ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Morphometric Analysis Of Lateral Ventricle Dimensions In Different Age Groups By Computed Tomography.

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ABSTRACT

Our study aimed to conduct a comprehensive morphometric analysis of lateral ventricles in males and females across different age groups using CT-scan imaging. Over a two-year period, CT brain images from 150 patients aged 20-80 years were examined. Inclusion criteria ensured normal ventricles, while exclusion criteria eliminated confounding factors. Linear measurements were conducted bilaterally, including the length of the anterior horn, length of the body and anterior horn, length of the posterior horn, transverse diameter of the inferior horn, and height of the inferior horn. Statistical analysis involved ANOVA tests to discern age-related changes. Significant increases in ventricular dimensions were observed with advancing age, consistent across measured parameters. The length of the anterior horn, combined length of the body and anterior horn, length of the posterior horn, transverse diameter, and height of the inferior horn all demonstrated statistically significant upward trends. Our morphometric study provides robust evidence of age-related changes in lateral ventricle dimensions. The quantified data offer valuable reference points for clinicians and researchers, contributing to the understanding of normal ventricular morphometry and facilitating the differentiation between age-related changes and pathological conditions.

Keywords: Lateral ventricles, CT-scan imaging, Morphometry, Age-related changes

https://doi.org/10.33887/rjpbcs/2023.14.6.28

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INTRODUCTION

The cerebral ventricular system, filled with cerebrospinal fluid, plays a crucial role in maintaining the structural integrity and homeostasis of the brain. Its volume, shape, and size are vital indicators of brain development, neurodevelopmental outcomes, and potential markers for various pathologies. This study aims to conduct a comprehensive morphometric analysis of the lateral ventricles in males and females across different age groups using CT-scan imaging [1, 2].

The cerebral ventricular system serves as a sensitive marker reflecting changes due to growth, aging, and both intrinsic and extrinsic pathologies. Notably, deviations in ventricular size and symmetry are associated with psychiatric disorders such as schizophrenia, while ventricular enlargement is correlated with Alzheimer's dementia. This highlights the diagnostic potential of ventricular morphometry in understanding neurodegenerative and psychiatric conditions [3].

Linear measurements on axial CT scans provide clinicians and surgeons with valuable information for differential diagnoses, assessing outcomes of interventions, understanding geriatric changes, and evaluating the effects of drugs [4-6]. The complex shape of the ventricular system, particularly in the occipital horns, presents challenges in accurate size measurements, emphasizing the need for precise morphometric studies [7, 8].

Age-related changes in ventricular parameters, particularly during the sixth and seventh decades, indicate age-dependent ventriculomegaly. Consequently, the diagnosis of ventriculomegaly in later decades requires careful consideration. The study aims to establish normal anatomic values for lateral ventricles, allowing for the detection of changes associated with specific diseases [9-11].

Utilizing modern Computerised X-ray Tomography, this research offers a safe and noninvasive approach to studying the lateral ventricles, providing valuable insights for neurosurgeons and radiologists.[12,13] By measuring various dimensions of the lateral ventricles in different age groups, the study aims to contribute to our understanding of normal ventricular size variations and their relationship with age, offering a foundation for future diagnostic and therapeutic applications in neurology and psychiatry.

MATERIAL AND METHODS

This research was conducted for two-year period and involved the examination of CT brain images from 150 patients. The study was conducted at the Anatomy and Radiology departments of Tertiary Health Care Centers in Mumbai. The sample size comprised 150 CT brain images that were selected based on strict inclusion and exclusion criteria.

Sample Selection Criteria

Inclusion criteria involved CT scans of patients aged 20-80 years with reported normal ventricles by radiologists. Exclusion criteria excluded patients with a history of local mass lesions, cerebral infarctions, hydrocephalus, or previous intracranial surgery. The goal was to ensure a diverse yet controlled sample that provided a representative view of normal lateral ventricle dimensions across different age groups.

CT Imaging Procedure

The radiological anatomy study utilized a "PHILIPS BRILLIANCE SLICE 64 MULTIDETECTER SPIRAL COMPUTED TOMOGRAPHY" machine at the Radiology department of Tertiary Health Care Centers in Mumbai. Patients were positioned head first in the supine position with a slice thickness of 2mm, a scanning time of 12-15 seconds, and a field of view of 237.0mm. Detailed demographic and CT number data were collected, and patients were categorized into three age groups (20-40, 41-60, and 61-80 years). Axial views were taken, and measurements were performed on images using Philips Diacom Works Software, encompassing parameters such as the length of the anterior horn, length of the body and anterior horn, length of the posterior horn, transverse diameter of the inferior horn, and height of the inferior horn. The meticulous approach ensured accurate and standardized measurements for meaningful analysis.

Parameters Measured

1. **Length of Anterior Horn:** The measurement of the anterior horn's length was conducted on axial CT images passing through the cerebral hemisphere, focusing on the anterior horn and the interventricular foramen. The length was precisely measured from the tip of the anterior horn up to the interventricular foramen. To ensure accuracy, the section displaying the maximum length was carefully chosen for each measurement.
2. **Length of Body and Anterior Horn:** Axial CT images depicting the anterior horn and trigone were used to measure the combined length of the body and anterior horn. The measurement commenced from the tip of the anterior horn and extended up to the anterior wall of the trigone. Similar to the anterior horn measurement, the section with the maximum length was selected for precise and consistent results.
3. **Length of Posterior Horn:** The length of the posterior horn was determined on axial CT images illustrating the trigone and the tip of the posterior horn. Measurement began from the anterior wall of the trigone, extending up to the tip of the posterior horn. The section presenting the maximum length was chosen for each measurement, ensuring a comprehensive assessment of the posterior horn's dimensions.
4. **Transverse Diameter of Inferior Horn:** Measurement of the transverse diameter of the inferior horn was performed on axial CT images featuring the tip of the temporal horn. The transverse diameter was specifically measured at the widest portion of the inferior horn, providing valuable insights into its structural dimensions.
5. **Height of Inferior Horn:** To determine the height of the inferior horn, the number of slices in which the anterior end of the inferior horn was visible was counted. This count was then multiplied by the slice thickness, providing an accurate measurement of the height of the inferior horn. Notably, all measurements were conducted bilaterally, and the results were expressed in millimeters, ensuring a comprehensive understanding of the lateral ventricle dimensions. This meticulous approach aimed to contribute precise anatomical data for a thorough morphometric analysis.

OBSERVATIONS AND RESULTS

Data were analysed by SPSS 16.0 for windows evaluation software.

Unpaired T test and ANOVA test was applied.

Table 1: Distribution of CT scans of males and females

Sex	Frequency	Percent
Male	96	64.0
Female	54	36.0
Total	150	100.0

Table 2: Descriptive statistic of CT scans of males and female

Age		Sex		Total
		Male	Female	
20 To 40 Yrs	Count	30	22	52
	Percent	57.7%	42.3%	100.0%
41 To 60 Yrs	Count	41	18	59
	Percent	69.5%	30.5%	100.0%
61 To 80 Yrs	Count	25	14	39
	Percent	64.1%	35.9%	100.0%
Total	Count	96	54	150
	Percent	64.0%	36.0%	100.0%

Table 3: Comparison of the length of anterior horn (mm) on right side in different age groups.

Length of ant horn(mm) on right side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	26.51	1.58	26.50	1.78	F Value	P Value
41 to 60 Yrs	59	28.02	1.57	28.00	1.40	54.549	0.000
61 to 80 Yrs	39	30.25	1.98	30.10	2.70	Diff is sig	

Table 4: Comparison of length of anterior horn (mm) on left side in different age groups.

Length of ant horn (mm) on lt side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	27.62	1.51	27.40	2.28	F Value	P Value
41 to 60 Yrs	59	29.17	1.41	29.20	1.30	81.510	0.000
61 to 80 Yrs	39	31.98	2.02	31.90	2.10	Diff is sig	

Table 5: Comparison of the length body and anterior horn (mm) on right side in different age groups

Length of body and ant horn on right side (mm)	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	61.62	3.48	60.70	5.40	F Value	P Value
41 to 60 Yrs	59	65.43	3.08	66.80	5.20	77.787	0.000
61 to 80 Yrs	39	70.15	3.10	69.40	3.60	Diff is sig	

Table 6: Comparision of length of body and anterior horn (mm) on left side in different age groups.

Length of body & ant horn on left side (mm)	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	63.44	3.30	63.10	6.08	F Value	P Value
41 to 60 Yrs	59	67.48	2.73	68.60	3.40	102.125	0.000
61 to 80 Yrs	39	72.59	3.05	72.20	3.90	Diff is sig	

Table 7: Comparison of length of posterior horn (mm) on right side in different age groups.

Length of post horn (mm) on right side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	24.16	1.49	24.55	2.08	F Value	P Value
41 to 60 Yrs	59	25.86	1.30	26.00	1.40	60.842	0.000
61 to 80 Yrs	39	27.14	0.97	27.20	1.20	Diff is sig	

Table 8: Comparison of length of posterior horn (mm) on left side in different age groups.

Length of post horn (mm) on left side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	52	25.76	1.53	26.20	2.10	F Value	P Value
41 to 60 Yrs	59	27.17	1.07	27.20	1.20	79.166	0.000
61 to 80 Yrs	39	29.00	0.90	29.00	1.60	Diff is sig	

Table 9: Comparison of transverse diameter of inferior horn (mm) on right side in different age groups.

TD of inf horn(mm) on right side.	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	49	2.08	0.34	2.10	0.60	F Value	P Value
41 to 60 Yrs	59	2.42	0.47	2.40	0.80	36.871	0.000
61 to 80 Yrs	39	2.88	0.48	2.80	0.60	Diff is sig	

Table 10: Comparison of transverse diameter of inferior horn (mm) on left side in different age groups.

TD of inf horn (mm) on left side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	48	2.09	0.39	2.10	0.55	F Value	P Value
41 to 60 Yrs	58	2.49	0.49	2.40	0.53	34.468	0.000
61 to 80 Yrs	39	2.95	0.56	3.00	0.40	Diff is sig	

Table 11: Comparison of height of inferior horn (mm) on right side in different age groups.

Height of inf horn (mm) on right side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	49	7.55	1.49	8.00	2.00	F Value	P Value
41 to 60 Yrs	59	9.76	2.35	10.00	4.00	65.016	0.000
61 to 80 Yrs	39	12.67	2.31	12.00	2.00	Diff is sig	

Table 12: Comparison of height of inferior horn (mm) among on left side in different age groups.

Height of inf horn (mm) on left side	N	Mean	SD	Median	IQR	One way ANOVA test	
20 to 40 Yrs	48	7.38	1.31	8.00	2.00	F Value	P Value
41 to 60 Yrs	58	10.28	2.13	10.00	4.00	99.241	0.000
61 to 80 Yrs	39	13.23	2.23	14.00	2.00	Diff is sig	

DISCUSSION

The intricate dimensions of the lateral ventricles have been a subject of considerable interest and investigation within the realm of neuroimaging and neuroscience. As highlighted in the literature, the ventricular system displays a remarkable degree of variety and asymmetry. Notably, this variability is not uniform across all parts of the ventricles, with the occipital horn standing out as a region prone to asymmetry and even unilateral or bilateral absence. Such structural nuances underscore the challenges associated with precisely measuring the size of the ventricular system, particularly given its complex and variable anatomy [11-13].

The importance of understanding normal ventricular morphometry becomes apparent when considering the myriad neurological disorders linked to ventricular size variations. Disorders such as Alzheimer's, Parkinson's, schizophrenia, and dementia have been associated with alterations in ventricular dimensions. However, before delving into the diagnostic implications of ventricular size changes, it is imperative for clinicians to possess a comprehensive understanding of the baseline morphometry of the ventricular system. This knowledge forms the foundation for distinguishing between normal age-related changes and pathological variations [14, 15].

The present study, conducted over a two-year period, aimed to contribute to this understanding by providing quantifiable data on the linear measurements of lateral ventricles using CT brain imaging. The inclusion of 150 patients within the age range of 20-80 years, with normal ventricular reports from radiologists, ensured a diverse yet controlled sample for a thorough examination of age-related changes. The inclusion and exclusion criteria were meticulously defined to eliminate confounding factors such as local mass lesions, cerebral infarctions, hydrocephalus, and previous intracranial surgery, thus enhancing the study's internal validity [16].

The CT brain imaging was performed using a state-of-the-art “PHILIPS BRILLIANCE SLICE 64 MULTIDETECTER SPIRAL COMPUTED TOMOGRAPHY” machine. The imaging procedure involved a head-first supine position with a slice thickness of 2mm, scanning time of 12-15 seconds, and specific scanning parameters to ensure optimal image quality. The collected data, comprising demographic details and CT numbers, were then categorized into three age groups (20-40 years, 41-60 years, and 61-80 years) to facilitate a comprehensive analysis of age-related changes in ventricular dimensions.

The measured parameters included the length of the anterior horn, length of the body and anterior horn, length of the posterior horn, transverse diameter of the inferior horn, and height of the inferior horn. These parameters were measured bilaterally, providing a thorough examination of both sides of the brain. The subsequent statistical analysis aimed to discern significant differences in these parameters across different age groups, shedding light on the progressive changes in ventricular morphometry with aging [17-19].

The results indicate a consistent and statistically significant increase in the dimensions of the lateral ventricles with advancing age. The length of the anterior horn, both on the right and left sides, demonstrated a notable increase from the younger age group (20-40 years) to the older age group (61-80 years). Similarly, the combined length of the body and anterior horn, as well as the length of the posterior horn, exhibited a significant upward trend with increasing age.

The transverse diameter of the inferior horn and the height of the inferior horn also displayed a clear pattern of increase across different age groups. The transverse diameter on both sides showed a statistically significant rise from the youngest to the oldest age group, emphasizing the importance of considering these parameters in the comprehensive assessment of ventricular size. Similarly, the height of the inferior horn increased significantly with age, providing additional insights into the complex three-dimensional changes occurring in the ventricular system.

The findings from our study align with observations made by other investigators, reinforcing the tendency for greater ventricular enlargement in the elderly. Notable researchers, including Roberts MA, Caird F.I., Hann FJY et al, Barron SA et al, Haug G, Gyldensted C et al, and Hughes CP et al, have previously reported on the increase in ventricular size with age [11-14]. Our present study contributes to this body of knowledge by quantifying the changes in lateral ventricle size across different age groups, offering valuable reference data for clinicians and researchers.

The progressive increase in ventricular dimensions with age observed in this study holds significant clinical implications. It underscores the importance of establishing normative data for ventricular morphometry in various age groups to differentiate between normal age-related changes and pathological conditions. Clinicians, neurosurgeons, and radiologists can utilize this data as a benchmark for interpreting CT brain images and making informed clinical decisions.

The retrospective nature of the analysis and the reliance on CT brain imaging, while offering valuable insights, may not capture certain subtleties that could be discerned through more advanced imaging techniques such as magnetic resonance imaging (MRI). Additionally, the exclusion criteria, while necessary for the study's focus on normal ventricular morphometry, might limit the generalizability of the findings to populations with specific neurological conditions.

CONCLUSION

In conclusion, our morphometric study provides robust evidence that the lateral ventricles of the brain undergo significant changes in size with age. The linear measurements conducted on both sides of the brain consistently demonstrate a gradual increase in dimensions from younger to older age groups. These findings contribute to the understanding of normal ventricular morphometry, serving as a crucial baseline for clinicians, neurosurgeons, and radiologists. The quantified data presented in this study can serve as a valuable reference for diagnosing abnormalities in ventricular size, providing a foundation for future research and clinical applications in neurology and radiology. Overall, the study enhances our comprehension of age-related changes in lateral ventricular dimensions and their clinical implications.

ISSN: 0975-8585

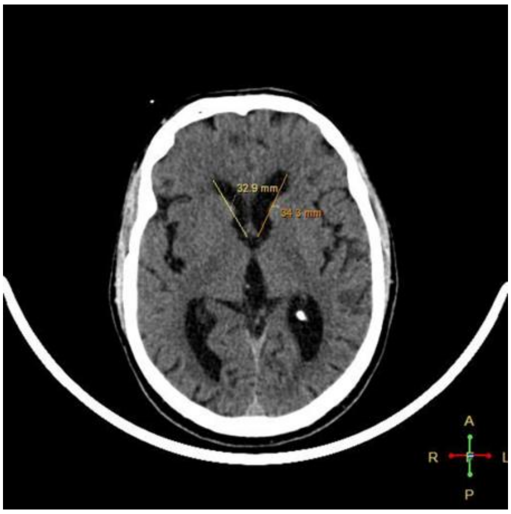

Figure 1: Length of anterior horn in 60 year male patient.

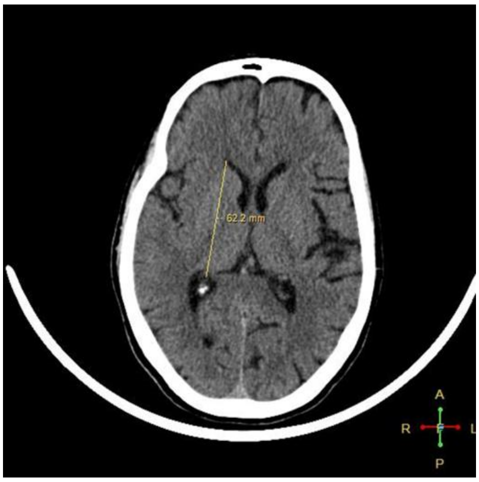

Figure 2: Length of body and anterior horn on right side in 62 year male.

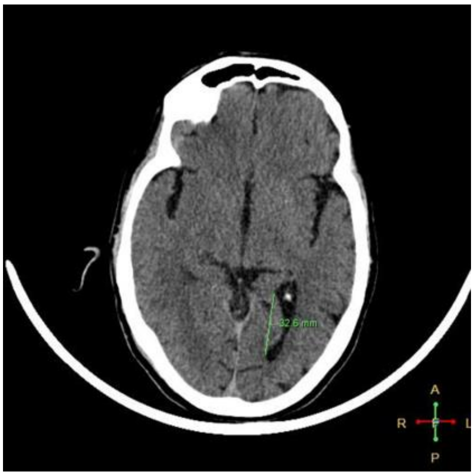

Figure 3: Length of posterior horn on left side in 60 year male patient.

ISSN: 0975-8585

Figure 4: Transverse diameter of inferior horn in 40 year male.

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