontal horn is more in males than in females which is in accordance with D'Souza et al, Brij et al and Gameraddin et al studies. Also, it is more on the left side when compared to right.

Table 7: Comparison of the length of the frontal horn and body of lateral ventricle

	Mean Length of Frontal Horn And Body			
	Males		Females	
	Right	Left	Right	Left
D'Souza et al [11]	69.6±7.6	70.9±7.8	65.7±7.7	67.3±7.7
Brij et al [12]	55.7±6.1	56.7±6.6	55.1±6.9	56.2±7.5
Gameraddin et al [13]	74.8±9.89	74.89±9.86	70.06±8.83	69.56±11.42
Present study	79.65± 2.6	82.2± 2.7	76.1± 2.5	78.9± 2.7

The length of the frontal horn and body in the CT scan study was 9-11 mm more in the present study compared with that of D'Souza study (2007)[11] and 15-20 mm more when compared to Brij et al study[12]. In Gammeraddin et al study[13], the measurements were almost similar to that of the present study.

Table 8: Comparison of length of the posterior horn of lateral ventricle

Parameter	Duffner's Study (MRI) (30)	Present Study (CT) (200)
Length of posterior horn (mm)	28	27.1
Range (mm)	13 – 56	22 – 35
SD	12.2	2.3

The length of the posterior horn in the present CT scan study is almost the same when compared to Duffner's study (2003)[14] done by MRI. Thus, both CT scan and MRI studies done on lateral ventricles of brain are comparable in defining its morphometric measurements.

Another study on lateral ventricles of brain which was done by Edogan AR et al showed that in right handers the volume of the lateral ventricle was higher on the right side when compared to the left side, but in left handers, the value was higher on the left side than that on the right side [15].

Conclusion

Measurements of the different parts of the lateral ventricles, that is, the frontal horn, the body and the posterior horn, were found to be more on the left side when compared to right side in both males and females. On the other hand, the measurements of transverse diameter of inferior horn were more in females than males on both the sides. Height of inferior horn was 0.23 mm more in males and 0.12 mm more in females, on the right side.

From the present study, the left lateral ventricle was found to be larger than the right side in both genders. Both the right and left lateral ventricles were larger in males. The size of the ventricular system was seen to be increasing with increase in age as well. The dilated or enlarged ventricles suggest an atrophy of brain in degenerative neurological conditions as well as in the aging process. Thus, the morphometric measurements of the lateral ventricles of brain in the population of South Kerala has been defined by CT scan study. This could be of great use to the clinicians in the diagnosis and management of neurological conditions.

Abbreviations

CT: Computerized Tomography
MRI: Magnetic resonance imaging
SD: Standard Deviation
CSF: Cerebrospinal fluid

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