Original Article

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Frontal Horn of Lateral Ventricle of Brain and Its Relation with Age, Gender and Side: Morphometric Study by Computed Tomography among Bangladeshi Population

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ABSTRACT

Background: *Knowledge of the baseline reference value of frontal horn size is necessary for the initial and precise analysis of ventriculomegaly. The purpose of this study was to determine the size of frontal horn of lateral ventricle and its relation with age, gender and side among adult Bangladeshi population of Chattogram district.*

Materials and methods: *This cross-sectional analytical study was conducted during the period from July 2022 to June 2023 in the Department of Anatomy, Chittagong Medical College, Chattogram, upon 150 respondents of 20-60 years who had normal Computed Tomography (CT) scans as reported by an expert radiologist. For statistical analysis,Mann-Whitney U test, Wilcoxon signed rank test and ANOVA test were done. p-value was considered significant if it was <0.05 at 95% level of confidence.*

Results: *The mean right and left frontal horn length was 25.50 (±3.95) mm and 25.28 (±4.04) mm respectively. The length of the frontal horn of both right and left sided lateral ventricle were significantly higher in male than that of female (p<0.01). Spearman's correlation coefficient indicated positive linear correlation of length of frontal horn (Right and left side) with age, insignificant in right side (p=0.061) but significant in left side (p=0.046).*

Conclusion: *Morphometric analysis of the frontal horn of the lateral ventricles among the Bangladeshi population produced a number of significant results that may help with the early diagnosis and treatment of neurological diseases that are particular to gender and age. These findings can be validated and expanded upon in future research using bigger sample sizes and cutting-edge imaging methods.*

Key words: Age; Computed tomography; Frontal horns of lateral ventricles; Gender; Human brain; Morphometric study and side.

Introduction

The ventricular system of the brain consists of two lateral ventricles, the third and fourth ventricle. Within each cerebral hemisphere lies the large C-shaped lateral ventricle which is divided into a body and 3 horns: Anterior, Posterior and Inferior.[1]

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The human brain has been the focus of intense research over the centuries. It is well recognized that individuals vary considerably in brain volume, cytology, distribution of grey and white matter, gyral pattern and ventricular size.[2] Radiologists and neurologists are frequently confronted with problems of finding out whether or not ventricles are inside within normal limits or enlarged for a patient's age.[3,4]

The brain experiences numerous gross and histopathological changes with aging, including brain tissue regression that causes ventricular hypertrophy.[5] Due to these changes that occur normally with aging, the diagnosis of diseases in elderly patients is often complicated. So, the two major changes that may occur in elderly individuals without neurologic deficits are enlargement of ventricles and cortical atrophy. To understand these changes, the knowledge of brain ventricular morphometry is important.[6]

Asymmetry between the two lateral ventricles is relatively common, found in 5–12% of the population. In healthy individuals, some studies have found that either the right or left lateral ventricle was consistently larger than the other while other studies have reported no significant difference in size between the two. The association between lateral ventricle asymmetry, handedness and sex is also controversial, with multiple

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studies showing a significant difference in lateral ventricle size in right- versus left-handed individuals and males versus females. Other studies have shown no significant difference in these populations. Smaller ventricles were supposed to be correlated with more extensive brain tissue, yet this was not consistent in all studies. A great deal of research has also been done on the lateral ventricles' shape.[7]

Morphometric analysis of brain ventricular system has become a focus of interest in recent studies due to its association with pathological conditions like hydrocephalus, Schizophrenia, Alzheimer's disease, Multiple sclerosis, Huntington's disease, Parkinson's disease, epilepsy, depression as well as aging which could lead to dementia.[8–11] There is an alteration in brain morphology, size and shape of ventricular system in chronic alcoholism.[12] Anatomical knowledge of ventricular system helps neurosurgeons with accurate localization and complete removal of space-occupying lesions like craniopharyngiomas and gliomas.[13] Morphometric analysis of ventricular system is also helpful in the diagnosis and classification of hydrocephalus and in the assessment and follow-up of enlargement of ventricular system during therapy[14]. Measurement of ventricles by the older radiographic methods like gas or contrast encephalography, were highly invasive and produced artifacts.[15] With the advent of newer imaging techniques like CT and MRI which are non-invasive and with no artifacts, evaluating ventricular sizes has become easier.[16–18] It also provides real-time images without the need for anesthesia and is safe.[19]

Worldwide, numerous morphometric studies have been conducted to measure the normal size of frontal horns of the lateral ventricles of the brain by Computed Tomography (CT) but there is a lack of data regarding this in our country. Keeping the above background and knowledge in mind, the present study was carried out to analyze the normal morphology of frontal horns of the lateral ventricles of the brain by CT among Bangladeshi population.

Materials and methods

This cross-sectional analytical study was carried out in the Department of Anatomy of Chittagong Medical College, Chattogram during the period from July 2022 to June 2023 among 150 respondents. Data were collected from three centers of Chattogram- the Department of Radiology and Imaging, Chittagong Medical College Hospital (CMCH), Popular Diagnostic Center Ltd and Epic Health Care. Approval was taken from ethical review committee of Chittagong Medical College.

CT scans were performed with the Siemens Somatom 128-slice CT scanner machine. Subjects had undergone axial transverse scanning of the brain. Axial sections were obtained from the skull base to the vertex at 5 mm slice thickness. A lateral image was taken to confirm the correct position of the subject. A cantho-meatal line was drawn and a line at an angle of 15 – 20 degrees to and 1 cm above it, representing the lowest tomographic section, which passes through the base of the skull. Without any overlap, eight or ten axial imaging slices of the brain were acquired.[20] All other technical parameters of the scans were as per the established standards (e.g., Time in ms, potential in kv, current in mA) and slice thickness of 05 mm. After collecting the DVDs of the participants who had undergone brain CT scans, it was evaluated by expert radiologists as normal at the Radiology and Imaging Department of mentioned facilities. The subjects were then selected by convenient sampling method according to enrollment criteria. The study subjects had no history of head injuries, cerebral ischemia, hemorrhagic infarctions, hydrocephalus, intracranial surgeries, intracranial space-occupying lesions, alcoholism and drug abuse.

The morphometric measurements were carried out by a skilled radiologist from CMCH utilizing DICOM image analysis software. The length of the frontal horn of lateral ventricle was measured in mm from the interventricular foramen to the tip of the frontal horn.[21] (Shown in Figure 1).

Figure 1 Axial CT scan showing the process of measurement of frontal horn length

All data were fed into Statistical Package for Social Sciences (SPSS-26) software for processing and analysis. The Shapiro-Wilk test was used to test the normality of the variables.Data were presented as number, percentage or mean ± standard deviation. Comparison with gender was completed using the Mann-Whitney U test. Comparison with laterality was completed using Wilcoxon signed rank test. Comparisons with age groups were done using the

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ANOVA test. Spearman's correlation was conducted to assess the relationship between right frontal horn length, left frontal horn length and age. Results were considered significant if p value was <0.05 at 95% level of significance.

Results

Out of 150 participants, there were 59 (39.3%) males and 91 (60.7%) females. The age of the respondents ranged from 20-60 years with the mean ± SD age of 35.85±11.77 years.

Table I Mean difference of length of frontal horn of lateral ventricles (n=150)

Participants	Side	Range	Mean ± SD	p value*
All	Right side	14.5-34.5	25.50±3.95	0.125
	Left side	14.3-33.5	25.28±4.04	
Male	Right side	15.1-34.5	27.33±3.87	0.000
Female		14.5-30.3	24.32±3.54	
Male	Left side	14.9-33.5	26.83±3.90	0.000
Female		14.3-32.1	24.27±3.83	

* p<0.05= significant.

In general, the length of the frontal horn of right-sided lateral ventricle ranged from 14.5-34.5 mm with a mean of 25.50±3.95 mm. The length of the frontal horn of left-sided lateral ventricle ranged from 14.3-33.5 mm with a mean of 25.28±4.04 mm. This difference was not statistically significant (p>0.05). The mean length of the frontal horn of right lateral ventricle in male is significantly higher (p< 0.01) than in female (27.33±3.87 mm vs. 24.32±3.54 mm). The mean length of the frontal horn of left lateral ventricle in male is significantly higher (p< 0.01) than in female (26.83±3.90 mm vs. 24.27±3.83 mm).

Table II Comparisons of ventricular measurements in relation to different age groups among the respondents (n=150)

Measurements (mm)	Age groups (years)					
	20-29 (n=56)	30-39 (n=31)	40-49 (n=40)	50-59 (n=16)	60-69 (n=7)	p value*
Length of the frontal horn (Right side)	24.65±4.77	25.67±3.45	25.68±3.33	26.75±3.24	27.73±1.76	0.158
Length of the frontal horn (Left side)	24.60±4.75	25.22±3.48	25.55±3.40	25.74±4.04	28.39±2.40	0.188

* p>0.05= not significant.

Length of the frontal horn (Right side) increased gradually from 24.65±4.77 mm (20 to 29 years age group, i.e., the youngest age group) to 27.73±1.76 mm (60 to 69 years group, i.e., the eldest age group). Length of the frontal horn (Left side) increased gradually from 24.60±4.75 mm (20 to 29 years group, i.e., the youngest age group) to 28.39±2.40 mm (60 to 69 years group, i.e., the eldest age group). According to ANOVA test, the difference in measurement of length of the frontal horn of lateral ventricle was not significant (p>0.05).

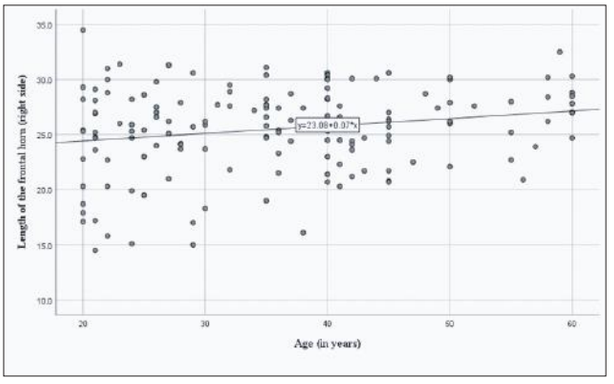

Figure 2 Relationship between age of the respondents with the length of right frontal horn (n=150)

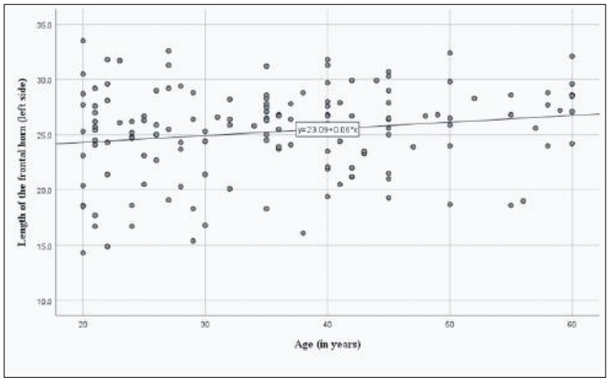

Figure 3 Relationship between age of the respondents with the length of left frontal horn (n=150)

Spearman's correlation coefficient test was done to see correlations, as data were not normally distributed. There was non-significant positive linear correlation of length of frontal horn (Right side) with age (r=0.153, R^2=0.023, p=0.061) and also non-significant positive linear correlation of length of frontal horn (Left side) with age (r=0.164, R^2=0.027, p=0.065).

Discussion

In the present study, frontal horn of right side was longer than that of left side among overallparticipants, but this differencewas not statistically significant (Table I).

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In a study in India, among 250 participants, the mean right and left frontal horn lengths were reported as 29.2 ± 3.72 mm and 28.7 ± 2.9 mm, respectively.[22] The mean lengths were higher than our population. But right sided length being higher than left side is similar to the findings of the present study. In contrast, another study conducted in Saudi Arabia among 152 participants revealed that the mean lengths of the right and left frontal horns were almost equal (27.55 ± 4.175 mm and 27.55± 4.184 mmrespectively).[23]

In a different study, carried out in Nagpur, India among 150 participants (54 female and 96 male) who had normal brain CT scans, participants' age range was 20-80 years. They observed higher values of the frontal horn length on the left side (29.36±2.34mm) in comparison to the right side (28.08±2.22mm).[24] In one more study in India, 200 participants (Age range 10 to 80 years) had normal brain CT scans and the mean values of right and left frontal horn length were 29.3mm and 30.5mm, respectively.[21] These dissimilarities may be due to the different age ranges of the participants in the studies.

In the present study, Mann-Whitney U test revealed that the length of the frontal horn of both right and left lateral ventricle was significantly higher in males than in females (p= 0.000).

From a study among adults of Northern Zone of Bangladesh it was found that male individuals had considerably longer frontal horns of the left and right lateral ventricles than female subjects did (p = 0.002 and p = 0.001).[25] From the study carried out in Nagpur, India the mean length of the frontal horn of right lateral ventricle was found as 28.52± 2.26 mm in males and 27.29± 1.91mm in females. The mean length of the frontal horn of left lateral ventricle was 29.81±2.41 mm in males and 28.57±1.99 mm in females. The length of the frontal horn of both right and left sided lateral ventricle were significantly higher in males than that of females (p<0.01).[24] In Maharashtra, India, one more study was performed on more than 500 patients using CT scans. The study group comprised 250 males and 250 women aged 20 to 79. The mean length of the frontal horn of right lateral ventricle was found as 28.5± 1.06 mm in males and 25.9±1.46 mm in females. The mean length of the frontal horn of left lateral ventricle was 30.3±1.46 mm in males and 29.7± 1.22 mm in females.[26] The differences were not statistically significant but as the values of these studies are nearly similar to the present study. Among the Ethiopian adults, the mean length of the frontal horn of left lateral ventricle was higher in males than females but were statistically insignificant (p>0.05). Being insignificant is inconsistent with the present study This could be due to the geographical and racial distribution of the population.[19] Some other studies' findings correlated with the findings of the current study.[21,27,28]

Singh et al. conducted a prospective study in Maharashtra, India, in which the brains of 358 individuals (207 male and 151 female) were analyzed using CT images. The mean length of the frontal horn of right lateral ventricle was found as 25.00 ± 3.18 mm in male and 25.34 ± 3.50 mm in female. The mean length of the frontal horn of left lateral ventricle was 26.26± 2.94 mm in male and 26.53 ± 3.38 mm in female. This study showed the length of both-sided frontal horn is greater in female than that of male. The findings of this study are dissimilar to the findings of the present study.[6] This dissimilarity may be due to a larger sample size and differences in the distribution of sex.

In the present study, the length of the frontal horn was seen to gradually increase from lower to higher age group. The ANOVA test was performed, and changes were statistically insignificant both in right side (p = 0.158) and and left side (p = 0.188) (Table II).

Farheen et al. revealed that from the 30-39 age groups onward, the mean length of the frontal horn gradually increased, reaching a maximum value in the 70-79 age groups on the right and left sides. No statistically significant difference was found between age groups according to the ANOVA analysis (p>0.05).[26] Yadav et al. conducted a study in Meerut, India, where measurements of frontal horns of lateral ventricles were evaluated among 200 participants (100 males and 100 females), age ranging from 10 to 80 years. It was observed that as age advances, the dimensions of the ventricles also enlarge, this difference was not statistically significant according to the ANOVA analysis (p>0.05).[27] The results of these studies agree with the results of the present study.[28]

Rathod P U and Mehera B categorized the participants in three groups such as: 20–40, 41–60 and 61–80 years. As age progressed, both sides of the average length of the frontal horn increased and the changes were statistically significant in relation to age (p=0.000).[24] Although the participants were not categorized in decades, the findings of the study were nearly similar to the present study.

In the present study, Spearman's correlation coefficient indicated positive linear correlation of length of frontal horn (Right and left side) with age, insignificant on right side (p=0.061) and also on left side (p=0.046). As coefficient of determination shows 23% and 27% values, there is poor relationship between age (Independent variable) and length of frontal horn (Dependent variable).

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Among the Ethiopian population, Pearson's correlation finding indicated a strong positive statistically significant correlation ($p<0.001$) between right frontal horn length, left frontal horn length, and age ($r= 0.786,0.784$ respectively)[19].

Limitations

The study was conducted in a selected area witha relatively small sample size. So, the present study may not be truly representative of the whole population of Bangladesh.

Conclusion

The study reported that among the population of Chattogram, Bangladesh having normal CT scans - the mean length of right sided frontal horn was larger than that of left side, without any significant difference between the sides. However, significant gender differences were found, with males having larger frontal horn lengths than females on both sides ($p<0.01$).The study also revealed an insignificant ($p>0.05$) gradual increase in the length of the frontal horn with advancing age. Non-significant positive linear correlation was found between age and the length of the frontal horns. The results of the present study provide some baseline data. These findings might also be helpful to clinicians, neurosurgeons and radiologists in clinical assessments and diagnostic procedures involving the lateral ventricles. In addition to facilitating comparative studies and promoting a greater understanding of neuroanatomical variability across different groups, this will contribute significant data to the worldwide pool of information on brain morphometry.

Recommendation

Multicenter-based studies with larger sample size are required to confirm the findings of such study.

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Disclosure

All the authors declared no competing interests.

References

1. Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 41st ed. Standring SS, editor. Philadelphia: Elsevier Limited. 2016.

2. Lüders E, Steinmetz H, Jäncke L. Brain size and grey matter volume in the healthy human brain. Neuroreport. 2002;13(17):2371–2374.

3. Igbaseimokumo U. Introduction to the Basics of Brain CT Scan. In: Brain CT Scans in Clinical Practice SpringerLink [Internet]. 1st ed. London: Springer-Verlag. 2009.
https://link.springer.com/book/10.1007/b98343.

4. Gaser C, Nenadic I, Buchsbaum BR, Hazlett EA, Buchsbaum MS. Ventricular enlargement in schizophrenia related to volume reduction of the thalamus, striatum and superior temporal cortex. Am J Psychiatry. 2004;161(1):154–156.

5. Schiller F. The cerebral ventricles. From soul to sink. Arch Neurol. 1997;54(9):1158–1162.

6. Singh BR, Gajbe U, Agrawal A, Y AR, Bhartiya S. Ventriclesof Brain: A Morphometric Studyby Computed Tomograohy | Abstract. Int J Med Res Health Sci. 2014;3(2):381–387.

7. Scelsi CL, Rahim TA, Morris JA, Kramer GJ, Gilbert BC, Forseen SE. The Lateral Ventricles: A Detailed Review of Anatomy, Development, and Anatomic Variations. AJNR Am J Neuroradiol. 2020;41(4):566–572.

8. Duffner F, Schiffbauer H, Glemser D, Skalej M, Freudenstein D. Anatomy of the cerebral ventricular system for endoscopic neurosurgery: A magnetic resonance study. Acta Neurochir (Wien). 2003;145(5):359–368.

9. Andreasen NC, Smith MR, Jacoby CG, Dennert JW, Olsen SA. Ventricular enlargement in schizophrenia: definition and prevalence. Am J Psychiatry. 1982;139(3):292–296.

10. McCarley RW, Shenton ME, O'Donnell BF, Faux SF, Kikinis R, Nestor PG, et al. Auditory P300 abnormalities and left posterior superior temporal gyrus volume reduction in schizophrenia. Arch Gen Psychiatry. 1993;50(3):190–197.

11. Huber SJ, Chakeres DW, Paulson GW, Khanna R. Magnetic resonance imaging in Parkinson's disease. Arch Neurol. 1990;47(7):735–737.

12. 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;146(2):157–170.

13. LeMay M. Radiologic changes of the aging brain and skull. AJR Am J Roentgenol. 1984 Aug; 143(2):383–389.

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14. 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;67(1):94–99.

15. Gawler J, Du Boulay GH, Bull JW, Marshall J. Computed tomography (the EMI Scanner): a comparison with pneumoencephalography and ventriculography. J Neurol Neurosurg Psychiatry. 1976;39(3):203–211.

16. Anik Y, Demirci A, Anik I, Etus V, Arslan A. Apparent diffusion coefficient and cerebrospinal fluid flow measurements in patients with hydrocephalus. J Comput Assist Tomogr. 2008;32(3):392–396.

17. Hashimoto M, Ishikawa M, Mori E, Kuwana N, Study of INPH on neurological improvement (SINPHONI). Diagnosis of idiopathic normal pressure hydrocephalus is supported by MRI-based scheme: A prospective cohort study. Cerebrospinal Fluid Res. 2010;7:18.

18. Moore DW, Kovanlikaya I, Heier LA, Raj A, Huang C, Chu KW, et al. A pilot study of quantitative MRI measurements of ventricular volume and cortical atrophy for the differential diagnosis of normal pressure hydrocephalus. Neurol Res Int. 2012;2012:718150.

19. Agegnehu A, Tenaw B, Gebrewold Y, Jemberie M. Morphometric Study of Frontal Horn of Lateral Ventricle of Brain and Its Correlation with Age, Gender and Side among Adults in the University of Gondar Comprehensive Specialized Hospital, Gondar, Northwest Ethiopia, 2019. Austin J Anat. 2021;8(1):1096.

20. Haaga JR, Boll D. Imaging of the Head and Neck. In: Dogra VS, Forsting M, editors. Computed Tomography & Magnetic Resonance Imaging of the Whole Body E-Book. 6th ed. Elsevier Health Sciences. 2008;469–731.

21. Mallika B, Menasinkai SB, Associate. Prof. Dept of Anatomy, SIMSRH Tumkur, Karnataka, India., M B, Radiologist, Mysore Medical College & Research Institute Mysore, Karnataka, India. Morphometric Study of Lateral Ventricles of Brain by Computerised Tomography. IJAR. 2016;4(4):3294–3297.

22. Honnegowda T, Nautiyal A, Mitra D. (PDF) A Morphometric Study of Ventricular System of Human Brain by Computerised Tomography in an Indian Population and its Clinical Significance. Austin Journal of Anatomy. 2017;4(4):1075.

23. Gameraddin M, Alsayed A, Ali A, Al-Raddadi M. Morphometric Analysis of the Brain Ventricles in Normal Subjects Using Computed Tomography. OJRad. 2015;05(01):13–19.

24. Pranjali RU, Mehera B, Professor and Head, Department of Anatomy, Cooper Medical College, Mumbai. Morphometric Study of Anterior Horn of Lateral Ventricle of Brain and Its Correlation with Age, Gender and Side: A CT Study. IJA. 2017;6(1):21–25.

25. Sharmin S, Afroz A, Rahman MA, Islam SA. Morphometric Study of Lateral Ventricles of Brain by MRI in Healthy Adults in Northern Zone of Bangladesh. Ibrahim card med j. 2021;10(1–2):45–50.

26. Farheen SS, Sukre SB, Professor and Head: Department of Anatomy,Government Medical College Aurangabad. Morphometric Study of Frontal Horn of Lateral Ventricle by Computerised Tomography. IJAR. 2017;5(3.1):4063–4066.

27. Yadav A, Sharma A, Nigam GL, Yadav A, Chauhan K, Pandey V. Morphometric Study of Frontal Horn of Lateral Ventriclesofthe Brainby Computed Tomographyin Western UP Population. J Anat Sciences. 2015;23(2):22–27.

28. D'Souza D, Natekar P. Morphometric study of the ventricular system of brain by computerised tomography. Anat Soc India. 2007;56(1):19–24.