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Original Research Article

Morphometric Study of the Normal Third and Fourth Ventricular Sizes on Computed Tomography

Dr. Kanakaraj K, Dr. Kalaichezhian Mariappan, Dr. Sunil Kumar
Dept. of Radiology and Imaging sciences, Sree Balaji Medical College and Hospital, Chromepet, Chennai-44.

***Corresponding author**
Dr. Kanakaraj K
Email: sbmch.radio@gmail.com

Abstract: The objective of this study is to establish baseline reference values for the third and fourth ventricular dimensions on normal brain Computed Tomography for patients, standardized for sex and age, from a sample pooled from patients who attended Radiology centre at Sree Balaji Medical College and Hospital. Six hundred and eighty five normal brain Computerized Tomograms (CT) of patients aged between ten and ninety years were obtained from our hospital diagnostic radiology centre, in SBMCH. They consisted of 357 males and 328 females. All patients with abnormal imaging findings of various intracranial and intraventricular pathology are not included. The images were analysed on viewing monitor and the measurements were made. The normal measurements of third and fourth ventricle were recorded. The normal measurements were then categorized based on age and sex. Normal third ventricle size was 4.06 ± 2.41 mm for males and 3.25 ± 1.80 mm females. Normal fourth ventricle size was 12.16 ± 2.05 mm in males and 11.38 ± 1.06 mm in females. This study shows variations of ventricular dimensions between males and females. The ventricular dimensions are smaller in females than in males. Our present study also has shown significant differences between male and female in relation to both the third and fourth ventricles measurement.

Keywords: brain, Fourth Ventricular Size, Tomography.

INTRODUCTION

The human cerebral ventricular system contains a series of interconnecting spaces and channels which derives from the central lumen of embryonic neural tube. The ventricular system in the cerebral hemispheres consists of two lateral ventricles; midline third and fourth ventricles connected by inter ventricular foramen and aqueduct of Sylvius respectively. A thorough Understanding of the normal and abnormal anatomy of the ventricular system of brain is helpful for the neurophysicians, neurosurgeons, and radiologists in their daily clinical practice. In the past the older techniques like Pneumoencephalography and ventriculography are used for visualizing the ventricular system by injecting air or contrast through lumbar puncture under local anesthesia [1, 2]. In children the Ventricular system can also be studied by two dimensional ultrasonic studies through the fontanelle [3]. In recent times, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI) have replaced the older methods of studying ventricular system [4]. The digital CT scan machines currently in use also allow direct visualization of ventricles in cross sectional images and direct real time measurement of various dimensions of the ventricular system thus assisting in understanding its anatomy. Morphometric analysis of cerebral ventricular system is essential for evaluating changes due to ageing, growth, and the various intrinsic and extrinsic pathologies [5]. Knowledge of anatomy of cerebral ventricular system is important for neurosurgery. It helps the neurosurgeons for accurate localization and complete removal of space occupying lesions around ventricular system [6]. The study of shape and size of ventricular system recently has become a main focus of interest in studies of some neuropsychiatric diseases like schizophrenia and Alzheimer's disease and chronic alcoholism [7-11]. Morphometric analysis of ventricular system is also helpful in the diagnosis and classification of hydrocephalus and in assessment, follow-up of enlargement of ventricular system during therapy (ventricular shunts) [12, 13]. The objective of this study is to establish baseline reference values for the third and fourth ventricular dimensions on normal brain Computed Tomography for adult patients, standardized for sex and age, from a sample pooled from patients who attended radiology Centre at Sree Balaji medical college and research institute.

METHODOLOGY

Procedure

The brain CT scans were taken from referred patients complaining of headaches , head injury, seizure disorders etc but whose CT scan reading were

found to be normal during the past one year. Ethical clearance was sought from and granted.

Patient selection

Six hundred and eighty five normal brain Computerized Tomograms (CT) of patients aged between ten and ninety years were obtained from our hospital diagnostic radiology centre, in sbmch. They consisted of 357 males and 328 females. All patients with abnormal imaging findings of various intracranial and intraventricular pathology are not included.

CEREBRAL VENTRICULAR MEASUREMENTS

The computed tomographic images were retrieved from the database of our ct machine HITACHI for the past one year. All the patients underwent both plain and contrast examinations utilizing our departmental HITACHI MULTI SLICE SCANNER at 2mm slice thickness at skull base and 5mm subsequently up to the vertex. The images were analysed on viewing monitor and the measurements were made using a computer program Dicom Viewer; which is a software tool at the disposal of radiologists. The measurement is calibrated to 0.1 millimeters.

The researcher made the following measurements

The third ventricle is a slit-like cavity, lies between the right and the left halves of the diencephalon (between two halves of the thalami). It communicates with the lateral ventricles above via interventricular foramina of Monro and with the fourth ventricle below via the cerebral aqueduct of Sylvius. The greatest distances between each lateral margin of the third ventricle is measured.

The fourth ventricle is pyramid-shaped cavity filled with CSF situated in the posterior part of the pons and the cranial part of the medulla and anterior to the cerebellum. Inferiorly, it tapers to a narrow channel that continues into the cervical region of the spinal cord as the central canal. The greatest width of the fourth ventricle is measured.

Fig-1: Measurement of third ventricle

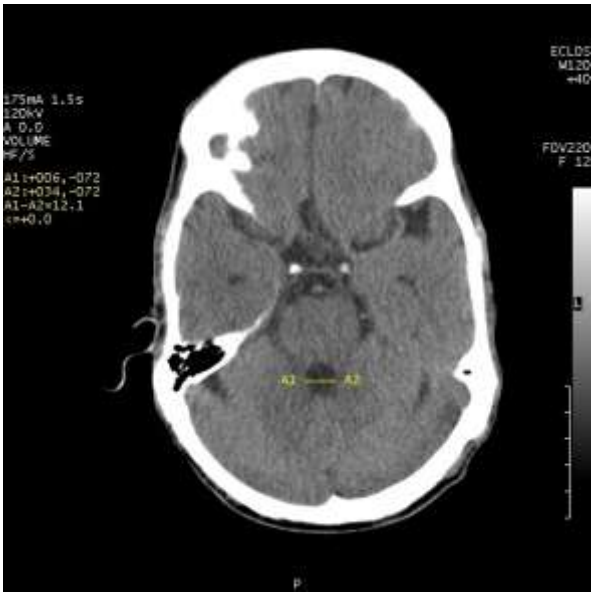

Fig-2: Measurement of fourth ventricle

The measurements listed above were used to compute the following ratios

STATISTICAL ANALYSIS OF DATA

Statistical analysis of the data was performed by using Statistical Package. The mean, standard deviations and standard errors of all measurements were estimated and 95% confidence interval, both upper and lower, was calculated for all. The data was analysed for significance if differences of the measurements between males and females.

OBSERVATIONS AND RESULTS

The patients are categorized into nine groups according to their ages as shown in the table-1 they consisted of 357 males and 328 females.

Table-1: Distributions of patients

AGE GROUP	MALE + FEMALE	MALE	FEMALE
0-10	37	27	10
11-20	89	45	44
21-30	148	89	59
31-40	107	44	63
41-50	106	48	58
51-60	97	47	50
61-70	57	28	29
71-80	31	21	10
81-90	13	8	5
Total	**685**	**357**	**328**

Table-2: Shows mean IIIrd and IVth ventricles measurement by age groups

Age Group	Male III	Male IV	Female III	Female IV
0-10	3.17±2.95	11.60±1.83	2.33±1.02	11.81±2.06
11-20	2.36±0.91	11.44±1.62	2.56±1.02	11.54±1.71
21-30	3.31±1.84	12.15±1.59	2.56±0.88	11.26±1.33
31-40	3.66±1.6	12.38±1.8	2.71±0.87	11.27±1.27
41-50	4.42±1.9	12.48±1.8	3.33±1.25	11.17±1.56
51-60	4.67±1.4	12.43±2.3	3.58±1.36	11.15±1.47
61-70	4.93±2.28	12.28±2.63	4.84±2.31	11.60±2.23
71-80	6.99±2.09	13.36±2.91	4.99±1.35	12.05±1.29
81-90	8.43±1.89	12.90±2.3	7.76±1.66	12.42±1.97

Table-3: Shows mean third and fourth ventricles measurement by gender

	Male + Female	Male	Female	P value
III	3.62 ± 1.96	4.06 ± 2.41	3.25 ± 1.80	<0.0001
IV	11.81 ± 1.85	12.16 ± 2.05	11.38 ± 1.06	<0.0001

The highest of dimensions in the third and fourth ventricle occur in the highest age group of > 70 yrs in both males and females.

DISCUSSION

This study shows variations of ventricular dimensions between males and females. The ventricular dimensions are smaller in females than in males

Significant sex related differences in measurements of the ventricular system using a rather small sample of adults, were reported by Gyldensted and Kosteljanetz [14].

This variation of ventricular sizes with sex was also observed by skullerud and gyldensted who documented that there are variations in the human brain, conditioned by differences in age, sex, and BMI and that these differences all have significant effects on ventricular sizes [15].

Women were found to have smaller brains and lateral ventricles than men even when the difference in height is taken into account. They observed that this difference was in proportion to the smaller size of the female cerebral hemispheres. The age difference among males and females in this study was statistically significant, and this could also account for the difference in their ventricular sizes [15].

Hamidu *et al*. 2015 reported that the mean third and fourth ventricular sizes were greater in males as compared to females, although this difference is statistically significant only for the third ventricle [16].

Our present study also have shown significant differences between male and female in relation to the third ventricle measurement but no significant differences noted for the fourth ventricle.

In addition, it has been observed that there is a reduction in brain weight, which probably starts after the age of 55 years. This shrinkage, he stated increases in ventricular sizes as a compensatory mechanism to cerebral atrophy, which occurs as a physiological process following aging [15].

THIRD VENTRICLE SIZE

The range in the current study of the third ventricle width was between 2.33 to 7.76 millimeters in females, 3.17 to 8.43 millimeters in males and there was a steady rise across age groups until the seventh decade, after which there was a sharp rise. This is because in normal aging ventricles undergo compensatory dilatation with increasing age due to factors such as cortical atrophy, a common feature at this age range [17].

The general trend that third ventricle sizes in males were larger than those in females was confirmed. The current findings were also in agreement with studies by Celik *et al*., (1995) in which compared to women, the size of the third ventricle was larger in men [18].

THE FOURTH VENTRICLE

Fourth ventricle width was generally found to be larger in males than in females, a finding which was statistically significant in a study by Gawler *et al.*, [19]. The latter reported a ventricular width of 10.8 mm comparable with 10.5 mm in the current study. Our study of fourth ventricular width was between, 11.54 to 12.05 in females, 11.6 to 13.36 in males.

In summary, normal third and fourth ventricular sizes have been obtained in order to serve as a standard normogram in our hospital diagnostic radiology department.

REFERENCES

1. Gawler J; du Boulay GH; Bull JHD; Marshall J. Computed Tomography: A comparison with pneumoencehalography and ventriculography. Journal of Neurology, Neurosurgery and Psychiatry. 1976. 39:203-211.
2. EVANS WA. An encephalographic ratio for estimating ventricular enlargement and cerebral atrophy. Archives of Neurology & Psychiatry. 1942 Jun 1;47(6):931-7.
3. Davies MW, Swaminathan M, Chuang SL, Betheras FR. Reference ranges for the linear dimensions of the intracranial ventricles in preterm neonates. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2000 May 1;82(3):F218-23.
4. Sabattini L. Evaluation and measurement of the normal ventricular and subarachnoid spaces by CT. Neuroradiology. 1982 Mar 1;23(1):1-5.
5. LeMay M. Review. Radiologic changes of the aging brain and skull. American journal of neuroradiology. 1984 May 1;5(3):269-75.
6. Jacoby RJ, Levy R, Dawson JM. Computed tomography in the elderly: I. The normal population. The British Journal of Psychiatry. 1980 Mar 1;136(3):249-55.
7. McCarley RW, Shenton ME, O'Donnell BF, Faux SF, Kikinis R, Nestor PG, Jolesz FA. Auditory P300 abnormalities and left posterior superior temporal gyrus volume reduction in schizophrenia. Archives of General Psychiatry. 1993 Mar 1;50(3):190-7.
8. Ashtari M, Zito JL, Gold BI, Lieberman JA, Borenstein MT, Herman PG. Computerized volume measurement of brain structure. Investigative Radiology. 1990 Jul 1;25(7):798-805.
9. Gallia GL, Rigamonti D, Williams MA. The diagnosis and treatment of idiopathic normal pressure hydrocephalus. Nature Clinical Practice Neurology. 2006 Jul 1;2(7):375-81.
10. Rohlfing T, Sullivan EV, Pfefferbaum A. Deformation-based brain morphometry to track the course of alcoholism: Differences between intra-subject and inter-subject analysis. Psychiatry Research: Neuroimaging. 2006 Mar 31;146(2):157-70.
11. Duffner F, Schiffbauer H, Glemser D, Skalej M, Freudenstein D. Anatomy of the cerebral ventricular system for endoscopic neurosurgery: a magnetic resonance study. Acta neurochirurgica. 2003 Jun 1;145(5):359-68.
12. Łosowska-Kaniewska D, Oles A. Imaging examinations in children with hydrocephalus. Advances in Medical Sciences (De Gruyter Open). 2007 Jan 2;52.
13. Ambarki K, Israelsson H, Wåhlin A, Birgander R, Eklund A, Malm J. Brain ventricular size in healthy elderly: comparison between Evans index and volume measurement. Neurosurgery. 2010 Jul 1;67(1):94-9.
14. Gyldensted C. Measurements of the normal ventricular system and hemispheric sulci of 100 adults with computed tomography. Neuroradiology. 1977 Jan 1;14(4):183-92.
15. Skullerud K. Variations in the size of the human brain. Influence of age, sex, body length, body mass index, alcoholism, Alzheimer changes, and cerebral atherosclerosis. Acta neurologica Scandinavica. Supplementum. 1984 Dec;102:1-94.
16. Hamidu AU, Olarinoye-Akorede SA, Ekott DS, Danborno B, Mahmud MR, Balogun MS. Computerized tomographic study of normal Evans index in adult Nigerians. Journal of neurosciences in rural practice. 2015 Jan;6(1):55.
17. LeMay M, Hochberg FH. Ventricular differences between hydrostatic hydrocephalus and

hydrocephalus ex vacuo by computed tomography. Neuroradiology. 1979 Jan 1;17(4):191-5.
18. Celik HH, Gürbüz F, Erilmaz M, Sancak B. CT measurement of the normal brain ventricular system in 100 adults. Kaibogaku zasshi. Journal of anatomy. 1995 Apr;70(2):107-15.
19. Gawler J; duBoulay GH; Bull JHD; Marshall J. Computed Tomography: A comparison with pneumoencehalography and ventriculography. Journal of Neurology, Neurosurgery and Psychiatry. 1976.