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ORIGINAL RESEARCH

To study the assessment of lateral ventricle brain indices in Indian population

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ABSTRACT

Aim: To study the assessment of lateral ventricle brain indices in indian population.

Materials and Methods: This investigation was conducted in the anatomy department with participation from radiology. The brain CT scans included in the research were of normal men and females aged 15 to 75 years who were classified as normal by radiologists in terms of normal cerebral ventricular size, form, and shape.

Results: The radiologist verified normal 200 brain Computed Tomography (CT) scan soft copies (110 men and 90 females) included in this investigation. Except for the cella media index, the differences between men and females in other indices were statistically significant. A substantially significant positive correlation coefficient existed between age and indices.

Conclusion: The current research reveals baseline values of ventricular linear indices with a positive connection between sexes and ages. Thus, understanding these indices is critical when evaluating different neurological and behavioural illnesses connected with ventriculomegaly.

Keywords: Linear Ventricular Indices, Evans Index, Bifrontal Index, Bicaudate Index , Cella Media Index , Third Ventricular Index , Huckman Index, Ventricular Index

INTRODUCTION

The ventricular system of the central nervous system is in charge of carrying cerebrospinal fluid generated by ependymal cells and the choroid plexus, as well as protecting the brain from trauma.[1,2] Ventricles account for 2% of brain volume. The lateral ventricles contribute 82% of the ventricular volume.[3] Hydrocephalus is defined as ventricular enlargement caused by an imbalance in the production and absorption of cerebrospinal fluid.[4,5] Cerebal ventricular enlargement is one of the characteristics in cerebral disorders associated with neurologic and psychiatric involvements. It has been shown to be an encephalographic abnormality in both children and adults.[6] Previous radiographic methods (gas or contrast encephalography) were invasive and had artifacts.[7] To overcome these limitations, newer neuro imaging techniques such as CT and MRI have led to better attempts at evaluating ventricular measurements.[8]

In the CNS examination of children and adults, many imaging modalities such as CT, MRI, and USG are employed. These imaging methods non-invasively scan the human central nervous system while also producing comprehensive anatomy and disease alterations. In the Indian context, CT is the primary modality of choice for assessing brain morphology,

including the size and shape of the ventricles, which will be useful in the diagnosis of conditions such as hydrocephalus, age-related brain atrophy, and other pathological conditions causing ventriculomegaly. It is essential to establish the reference value that specifies the typical size of intracranial fluid gaps before evaluating them. Evans index, Bifrontal index, Bicaudate index, ventricular index, Bicaudate - temporal index, Bioccipital index, Schiersmann's index, and Huckman number are some of the indices available to analyse the ventricular system based on linear measurement.

MATERIALS AND METHODS

This research was conducted in the anatomy department with support from radiology. This was a retrospective cross-sectional research that employed CT scans of 200 people aged 15 to 75 from either sexes who attended the Department of Radiology. The brain CT scans included in the research were of normal men and girls aged 15 to 75 years, who were classified as normal by radiologists in terms of normal cerebral ventricular size, form, and shape. The investigation eliminated CT scans with a history of head injuries, cerebral infarctions, local mass lesions, or prior intracranial procedures.

METHODOLOGY

The patient was put on the CT table, and the head was centred and supported for proper placement and to prevent picture blurring. A lateral scout picture was acquired to check proper patient placement and exposure variables. A line was drawn at an angle of 15 - 20 degrees to and 1 cm above the orbito-meatal line, marking the lowest tomographic section that travelled through the base of the skull. Without any overlap, 30 axial imaging slices of the brain were acquired.

The following measurements will be taken:

A: The maximum bifrontal diameter: the transverse distance defined by a line connecting two anterior corners of the frontal horns.

A1: The first transverse diameter of the brain (brain width): the distance measured along the bifrontal diameter.

B: Minimum width of lateral ventricles.

B1: The second transverse diameter of the brain (brain width) - the distance measured along the line of minimum width of lateral ventricles.

C: Maximum inner skull diameter (MISD)

D: The greatest distances between each lateral margin of the third ventricle.

D1: The second transverse diameter of the brain (brain width): the distance measured along the line of D extending from left to the right cortical surfaces.

E: Width of both cellae media.

Table: With these measurements the following indices was calculated

Ventricular indices	Parameters
Bi frontal index	The maximum bifrontal diameter: the transverse distance defined by a line connecting two anterior corners of the frontal horns (A) / first transverse diameter of the brain (brain width): the distance measured along the bifrontal diameter (A1)
Bicaudate index	Minimum width of lateral ventricles (B) / The transverse diameter of the brain at the level of B (B1).
Evan's index	The maximum bifrontal diameter: the transverse distance defined by a line connecting two anterior corners of the

	frontal horns (A) / Maximum inner skull diameter (C)
Ventricular index	Minimum width of lateral ventricles (B) / The maximum bifrontal diameter (A) .
Huckman's index	Minimum width of lateral ventricles (B) + The maximum bifrontal diameter (A).
Cella media index	Width of both cella media (E) / Maximum inner skull diameter (C).
Third ventricle Ratio/index	The greatest distances between each lateral margin of the third ventricle (D) / The transverse diameter of the brain measured at the level of D (D1)

STATISTICAL MEASURES

All of the ventricular indicators listed above were examined and reported using descriptive statistics such as mean and standard deviation (SD). The T TEST was used to evaluate the mean value of these measures across genders, and the ANOVA test was used to examine statistical significant differences between ages.

RESULTS

Table 1: Mean and standard deviation of all the indices

Indices	Mean ± Standard deviation
Bifrontal index	0.31 ± 0.04
Bicaudate index	0.12 ± 0.04
Ventricular index	0.39 ± 0.08
Huckman index	4.41 ± 0.81
Evans index	0.26± 0.04
Third ventricular index	0.04 ± 0.02
Cella media index	0.23 ± 0.05

Table 2: **Gender wise comparison of linear measurements and indices using T - Test.**

Indices	Male	female	P value
Bifrontal index	0.32± 0.03	0.29 ± 0.04	<0.001
Bicaudate index	0.12 ± 0.03	0.11 ± 0.04	<0.001
Ventricular index	0.41 ± 0.09	0.38 ± 0.11	0.021
Huckman index	4.73 ± 0.81	4.11 ± 0.77	<0.001
Evans index	0.26 ± 0.03	0.25 ± 0.05	<0.001
Third ventricular index	0.03 ± 0.01	0.03 ± 0.01	<0.001
Cella media index	0.23 ± 0.04	0.23 ± 0.05	0.41

P value $\leq$ 0.05 is statistically significant

Table 3: Age wise comparison of linear measurements and indices using ANOVA test.

Age group Indices	15-25	25-35	35-45	45-55	55-65	65-75	P value	r value
Bifrontal index	0.29± 0.04	0.29 ± 0.04	0.29 ± 0.04	0.28 ± 0.04	0.31 ± 0.04	0.34 ± 0.04	<0.001	0.33
Bicaudate index	0.08 ± 0.03	0.09 ± 0.03	0.11 ± 0.03	0.12±0. 03	0.13 ± 0.04	0.15 ± 0.04	<0.001	0.52
Ventricular index	0.34 ± 0.11	0.35 ± 0.08	0.38 ± 0.11	0.42 ± 0.09	0.43 ± 0.08	0.47 ± 0.08	<0.001	0.54
Huckman index	4.11 ± 0.67	4.33 ± 0.74	4.31 ± 0.91	4.32 ± 0.74	4.61 ± 0.82	5.1 ± 0.91	<0.001	0.37

Evans index	0.25 ± 0.04	0.25 ± 0.03	0.25 ± 0.04	0.25 ± 0.04	0.26 ± 0.03	0.28 ± 0.04	<0.001	0.32
Cella media index	0.23 ± 0.051	0.22 ± 0.04	0.22 ± 0.031	0.23 ± 0.05	0.24 ± 0.05	0.27 ± 0.04	<0.001	0.44
Third ventricle index	0.02 ± 0.008	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	<0.001	0.41

P value $\leq$ 0.05 is statistically significant

RESULTS

This research contained 200 brain Computed Tomography (CT) scan soft copies (110 men and 90 females) that were declared normal by a radiologist. Table 1 shows the results of the statistical analysis, including the mean and standard deviation of the indices. Table 2 shows that the differences in indices between men and females were statistically significant in all indices except the cella media index. Table 3 shows that a statistically significant positive correlation coefficient existed between age and indices.

DISCUSSION

Despite the fact that ventricular volume is regarded the standard measurement of ventricular size, it is not always feasible to obtain ventricular volume owing to clinical practise time restrictions. Saraha et al. discovered a good connection between linear measures of ventricles and ventricular volume in adults, indicating the feasibility of employing these measurements instead of subjective assessment of ventricular size.[9]

The following indices were assessed in the current study: bifrontal, bicaudate, ventricu- lar, huckman, evans, third ventricular, and cella media. According to some writers, the bifrontal index is one-third of the breadth of the brain.[10-12] In the current investigation, the bifrontal index was 0.31± 0.04, which was consistent with the results of other authors. Poonam Patnaik et al discovered a negative relationship between age and bifrontal index. Some researchers discovered that the bifrontal index has a considerable impact on gait disruption, which is most likely due to precentral motor cortex fibre displacement on their approach to the internal capsule produced by ventricular dilatation.[13]

The bicaudate index has been used in several studies to assess caudate atrophy in patients with Huntington's chorea, cerebral atrophy, or multiple sclerosis.[14-16] Some authors have discovered significant correlations between the bicaudate index and the duration of Huntington's chorea.[17] In the current study, the bicaudate index was 0.12± 0.04. Previous research has shown that the bicaudate ratio is more responsive to alteration than other linear ratios. Males had a considerably higher bicaudate index than females in the current research. Gender-specific brain bases of thinking, including visuospatial abilities, linguistic processing, and information binding, have recently been studied using voxel-based morphometry. These studies revealed that males rely more on visuospatial ability, which is associated with dorsolateral prefrontal cortex, and females rely on verbal processing and information binding, which is associated with inferior frontal cortex.[18] Thus, the difference in bicauate ratio in males and females can be explained by differences in regional volumes in parts of frontal cortex.

William Evans was the first to recognise the need of defining the normal boundaries of the cerebral ventricles, and linear measurements were widely used in youngsters. He discovered that the normal range of the Evans index was 0.20 to 0.25, that 0.25 to 0.30 indicated early ventricular enlargement, and that values more than 0.30 indicated ventricular enlargement. Evans index was one of the older ventriculographic indices that represented ventricular volume, and it was widely used in the diagnosis of idiopathic normal pressure hydrocephalus, as well as in the assessment of outcome of patients undergoing shunt placement, which is the

primary mode of treatment.[19] In the current study, the mean Evans index was 0.26±0.04, which was due to shrinkage of brain parenchyma, which was compensated for by an increase in ventricle size.

The cella media index is calculated as the ratio of cella media width to maximal inner skull diameter. It may be used to diagnose and treat obstructive hydrocephalus (r=0.28, p=0.001). Previous studies done by Haug revealed the mean cella media index to be 0.295, which steadily increased with age.[20] In the current research, the cella media index was 0.23±0.05, which was comparable to the values in the study done by Poonam Patnaik et al, owing to the larger age group used.[21]

The third ventricle index is a ratio of the largest distances measured at the same level between each lateral edge of the third ventricle and the transverse diameter of the brain. The third ventricular index is a measure of third ventricle enlargement caused by a tumour or cyst in this area. According to Zilundu et al, the third ventricular index was 0.03 in their research, which was identical to the current study. The Huckman index is the sum of the lateral ventricle's minimum width and the maximal bifrontal diameter. It is a valuable measure for determining the diameter of the lateral ventricle's anterior horn. The ventricular index is a ratio of the lateral ventricle minimum width to the maximal bifrontal diameter. Knut Kohlmeyer investigated these indices in demented and non-demented groups and discovered a substantial statistically significant relationship between clinical dementia diagnosis and mean values of these indices. These indices were also statistically considerably higher than those of non-demented groups.[22] Yi Zhang et colleagues employed these indices as a diagnostic tool to distinguish Alzheimer's patients from normal subjects.[23] Swati et al. shown that combining various indicators together yields a better grading of ventricular dilatation than a single index. These indices, assessed using a CT scan, are a useful tool for distinguishing between obstructive and non-obstructive hydrocephalus, identifying the amount of blockage, and diagnosing the aetiology of hydrocephalus.[24] As a result, these indices may be utilised to diagnose and prognosticate normal pressure hydrocephalus, brain shrinkage in alcoholics, Alzheimer's disease, schizophrenia, and dementia.

Table 4 Present study with previous studies

Indices	P. Patnaik and Vishram Singh21	Kohlmeyer K et al22 values of control group	Yi Zhang et al23 values of control group	Present study
Bifrontal index	0.30 ± 0.04	0.28 ± 0.05	---	0.31 ± 0.04
Bicaudate index	0.12 ± 0.03	0.13 ± 0.03	0.130 ± 0.023	0.12 ± 0.04
Evans index	0.27 ± 0.035	0.25 ± 0.05	---	0.26± 0.04
Cella media index	0.22 ± 0.04	0.37 ± 0.07	0.205 ± 0.041	0.23 ± 0.05
Huckman index	---	4.92 ± 0.75	5.46 ± 0.69	4.41 ± 0.81

CONCLUSION

The current research gives baseline values of ventricular linear indices with a favourable connection between sexes and ages. Thus, understanding these indices is critical when evaluating different neurological and behavioural illnesses connected with ventriculomegaly. As a result, radiologists, neurologists, neurosurgeons, and psychiatrists will benefit from this research.

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