IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 2 Ser. 5 (February. 2024), PP 25-29
www.iosrjournals.org

Refined Analysis Of Variability In Lateral Ventricular Dimensions Using Computed Tomography: Insights Into Evans Index In Tamil Nadu Population.

Dr. Mary Rachel Myers[1], Dr. Thangam Vinoth[2].
[1,2] *(Department Of Radio-Diagnosis, A.C.S Medical College And Hospital, Tamil Nadu, India.)*

Abstract:
Background: *The assessment of parameters of various segments of lateral ventricles plays a crucial role in diagnosing age- related degenerative diseases of the Central nervous system, along with the psychiatric disorders. The aim of this study was to gather comprehensive data on the normal morphological parameters of the human brain's lateral ventricles and their associations with age and sex. This effort seeks to establish a robust foundation for diagnosing pathological changes and enhancing diagnostic accuracy.*
Materials and Methods: *This is a cross- sectional study including 500 subjects, spanning ages 7 to 85 representing both genders (258 Males and 242 Females) conducted within the Radio-diagnosis department of A.C.S Medical College and Hospital, Tamil Nadu, India. The width of distinct segments within the lateral ventricles was measured, and its correlation with age and gender was systematically evaluated. Furthermore, the calculation of the Evans Index was incorporated as a sophisticated component of the analysis*
Result: *The study has revealed a statistically significant correlation between the width of distinct segments within the lateral ventricles and age. The average (EI) within our study population was 0.26 ± 0.04 for males, 0.26 ± 0.02 for females and mean for the sample population was 0.26 ± 0.03 . No statistically significant difference in this parameter was observed between male and female groups. The width of distinct segments within the lateral ventricles increases with age.*
Conclusion: *The width of lateral ventricle segments increases with age, showing similar trends across genders. Specifically, the frontal, occipital and middle thirds of the body widen with age. Our study establishes the normal range of Evan's Index (EI<0.30) in the South Indian population, incorporating age and gender factors. Evan's Index (EI) offers a practical, easily reproducible, and time-efficient measure for routine clinical use.*
Keywords: *Gender, Age, Computed Tomography, Brain, Lateral ventricles, Evan's Index.*

Date of Submission: 09-02-2024 Date of Acceptance: 19-02-2024

I. Introduction:

The ventricles in the human brain are fluid-filled cavities containing Cerebrospinal fluid, representing the remnants of the initial embryonic brain vesicles. They communicate through a system of foramina and channels, facilitating the normal circulation of Cerebrospinal fluid. The lateral ventricles constitute approximately 82% of the entire ventricular system [1]. The lateral ventricles of the brain serve as the cavities of the telencephalon and connect with the third ventricle via the interventricular foramina of Monro [2]. Obstruction in the connections between the ventricles and the Subarachnoid space, coupled with an imbalance in Cerebrospinal fluid production and absorption, may result in the onset of hydrocephalus [3]. The nature of hydrocephalus can be classified as communicating or non-communicating, contingent upon the underlying mechanism of development [3]. The ventricular system of the human brain is currently a focal point of active research, owing to the widespread availability of medical imaging worldwide. Computed Tomography (CT) is a widely accepted diagnostic procedure for identifying various pathological conditions and assessing ventricular size.

The assessment of ventricular size can be conducted through linear or volumetric measurements, with the linear ratios, such as the maximum width of the frontal horns of lateral ventricles to the maximum width of the skull or brain, being the simplest and most reproducible method [4,5,6]. This valuable methodology plays a crucial role in diagnostics and research, differentiating between normal and abnormal conditions. The assessment of various parameters of the ventricles is employed in the diagnosis of degenerative diseases of the central nervous system, including Parkinson's disease, Alzheimer's disease and Huntington's disease [7,8,9]. Alterations in various parameters of the ventricular system serve as a valuable diagnostic indicator for specific psychiatric disorders, including Schizophrenia, bipolar disorders as well as for general cognitive decline and Dementia [10,11,12].

Comprehending the normal anatomic parameters of the ventricular system is crucial for the timely diagnosis of any pathological changes in its size, volume or symmetry [13]. Numerous studies have focused on examining the parameters of the Third and Fourth ventricles, along with the lateral ventricles of the brain. Particularly valuable are techniques that extract information from patient brain imaging studies [14,15]. This underscores the desirability of early diagnosis, as timely interventions can then be implemented to prevent further progression of the pathological changes. Detailed information regarding Age and Gender related variability holds significant value in the development of new surgical techniques and approaches to the ventricles, including procedures like ventricular puncture [16].

The principal aim of this study is to thoroughly gather data regarding the diverse morphological parameters of the lateral ventricles within the human brain, alongside calculating Evans ratio. Through a meticulous analysis, our goal is to elucidate potential relationships and discern variations in lateral ventricular dimensions across various demographic groups delineated by age and gender

II. Materials and Methods:

This cross-sectional study was conducted at the Department of Radio-diagnosis, A.C.S Medical College and Hospital, Tamil Nadu, India involving a period of 6 months from June 12, 2023 to December 14, 2023. It included 500 participants ranging from 7 to 85 years of age, all with normal CT brain scans, were included in this study.

Study Design: Cross-sectional study.

Study Location: The study was conducted in tertiary care teaching hospital in Department of Radio-diagnosis, at A.C.S Medical College and Hospital, Tamil Nadu, India.

Study Duration: June 12, 2023 to December 14, 2023

Sample size: 500 patients.

Subjects and Selection method:

Inclusion criteria:

1.Patients with neurological complaints who were referred to Radiology Department for CT brain scans during the study period.

2.Those with reported normal CT results, Examples of symptoms prompting imaging included non-CNS-related dizziness, fainting attributed to metabolic causes.

3. Patients showing willingness to participate in study.

Exclusion criteria:

1.Pregnant women

2.Patients with a history of congenital intracranial anomalies, dementia, neurodegenerative disorders, cerebral infarction, trauma, local mass lesions, prior intracranial surgery

3. Patients exhibiting unwillingness for the study.

Procedure methodology:

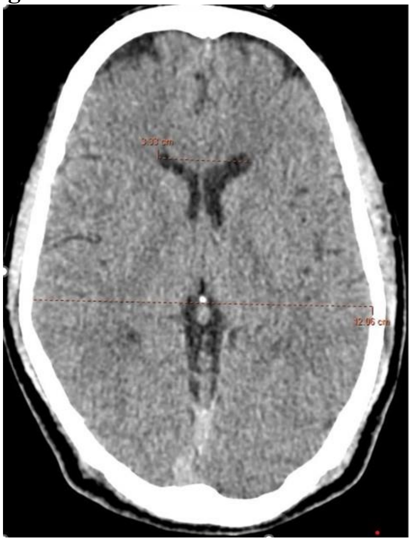
The subjects were categorized into subgroups based on both age and gender, resulting in a study cohort consisting of 258 males and 242 females as shown in Table 1. CT brain scans for all subjects were conducted using Multidetector CT Scanner Somatom Scope 32 slice configuration (Siemens Shenghai Medical Equipment Limited) with the following parameters : Scan type - helical/0.8 sec, Gantry tilt - 0 degrees, Tube settings:120 kVp, 200-250 mAs (depending on patient size), Collimation setting of 16 ×0.6 mm, Pitch value- 0.75 to 1.5 and 5mm Collimation cross sectional thickness, from the skull base to the vertex. The images were subsequently reconstructed to a 2mm slice thickness. DICOM images were analyzed on a viewing console and measurements were taken using in- built linear calipers calibrated to 0.1mm. Parameters included the widest anterior horn width (AHW) of the cerebral lateral ventricles and the widest inner diameter of the skull (IDS). Evan's Index is calculated as the ratio of Anterior Horn Width (AHW) to Inner Diameter of the Skull (IDS) as shown in (Figure 1). The measurements of the anterior horns encompassed their anterior thirds, while for the occipital horn, measurements were confined to its posterior third along with the middle third of the body as depicted in (Figure 2). Each measurement was independently taken for both the right and left ventricles. Patient-identifying details, dates and additional information were removed from the images in the article to protect patient privacy. The study adhered to all ethical standards and received approval from the institutional review board prior to commencement of study.

Table no 1: Demographic Analysis: Age and Gender distribution in the sample population.

Age Group (years)	Male (n=258)	Female (n=242)	Total (n= 500)
< 20	35 (13.5%)	30 (12.3%)	65 (13.0%)
21-30	58 (22.4%)	55 (22.7%)	113 (22.6%)
31-40	29 (11.2%)	36 (14.8%)	65 (13.0%)
41-50	37 (14.3%)	24 (9.9%)	61 (12.2%)

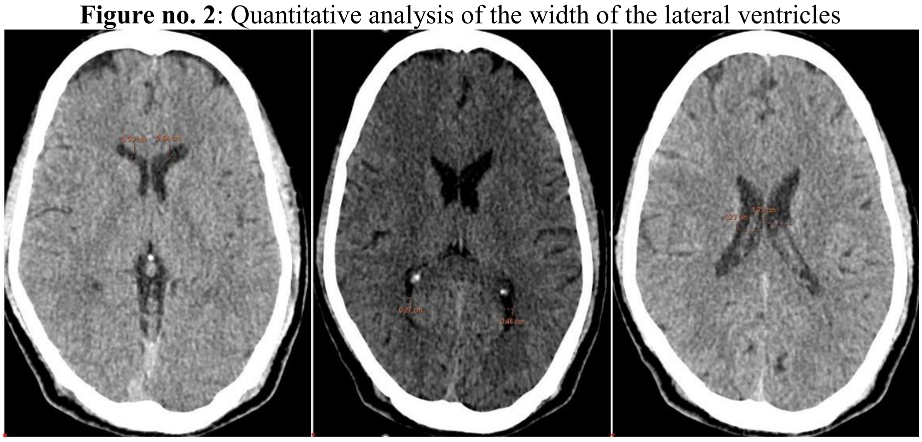
51-60	22 (8.5%)	19 (7.8%)	41 (8.2%)
61-70	25 (9.6%)	32 (13.2%)	57 (11.4%)
71-80	31 (12.0%)	27 (11.1%)	58 (11.6%)
>80	21 (8.1%)	19 (7.8%)	40 (8.0%)
Mean age (Mean ± SD) years	40.46 ± 6.25	40.77 ± 4.96	40.60 ± 5.40

Figure no 1: Illustration of Evan's Index.



An axial CT image illustrating the maximum width of the anterior horns of the cerebral lateral ventricles alongside the widest inner diameter of the skull.

Figure no. 2: Quantitative analysis of the width of the lateral ventricles



(a) (b) (c)

The width measurements of the frontal horns in the anterior third (a), the occipital horns in the posterior third (b), and the mid-body segment of the lateral ventricles (c).

Statistical Analysis:

The statistical analysis was meticulously performed using the advanced statistical package for the social sciences (SPSS version 23) software. Data presentation involved expressing frequencies as percentages and providing detailed descriptions of mean values alongside their respective standard deviations. To ensure precision across diverse subgroups, the analysis employed a sophisticated one-way Analysis of Variance (ANOVA) tailored for efficient error management. A significance threshold of $p < 0.05$ was adopted to discern statistically meaningful outcomes.

III. Result

In our study, our aim was to impartially evaluate and present precise data on the width of distinct segments of the lateral ventricles in the brain, exploring their associations with Age and Gender. Additionally, we sought to compare widths of specific segments of the right and left lateral ventricles within the entire sample. The mean and standard deviation were separately calculated for males and females, presented in centimeters and showed that the middle third of the body exhibited the most pronounced dimension. Conversely, statistical analysis revealed no significant disparity in the width between the width of the middle third of the body, anterior and occipital horns of the Right and Left ventricles as summarized in the Table 2.

Table no 2: Quantitative Assessment of Lateral Ventricle Width Variations Across Brain Segments (Measured in Centimeters)

Parameters of distinct regions within lateral ventricle	Male (n=258)		Female (n=242)	
	Right	Left	Right	Left
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Anterior horn	0.41 (0.18)	0.47 (0.19)	0.40(0.21)	0.45 (0.23)
Middle third of the body	1.14 (0.30)	1.12 (0.33)	1.11 (0.31)	1.12 (0.32)
Occipital horn	0.53 (0.19)	0.55 (0.16)	0.50 (0.15)	0.52 (0.19)

The mean Evan's index for males was 0.26 ± 0.04 and 0.26 ± 0.02 for females as shown in Table 3. Males consistently exhibited larger widest Anterior Horn Width (AHW) of the cerebral lateral ventricles and widest inner diameter of the skull (IDS) compared to females across all age groups. In our study, there was no statistically significant difference in Evan's Index (EI) values between males and females.

Table no. 3: Gender Based Descriptive analysis of Ventricular Dimensions

Parameter	Mean ± SD			P- value
	Males	Females	Males + Females	
AHW (mm)	3.39 ± 0.44	3.19 ± 0.35	3.29 ± 0.41	0.005
IDS (mm)	12.50 ± 0.51	12.06 ± 0.45	12.27 ± 0.52	<0.001
Evan's Index	0.26 ± 0.04	0.26 ± 0.02	0.26 ± 0.03	0.160

IV. Discussion:

Several studies have investigated the length of various segments of the lateral ventricles in the brain using Computed Tomography [17,18,19,20]. In our interpretation, the intricate spatial arrangement of the lateral ventricles, including the curves of the frontal and temporal horns and the lateral extension of the ventricular body from the sagittal plane, hinders the acquisition of accurate longitudinal measurements in axial sections without 3D reconstruction. This led us to concentrate on the transverse parameter, specifically the width, as it can be readily measured in axial sections. In various studies, an alternative approach to analysing lateral ventricles was employed. In previous researches, The authors utilized different ratio assessments, including the frontal horn ratio, the bicaudate ratio and Evan's ratio [21]. We opted not to incorporate the frontal horn ratio in our analysis, considering its potential susceptibility to the shape and curvature variations of the frontal horn across different anatomical planes (Sagittal, Frontal and Horizontal). Our focus was on the direct measurements of the widths of each lateral ventricle horn and the three distinct portions of the ventricular body. This approach provides a clearer representation of these ventricular parameters without being influenced by their spatial relations with surrounding structures. Additionally, we find that the use of the bicaudate ratio offers a limited understanding of ventricular width and may be influenced by the presence of the cavum septi. The bicaudate ratio tends to be more indicative of caudate nuclei volume rather than ventricular volume. Hamidu AU et al., in a study involving 488 adult subjects from the Nigerian population, noted an age-related increase in Evans Index with a mean EI of 0.252 ± 0.04 which is similar to our study [22]. The rise in Evan's Index (EI) with advancing age can be attributed to several factors. With increasing age, there is corresponding reduction in brain weight coupled with an increase in ventricle size [23]. This compensatory mechanism occurs to counteract brain atrophy, yet the EI remains below 0.3 [22]. In the study conducted by Patnaik P et al., involving 120 patients, the mean Evan's Index (EI) was recorded as 0.27 ± 0.035 [21]. Notably, our study also reports a similar mean EI of 0.26 ± 0.03. The lack of statistically significant difference in Evan's Index (EI) values between males and females in our study may be attributed to the proportionately smaller size of lateral ventricles and cerebral hemispheric size in females which is approximately 110-115 grams less than males [23].

Evan's Index exceeding 0.30 serves as the established cutoff values for diagnosing hydrocephalus according to Internation guidelines [24,25]. Normal pressure hydrocephalus (NPH) is characterized by ventricular enlargement associated with gait disturbance and urinary incontinence [26]. We propose that the data derived from our study can provide valuable insights into the normal anatomical parameters of the ventricular system. This understanding is crucial for physicians and scientists to promptly diagnose and effectively treat any pathological alterations in the size, volume or symmetry of the system.

V. Conclusion:

We have discerned statistically significant alterations in the width of various segments of the lateral ventricles associated with age. The width of the frontal, occipital and temporal horns, the anterior and middle thirds of the body and antrum of the lateral ventricles increases with advancing age.

Our study has defined the normal range of Evan's Index in the South Indian population, considering Age and Gender factors. Evan's Index (EI) is less technical, easily reproducible, time efficient and suitable for routine clinical practice. The Evan's Index (EI) of 0.26 ± 0.03 in our study aligns with the international guideline cut-off value of EI > 0.30 for diagnosing hydrocephalus in the South Indian population particularly in the people of Tamil Nadu.

References:

[1]. Akdogan I, Kiroglu Y, Onur S, Karabuluti N. The Volume Fraction Of Brain Ventricles To Total Brain Volume: A Computed Tomography Stereological Study. Folia Morphol (Warsz). 2010; 69(4):193-200.
[2]. 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, 41:566-72. 10.3174/Ajnr.A6456
[3]. Alselisly Am, Ashry Ah, Mahmoud At: Hydrocephalus With Lateral Ventricular Lesions: Case Series And Review Of Literature. Egypt J Neurol Psychiatry Neurosurg. 2021, 57:31. 10.1186/S41983-021-00283-7
[4]. Brix Mk, Westman E, Simmons A, Et Al.: The Evans' Index Revisited: New Cut-Off Levels For Use In Radiological Assessment Of Ventricular Enlargement In The Elderly. Eur J Radiol. 2017, 95:28-32. 10.1016/J.Ejrad.2017.07.013
[5]. Pradhan A, Chalise U, Shrestha A, Dhungel S: Study Of Normal Values Of Evan's Index On Brain Ct Scan In Individuals Attending Nepal Medical College Teaching Hospital, Kathmandu, Nepal. Nepal Med Coll J. 2021, 23:41-7. 10.3126/Nmcj.V23i1.36227
[6]. Hamidu Au, Olarinoye-Akorede Sa, Ekott Ds, Danborno B, Mahmud Mr, Balogun Ms. Computerized Tomographic Study Of Normal Evans Index In Adult Nigerians. J Neurosci Rural Pract. 2015;6(1):55-58.
[7]. Mak E, Su L, Williams Gb, Et Al.: Longitudinal Whole-Brain Atrophy And Ventricular Enlargement In Nondemented Parkinson's Disease. Neurobiol Aging. 2017, 55:78-90. 10.1016/J.Neurobiolaging.2017.03.012
[8]. Ott Br, Cohen Ra, Gongvatana A, Et Al.: Brain Ventricular Volume And Cerebrospinal Fluid Biomarkers Of Alzheimer's Disease. J Alzheimers Dis. 2010, 20:647-57. 10.3233/Jad-2010-1406
[9]. Jahanshahi A, Boonstra Jt, Alosaimi F, Ozsoy O, Michielse S, Temel Y: Hidden Brain Atrophy In Ultra-High Field Mr Images In A Transgenic Rat Model Of Huntington's Disease. Brain Disord. 2022, 6:100039. 10.1016/J.Dscb.2022.100039
[10]. Del Re Ec, Konishi J, Bouix S, Et Al.: Enlarged Lateral Ventricles Inversely Correlate With Reduced Corpus Callosum Central Volume In First Episode Schizophrenia: Association With Functional Measures. Brain Imaging Behav. 2016, 10:1264-73. 10.1007/S11682-015-9493-2
[11]. Kuang L, Cui D, Jiao Q, Et Al.: Alterations Of Cognition And Cerebral Ventricle Volume In Manic And Euthymic Pediatric Bipolar Disorder. Front Psychiatry. 2020, 11:593629. 10.3389/Fpsyt.2020.593629
[12]. Manera Al, Dadar M, Collins Dl, Ducharme S: Ventricular Features As Reliable Differentiators Between Bvftd And Other Dementias. Neuroimage Clin. 2022, 33:102947. 10.1016/J.Nicl.2022.102947
[13]. Polat S, Öksüzler Fy, Öksüzler M, Kabakci Ag, Yücel Ah: Morphometric Mri Study Of The Brain Ventricles In Healthy Turkish Subjects. Int J Morphol. 2019, 37:554-60.
[14]. Zhuravlova I, Kornieieva M: Anatomic Variability Of The Morphometric Parameters Of The Third Ventricle Of The Brain And Its Relations To The Shape Of The Skull. J Neurol Surg B Skull Base. 2021, 82:E315-20. 10.1055/S0040-1701527
[15]. Zhuravlova I, Kornieieva M, Rodrigues E: Anatomic Variability Of The Morphometric Parameters Of The Fourth Ventricle Of The Brain. J Neurol Surg B Skull Base. 2018, 79:200-4. 10.1055/S-0037-1606331
[16]. 7. Zhong S, Li W, Wang B, Et Al.: Selection Of The Best Point And Angle Of Lateral Ventricle Puncture According To Dti Reconstruction Of Peripheral Nerve Fibers. Medicine (Baltimore). 2018, 97:E13095. 10.1097/Md.0000000000013095
[17]. Farheen Ss, Sukre Sb: Morphometric Study Of Frontal Horn Of Lateral Ventricle By Computerised Tomography . Int J Anat Res. 2017, 5:4063-6. 10.16965/Ijar.2017.250
[18]. Malika B, Sharada Bm, Brahmendra M: Morphometric Study Of Lateral Ventricles Of Brain By Computerised Tomography. Int J Anat Res. 2016, 4:3294-7. 10.16965/Ijar.2016.465
[19]. Rathod Pranjali U, Mehera B: Morphometric Study Of Anterior Horn Of Lateral Ventricle Of Brain And Its Correlation With Age, Gender And Side: A Ct Study. Indian J Anat. 2017, 6:21-5. 10.21088/Ija.2320.0022.6117.4
[20]. Gameraddin M, Alsayed A, Ali A, Al-Raddadi M: Morphometric Analysis Of The Brain Ventricles In Normal Subjects Using Computerized Tomography. Open J Radiol. 2015, 5:13-9. 10.4236/Ojrad.2015.51003
[21]. Patnaik P, Singh V, Singh D, Singh S: Age And Gender Related Variations In Lateral Ventricle Brain Ratios . Int J Health Sci Res. 2016, 6:78-84
[22]. Hamidu Au, Olarinoye-Akorede Sa, Ekott Ds, Danborno B, Mahmud Mr, Balogun Ms. Computerized Tomographic Study Of Normal Evans Index In Adult Nigerians. J Neurosci Rural Pract. 2015;6(1):55-58.
[23]. 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 Neurol Scand Suppl. 1985;102:1-94.
[24]. Toma Ak, Holl E, Kitchen Nd, Watkins Ld. Evans' Index Revisited: The Need For An Alternative In Normal Pressure Hydrocephalus. Neurosurgery. 2011;68:939-44.
[25]. Tullberg M, Jensen C, Ekholm S, Wikkelsø C. Normal Pressure Hydrocephalus: Vascular White Matter Changes On Mr Images Must Not Exclude Patients From Shunt Surgery. Ajnr Am J Neuroradiol. 2001;22:1665-673.
[26]. 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.