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MORPHOMETRIC STUDY OF THE ADULT HUMAN BRAIN VENTRICULAR SIZES ON COMPUTED TOMOGRAPHY SCANS IN NIGERIAN.

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ABSTRACT

Background: Aging as well as pathological conditions are associated with gross brain changes leading to enlargement of the ventricles. Knowledge of the normal ventricular sizes is important to understanding these changes. **Aim:** To establish base line values of the 3rd, 4th and lateral ventricles of the brain in north-central Nigeria for reference purposes. **Materials and method:** A retrospective review of axial images from Computed Tomography (Philips 16 brilliance) were conducted. Measurements were done using in-built linear calipers of the CT machine. The anterior-posterior (AP) lengths of the body of the lateral ventricles in their entirety were measured on both sides; the length of the anterior horns on both sides were obtained at the level of the foramen of Morrow; the widest diameter of the third and that of the forth ventricles with its height were obtained at their corresponding levels; these were statistically analyzed. **Result:** 132 subjects (Males 90; Females 42) were studied. The anterior-posterior extent of the body of the lateral ventricles on the right side was 79.94 ± 7.26 mm and 74.29 ± 6.94 mm in the males and females and on the left side was 80.95 ± 6.71 mm and 76.84 ± 6.35 mm in the males and females respectively; the length of the frontal horns on the right side was 29.70 ± 3.79 mm and 27.57 ± 2.66 mm in the males and females and on the left side was 31.08 ± 3.47mm and 28.89 ± 3.72 mm in the males and females respectively. The width and height of the fourth ventricle were 11.88 ± 2.69 mm and 11.8 ± 2.08 in the males and 11.93 ± 2.15 mm and 11.11 ± 2.24 in the females. The width of the third ventricle was 5.08 ± 2.03mm and 3.91 ± 0.98 mm in the males and females respectively. **Conclusion:** The morphometric measurement of the lateral ventricles, the third and the fourth ventricles have been established. This will aid in patient management and also serve as reference figures in our environment for demographic purposes.

KEYWORDS: Human brain, lateral ventricles, 3rd and 4th ventricle, Computed Tomography.

INTRODUCTION

Radiologists are frequently faced with problems of deciding whether ventricles are within normal limits or enlarged for a patient's age. Such decisions are often based on experience that may be subjected to judgmental errors resulting to misdiagnosis.[1,2] In the fields of neuroanatomy, psychiatry, neuroradiology and neurology, there has been debate over the best method of assessing the various parts of the cerebral ventricular system.[3]

The ventricular system of brain is the cavity of brain. The largest is the lateral ventricle, it is paired, located in the cerebrum. The unpaired; the third ventricle is in the diencephalon of the forebrain between the two thalami and the fourth ventricle, is located at the back of the pons and upper half of the medulla oblongata of the hindbrain.[4]

The variation in the cerebral hemispheres, as a result of differences in sex, age and body mass index (BMI) all have considerable effects on ventricular sizes. It is documented that women have smaller brain and ventricles than men,[5] this is probably because males have heavier and bigger skull, the capacity of the skull is 10% more compared to female skull. Physiologically, the brain parenchyma shrinks in size as age advances while the cerebrospinal fluid spaces which include the ventricles increase in size in order to compensate for the atrophying brain parenchyma.[6]

Several authors including Duffer et al and Jacoby et al have documented that Morphological analysis of the anatomy of the ventricular system of the brain is important for Neurosurgeons during surgical intervention.[7,8] Furthermore, due to increased evidence in changes associated with pathological conditions such

as schizophrenia, tumors, trauma, alcoholism… etc., as well as gender and aging which could lead to dementia and or brain geriatric, morphological analysis of the human brain of recent has been extensively scrutinized.[9,10,11] Lastly, ventricular size measurement are crucial in the diagnosis and classification of hydrocephalus and follow-ups after ventricular shunts interventions.[12,13]

This morphometric analysis of the lateral, third and fourth ventricles of the brain was undertaken among north central Nigerian adults to document reference values for the region.

MATERIALS AND METHOD

This was a retrospective study whereby Computer tomography (CT) images of Neurologic patients aged above 15 years were used. Images were obtained from the local database of the CT machine (Philips 16 brilliance) and backup compact discs from the CT archives of the Radiology Department covering a 4 year period (2013-2016). Brain images reported as essentially normal by 2 independent Radiologist were selected out of 172 images acquired at the period. Axial images were first obtained at 5mm cuts from the skull base through to the vertex with subsequent coronal and sagittal reconstruction in both native and contrast series as the case may be. The study was approved by the ethics committee of Benue State University Teaching Hospital.

Measurements in millimeters (mm) were obtained at the following levels:[11]

1) Level of Interventricular Foramen

- Length of frontal horns of right and left lateral ventricle in Foramen.

(Measured from its tip to the interventricular foramen).

2) Lateral Ventricle Measurement:

- Length of right and left lateral ventricular body inclusive of frontal horn.

(Taken from tip of frontal horn to the atrium).

3) Level of third Ventricle

- The widest diameter of the third ventricle

4) Level of Fourth Ventricle

- Greatest height and width of fourth ventricle.

The images were viewed on the computer monitor and the measurements were taken with in-built linear calipers.

RESULTS

A total of 132 patients were reviewed aged 15 to 74 years with a mean age of 39.70 years. Ninety (68.2%) were males with mean age of 40.86 ± 16.13 years while 42 (31.8%) were females with mean age 37.27 ± 16.43 (tables 1). The mean age difference among males and females in this study was statistically significant (P=0.008) (table 2).

All the mean values of the ventricular sizes were higher in the males except the fourth which by width and height were slightly higher in the female group; however it was not statistically significant (fig 1).

The mean ventricular parameters for the entire population are shown in fig. 2. The mean length of the width and height of the fourth ventricle was 11.89 ± 2.53 and 11.59 ± 2.12 respectively.

The length of the frontal horns of the left lateral ventricles and the body in its entirety was slightly higher than that of the right though it was not statistically significant (table 3).

There was statistically significant increase in size of the ventricles with increasing age (P<0.005) however the height of the 4th ventricle which even though increases is size with age was not statistically significant (P=0.268) (fig. 3).

Table 1. Age and sex distribution

Age (years)	Male	Female	Total	%
<20	8	7	15	11.36
20-29	22	12	34	25.76
30-39	12	4	16	12.12
40-49	19	7	26	19.70
50-59	11	4	15	11.36
60+	18	8	26	19.70
Total	90	42	132	100

Table 2. Mean age for sex group

SEX	Mean age ± SD (years)
Male	40.86 ± 16.13
Female	37.27 ± 16.43
p-value	0.008

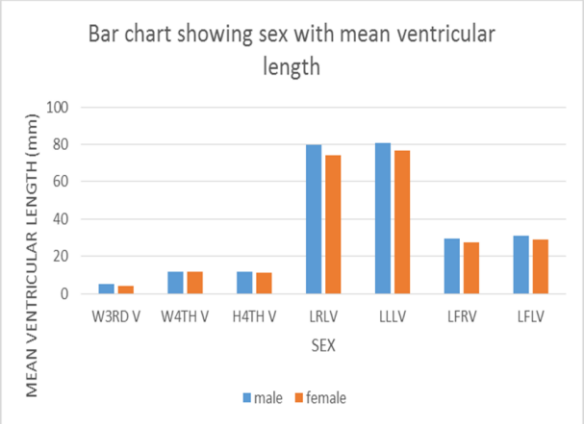

Fig 1

Key
W3RD V- Width of 3rd Ventricle.
W4TH V-Width of 4th ventricle.
H4TH V- Height of 4th ventricle.
LRLV- AP length of right lateral ventricle.
LLLV- AP length of left lateral ventricle.
LRFH- Length of right frontal horn of lateral ventricle
LLFH- length of left frontal horn of lateral ventricle.

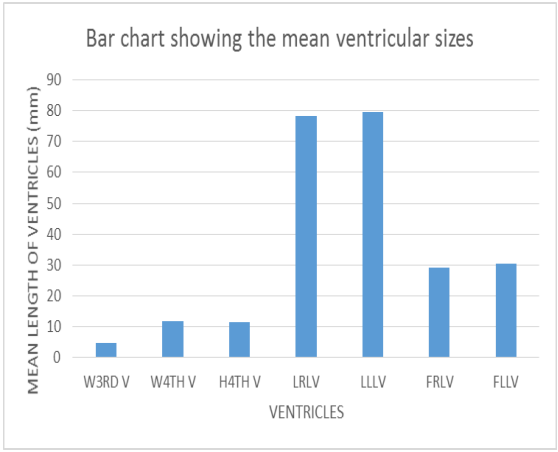

Fig.2

W3RD V- Width of 3rd Ventricle.
W4TH V-Width of 4th ventricle.
H4TH V- Height of 4th ventricle.
LRLV- AP length of right lateral ventricle.
LLLV- AP length of left lateral ventricle.
FRLV- Length of right frontal horn of lateral ventricle
FLLV- length of left frontal horn of lateral ventricle.

Table 3. Relationship of the lateral ventricles

Ventricle	Right (mm)	Left (mm)	p-value
Length of Lateral Ventricle.	78.14 ± 7.61	79.64 ± 6.84	0.984
Length of Frontal Horn Lateral Ventricle	29.02 ± 3.59	30.38 ± 3.68	0.921

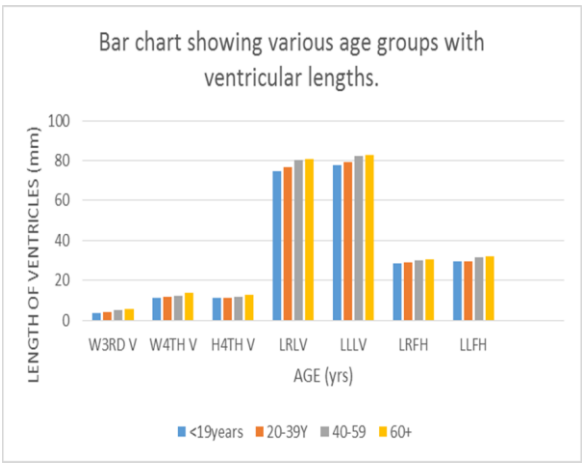

Fig. 3

Key
W3RD V- Width of 3rd Ventricle.
W4TH V-Width of 4th ventricle.
H4TH V- Height of 4th ventricle.
LRLV- AP length of right lateral ventricle.
LLLV- AP length of left lateral ventricle.
LRFH- Length of right frontal horn of lateral ventricle
LLFH- length of left frontal horn of lateral ventricle

DISCUSSION

This study showed that the ventricles were slightly larger in the males. This is similar to documentations by Hamidu et al,[14] Skullerud[15] and Gyldensted.[16] The statistically significant difference in the mean age among males and females could account for the differences in their ventricular sizes.

The mean anterior-posterior (AP) length of the lateral ventricles in this study collaborated with that of Gomori et al,[17] Takeda and Matsuzua[18] and Goldestien et al[19] who demonstrated that the left lateral ventricles are usually larger than the right. The AP lengths in this study however were larger than that obtained by D'Souza and Natekar. This may be due to the differences in age group that was higher in this study compared to D'Souza and Natekar study which was limited between 30 and 50 years.[20]

The mean value of the width of the third ventricle in the index study was in keeping with the documented findings on Computed Tomography (CT) and MRI of <5 mm in children, <7 mm in adults <60 years of age and <9 mm in adults above 60 years.[21]

The values for the height of the fourth ventricle in our study collaborated with that of D'Souza and Natekar which gave the height of the fourth ventricle of 11.8 mm and 11.10 mm for the male and female respectively.[20] However, the values in the index study were higher than that of Hamidu et al in the north-west Nigeria even

though the subjects used in that were more in number and older. This disparity could possibly be due to variation in the cortical thickening between the regions, which to the best of my knowledge has not been looked into.

Highest measurement were obtained in the older age group and there were statistically relationships between the ages of subjects involved and the ventricular sizes. This confirms that ventricular dimensions increase in size with increasing age in conformity with the work of Celik et al. who examined 100 voluntary individuals with no physical or neurological deficit and he discovered that the sizes of the cerebral ventricles increase with age in both sexes.[22] Similar findings were also reported by Hamidu et al in assessment of the third and Fourth Cerebral Ventricular Sizes among Normal Adults in Zaria-Nigeria.[14]

CONCLUSION

The study provided useful morphometric data about the lateral, third and fourth ventricles. This will serve as reference values which will assist Neuroanatomist, psychiatrist, Neuroradiologist and Neurologist in deciding whether ventricles are within normal limits or enlarged for a patients age.

REFERENCES

1. Haug G. Age and sex dependence of the size of normal ventricles on computed tomography. Neuroradiology. 1977; 14: 201-204.
2. Gallia GL; Rigamonti D; Williams MA. The diagnosis and treatment of idiopathic normal pressure hydrocephalus. Nature Clinical Practice Neurology. 2006; 2(7).
3. Gyldensted, C. and Kosteljanetz, M. Measurements of the Normal Ventricular System and Hemispheric Sulci of 100 Adult Patients with Computed Tomography. Neuroradiology. 1977; 14: 138-192.
4. Singh, V. Textbook of Clinical Neuroanatomy. Elsevier. 2010; 120-123, 137.
5. Williams, P.L., Bannister, L.H., Berry, M.M., Collins, P., Dyson, M. and Dussek, J.M. (1995) Gray's Anatomy: The Anatomical Basis of Medicine and Surgery. 38th Edition, Elsevier Churchill Livingstone, Edinburgh, 1205-1209.
6. Hamidu AU, Sefiya AO. Ekott DS. Barnabas D. Muhammad R. Muhammad SB. Computerized tomographic study of normal Evans index in adult Nigerians. J Neurosci Rural Pract. 2015; 6(1): 55–58.
7. Duffner F; Schiffbaur H; Glemser D; Skalei M; Freudenstein D. Anatomy of the cerebral ventricular system for endoscopic neurosurgery: a magnetic resonance study. Acta Neurochirgica (Wien) 2003; 145(5): 359-68.
8. Jacoby RJ; Levy R; Dawson JM. Computed Tomography in the elderly: The normal population. British Journal of Psychiatry. 1980; 136: 249-255.
9. Haslam, R.H. (1992) Hydrocephalous. In: Behrman, R.E, Kliegman, R.M., Nelson, W.E. and Vaughan, V.C., Eds.,Nelson Text Book of Pediatrics, 14th Edition, W.B. Saunders Co. Philadelphia, 1487.
10. Soni, J. Gupta B. Soni B. Singh R. Purohit N. Gupta M. Dabi N. Normal Parameters of Ventricular System in Healthy Infants. Indian Pediatric, 32: 549-555.
11. Moawia G. Abdalrahim A. Amir A. Mosleh A. Morphometric Analysis of the Brain Ventricles in Normal Subjects Using Computerized Tomography. Open Journal of Radiology. 2015; 5: 13-19.
12. Losowska-Kaniewska D; Oles A. Imaging examinations in children with hydrocephalus. Advances in Medical Science, 52(1): 176-9.
13. Ambarki K; Israelsson H; Wahlin A; Birgander R; Eklund A; Malm J. Brain ventricular size in healthy elderly: Comparison between Evans Index and Volume measurement. Neurosurgery, 2010; 67(1): 94-99.
14. Hamidu AU, David SE, Olarinoye-Akorede SA, Danborno B, Jimoh A, Fatai O. Third and Fourth Cerebral Ventricular Sizes among Normal Adults in Zaria-Nigeria. Sub-Saharan Afr J Med, 2015; 2: 89-92
15. Schroter S, Plowman R, Hutchings A, Gonzalez A. J Med Eth, 2006; 32: 728-3.
16. Gyldensted C, Kosteljanetz M. Measurements of the normal ventricular system with computer tomography of the brain: A preliminary study on 44 adults. Neuroradiology, 1976; 10: 205-13.
17. Gomori, J.M., Steiner, I. and Meland, E. The Assessment of Changes in Brain Volume Using Combined Linear Measurements. A CT Study. Neuroradiology, 1984; 26: 21-24.
18. Takeda, S. and Matsuzua, T. Age-Related Changes in Volumes of the Ventricles, Cisternae and Sulci: A Quantitative Study Using CT. Journal of the American Geriatrics Society. 1985; 33: 264-268.
19. Goldstien, J.M., Seidman, L.J., Horton, N.J., Markis, N., Kenneky, D.N., Caviness, V.S., Faraone, S.V. and Tsuang, M.T. Normal Sexual Dimorphism of the Adult Human Brain Assessed by in Vivo Magnetic Resonance Imaging Cerebral Cortex. 2001; 11: 490-497.
20. D'Souzae, D.M. and Natekar, P.E. (2007) Morphometric Study of the Ventricular System of Brain by Computerized Tomography. Journal of the Anatomical Society of India, 56: 19-24.
21. Meese W, Kluge W, Grumme T, Hopfenmtiller W. CT evaluation of the cerebrospinal fluid spaces of healthy persons. Neuroradiology 1980; 19: 131-6.
22. Celik HH, Gürbüz F, Erilmaz M, Sancak B. CT measurement of the normal brain ventricular system in 100 adults. Kaibogaku Zasshi 1995; 70: 107-15.