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Assessment of Brain Ventricular System by CT in Indian Population and its Clinical Significance

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Abstract

Background: Current radiological diagnosis of various cerebral dystrophy requires subjective judgment for comparing with the normal brain ventricular system dimensions, thereby knowledge of morphometric and size of normal ventricular system of brain is of paramount importance to understand these changes.

Methods: For the present perspective study, computerized tomography (CT) of 500 patients (Males-339 and Females-161) were studied for the measurements of lateral ventricle, third ventricle and fourth ventricle and it was statistically analyzed.

Results: The antero posterior extent of the body of the lateral ventricles on the right side was 75.23 ± 6.8 mm and on the left side was 71.02±7.78 mm; the length of the frontal horns on the right side was 28.2± 2.72 mm and on the left side was 27.7±2.9 mm respectively. The width and height of the fourth ventricle were 11.87±1.08 and 8.9±1.5 mm whereas width of the third ventricle was 5.58±2.10 mm.

Conclusion: The present study has defined the morphometric measurements of the Brain ventricular system (BVS) such as lateral ventricles, third ventricle, and fourth ventricle of the brain of normal individuals which has clinical correlations in diagnosis and for appropriate treatment.

Keywords : Brain ventricular System; Morphometry; PET /CT scan.

Introduction

A unique feature of the vertebrate brain is the brain ventricular system (BVS), a series of connected cavities lying deep within the brain, filled with cerebrospinal fluid (CSF).[1] Lateral ventricles are the largest paired ventricles present within the cerebrum; the third ventricle is in the diencephalon and fourth ventricle is located posterior to the Pons and open part of the medulla oblongata.[1,2] In the recent times for the researchers the objective and morphometric studies of human brain ventricles is under limelight, due to its relation with several disorders such as schizophrenia, hydrocephalus, tumors, trauma and as well age related changes.[3] Estimates of ventricular size are important in diagnosis, in deciding about the need to intervene surgically. The range of changes in ventricular size encountered in clinical practice has led most people to feel that decisions can be taken without an exact measure of ventricular size. But in number of circumstances precise measurements will be of paramount important.[4] It should be noted that there is a continuous debate in the literature of neuroradiology, neurology, neuroanatomy and psychiatry, over the best method of assessing the brain ventricular system and the information known regarding the accurate measurements of the brain ventricles is limited in the literature.[5] By CT scanning BVS it can be studied and well visualized

overall configuration which can be reconstructed from a series of contiguous slices.[6] The present work is undertaken for morphometric analysis of the lateral, third and fourth ventricles of the brain in normal Indian subjects using CT scan.

Clinical Material and Methods

Population Studied

500 participants were prospectively recruited between the age group of 20 to 70 years, attending the department for Brain PET/CT procedure at Institute of Nuclear Medicine & Molecular Imaging, AMRI Hospital, Kolkata. All participants gave written, informed consent for clinical evaluation. Patients with no confirmed history of cerebral infarction, local mass lesions, probable communicating hydrocephalus, alcoholism, drug abuse, trauma or previous intra-cranial surgery and other hereditary diseases and were not on medication at the time of this study. This study was reviewed and approved by the institutional human research committee.

Procedure of CT Scanning Technique

The CT scanner used in this study was the General electric GE discovery 690 PET/CT (64 slices). All CT Scans was performed in axial mode with iterative reconstruction algorithm. The patient was placed on the PET/CT table and the head was centralized and supported for correct positioning and to avoid blurring of images. A lateral scout image was taken to confirm correct positioning of patient. Orbito-meatal line was drawn and a line at an angle of 15-20 degrees to and 1 cm above it was drawn, representing the lowest tomographic section, which passed through the base of skull.[7]

Method of assessment of the Brain ventricle systems

The Procedure for the measurements of BVS followed as:

1. Lateral Ventricle Measurement: a) Length of left lateral ventricular body inclusive of frontal horn (taken from tip of frontal horn to the atrium) can be seen in Figure 1.
2. Level of Interventricular Foramen.
    a. Length of frontal horns of right lateral ventricle in Foramen (measured from its tip to the interventricular foramen).
    b. Length of frontal horns of left lateral ventricle in cm (measured from its tip to the interventricular foramen) can be seen in Figure 2.

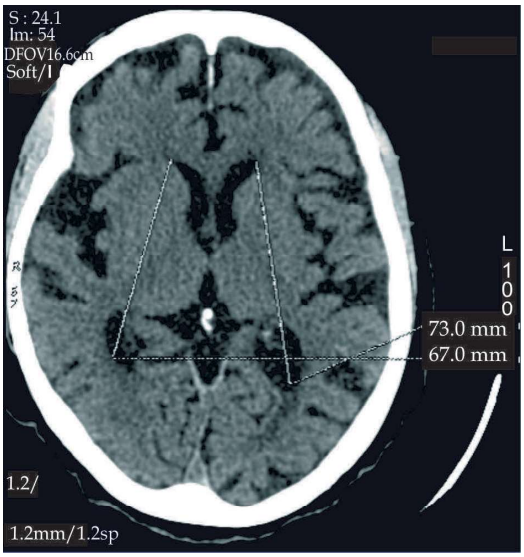

Fig. 1 CT axial image of the brain showing the length of right and left ventricles. The gray lines indicate the height and the width.

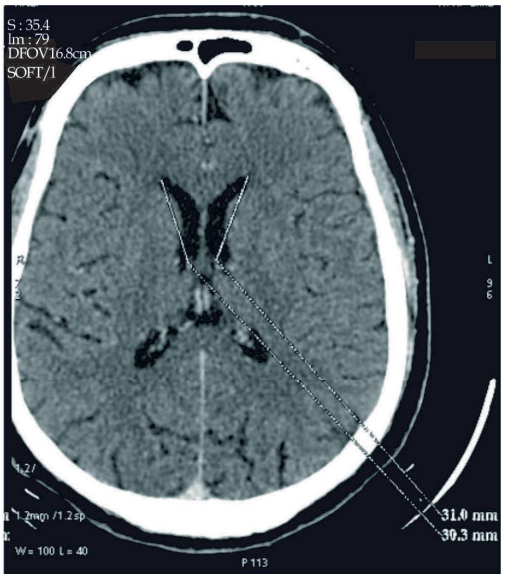

Fig. 2 CT axial image of the brain showing the length of body of the lateral ventricles. The gray lines indicate the length of the body of both lateral ventricles.

3. Level of Third Ventricle
    a. Greatest width of third ventricle in mm can be seen in Figure 3.
4. Level of Fourth Ventricle
    a. Greatest height of fourth ventricle in mm (Figure 4).
    b. Greatest width of fourth ventricle in mm (Figure 4).

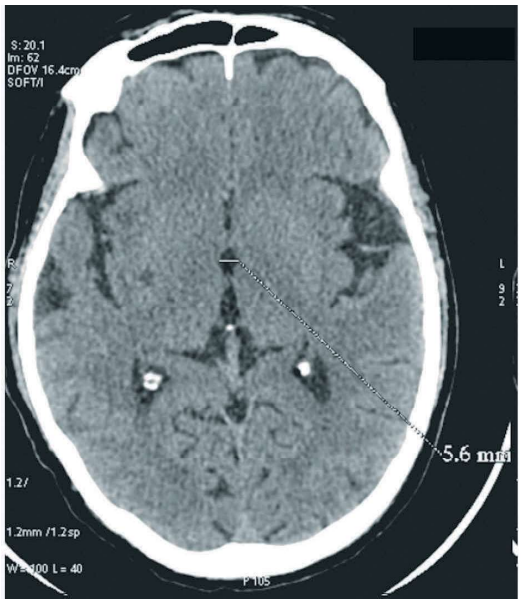

Fig. 3 CT axial image of the brain showing the length of the left lateral ventricle and body of right ventricle. The three lines show the length of body of right ventricle, length of the whole left ventricle and width of the third ventricle respectively.

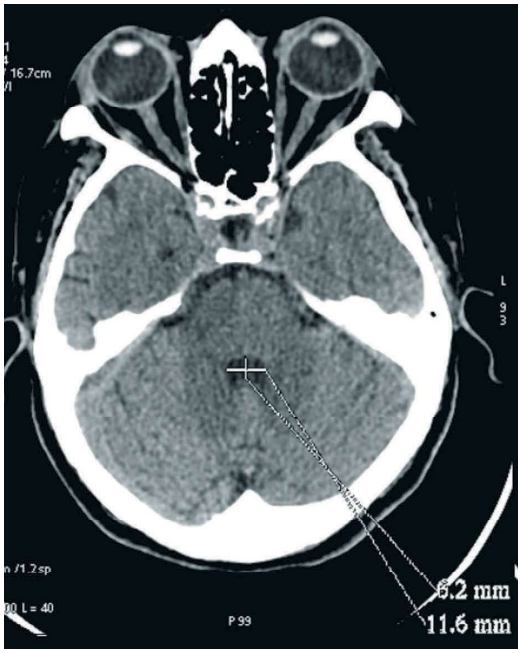

Fig. 4. CT axial image of the brain showing the width and height measurement of the 4th ventricle. The gray lines indicate the height and the width.

2.4. Statistical analysisThe data were analyzed using the SPSS version 20 (SPSS Inc., Chicago, IL, USA). The distribution of the data was checked for normality using Kolmogorov–Smirnov test. Since the data was normally distributed parametric tests were used. Continuous variables were assessed using Student t tests for significance of difference of the measurements between males and females. Two-sided P-values were considered statistically significant at P<0.05. Results are expressed as means±standard deviation (SD) unless otherwise indicated. The correlation between age with width of third and fourth ventricle was determined by Pearson's correlation coefficient.

Results

Among 500 subjects there were more males (339) and than females (161) in this study with a male: female ratio of 1.7:1.0. Most patients were between 24 and 39 years and their mean age was 37.26 years. It was observed that the anteroposterior extent of the body of the right and left ventricles was almost equal in female's 69.10±6.4 mm whereas, it was larger in the right side 75.00±6.76 mm than the left side 74.66±8.4 mm in the males. The length of the frontal horns on the right side was 29.53 +3.88 mm and 27.16 + 4.21 mm in the males and females and on the left side was 30.54±3.4 mm and 26.9±3.2 mm in the males and females (Table 2). The mean height and width of the fourth ventricle were 9.90±2.1 and 13.0±1.1mm in the males and 9.6±1.2 mm and 11.9±1.5mm in the females respectively [Table-2]. On correlation between width of third and fourth ventricle with age showed positive correlation which was statistically significant as shown in (Table-3). The measurement of the ventricles was obtained from the CT monitor using the curser were shown in Figures 1-4.

Table 1: Descriptive Statistics of Study Population.

	Percentage	Age (Mean±SD)
Males	339 (67.8%)	35.10±2.64
Females	161 (32.2%)	29.09±2.45

Table 2: List of ventricular measurements (mean ± SD) in males and females.

Parameters	Mean ± SD	(Max-Min)	P-value
	Males (n=339)	Females (n=161)	
Length of body of the right ventricle	75.00±6.76	69.66±8.4	0.010*
Length of body of the left ventricle	74.66±8.4	69.10±9.4	0.032**
Length of right frontal horn of Lateral ventricle	29.54±3.4	27.4±3.2	0.044**
Length of left frontal horn of lateral ventricle	29.83±4.7	26.9±3.2	0.015*
Width of the third ventricle	5.8±1.5	5.2±1.9	0.005*
Height of the fourth ventricle	9.90±2.1	9.6±2.2	0.556
Width of the fourth ventricle	13.0±1.2	11.9±1.5	0.024*

* P value significant at the level of 0.005; ** P value significant at less than 0.05.

Table 3: Correlation study between age and width of the 4th and 3rd ventricles.

	Pearson Correlation Coefficient	P value
Width of 4th ventricle and age	0.227	0.045
Width of the third ventricle and age	0.389	0.029

Discussion

The ventricular size of the brain is likely to be an increased in several neurological disorders such as hydrocephalus, cerebral atrophy, Alzheimer's disease, Parkinson's disease, in which precise measurements will be of important value.[8] Volumetric and Morphometric study of cerebral ventricles provides useful indices of cerebral asymmetry and atrophy[9]. A study by Williams P, L et al[10]. shown that the left lateral ventricle was larger than the right one and both were of same size in females. But our study results are contrary to the previous study wherein in males right one in slightly larger than left and both left and right ventricles were large in males compared to females. This is because males skull were heavier and bigger, the capacity of the skull is more compared to female skull and also because the brain size is more in males compared to females.[10]

Our study results revealed that the length of the right frontal horns was 29.54±3.4 mm in males and 27.4±3.2 mm in females and that of left frontal horns was equal to the right one in the males but slightly shorter in the females 26.9±3.2 mm. Studies by D'Souza and Natekar revealed that the height of fourth ventricle was 13.0±1.2and 11.9±1.5mm for the male and female respectively.[11]

Earlier study by Gawler et al.[12] revealed that the greatest distance between the roof and the floor of fourth ventricle was less than 10.8 mm; however in our study this distance was significantly lesser (9.90±2.1mm) in males and females (9.6±2.2 mm) with the mean 9.50 ± 0.17 mm and it has been found that the width of the fourth ventricle was found to be greater than the height in both genders and was more in males (13.0±1.9) than in females 12.0±2.0) with the mean 12.4±1.08 mm. Gawlar J et al.[12], Soininen et al[13]., D'Souza et al.[11], Meshram, P et al.[14], Brinkman et al.[15] measured the width of third ventricle, found that the maximum mean width of the third ventricle was 5.9 mm, 9.2 mm, 4.2 mm. In our study, found this measure was significantly higher in males (5.8 mm) as compared to females (5.2 mm) with mean (5.5 mm). On performing student 't' test to all the parameters between right and left in male and female have showed significant results (P<0.05) except height of fourth ventricle (p=0.556) [Table 2].

Conclusion

The study provided useful morphometric data to better understand the lateral, third and fourth ventricles while diagnosing clinical problems associated with the various types of ventricular enlargement and other pathologic disorders.

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