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VARIATIONS OF NORMAL VENTRICULAR INDICES DEPENDING ON AGE AND SEX BY COMPUTED TOMOGRAPHY

Anatomy

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ABSTRACT

In many neurological and psychiatric disorders there is change in the ventricular size hence morphometric study of ventricular indices will provide a baseline data for different age and sex groups.

Aim-The aim of our study is to establish the variations of morphometric measurements of ventricular system in different age and sex groups , to acquire the knowledge of age related normal changes that occur in ventricles and to analyse abnormal findings.

Materials And Methods – The brain of 126 normal individuals were examined by 16 slice computed tomography. CT was taken of individuals of age group 10 to 89 years. 126 CTscan of brain which were reported normal were examined. Those with history of cerebral infraction, injury, focal lesions, and hemorrhage were excluded.The data was collected from College of Medicine and Sagar Dutta Hospital and NBMC. The parameters that were chosen for study were Bifrontal index, Bicaudate index, Evans index, Ventricular index, Huckman's index, Cella media index and Third ventricle ratio/index. Data was collected in a tabulated sheet and statistically analyzed to see the differences.

Results: Some of the ventricular indices showed statistically significant differences between males and females and age related changes were also seen.

Conclusion: The study will add to a baseline data and is a valuable information for neurosurgeons, clinicians and radiologists.

KEYWORDS

Computed Tomography, Bifrontal index, Bicaudate index, Evans index, Ventricular index, Huckmans index, Cella media index, Third Ventricular Ratio/Index.

INTRODUCTION

Human brain is the most complicated organ and is the area of interest in various fields and aspects. The ventricular system of the cerebral hemisphere consists of two lateral ventricles and in the midline third and fourth ventricle connected by the Aqueduct of Sylvius[1]. The ventricles of the brain are formed due to flexures of the primitive brain tube. The intracranial CSF volume is estimated to be 123ml out of which 25ml is in the ventricles and 98 ml in the sub arachnoid space [1]. Though there are many modern techniques, CT brain is easily available. The ventricles of the brain can be assessed by taking (1) Linear measurements (2) Planimetric and (3) Volumetric measurements. The linear method of measurement is a easier method without any intervention and is of choice. Change in ventricular size is mainly due to a disproportion between the CSF and brain matter. According to Monro Kellie Doctrine the cranial box is rigid containing blood, brain and CSF and if one of the contents increase in volume the other two must be depleted. [2]

AIM

1. To establish the variations of morphometric measurements of ventricular system in different age and sex groups.
2. To acquire knowledge of age related normal changes that occur in ventricles and to analyze abnormal finding.

MATERIALS AND METHOD

This is a retrospective study done from January 2019 – September 2019 in NBMC and College of Medicine and Sagore Dutta Hospital using GE 16 slice CT Scanner. Brain scan was done with 5mm slice thickness of 126 patients (Female-74 & Male-52). The patients were referred from OPD with some neurological complains. 126 brain scans reported as normal were selected as ethical aspect do not permit CT scan of normal individual for radiations issues. The images were reviewed on computer monitor (512x512 matrix).

All the linear measurements were taken. The parameters chosen for study were (1) Bifrontal index (2)Bicaudate index (3) Evans index (4) Ventricular index (5) Huckmans index (6) Cella Media index and (7) Third ventricular ratio/index. Data was collected in a tabulated sheet and statistical analysis was performed using IBM SPSS 20.o package. Exculsion criteria in this study were any lesion in brain or with cerebral infarction and intracranial surgery and trauma. The median, minimum and maximum and percentiles were calculated and Box and whisker plots were done based on age groups.

The parametes that were measured were calculated as described by Namrata et al &Haug[3,4,5]

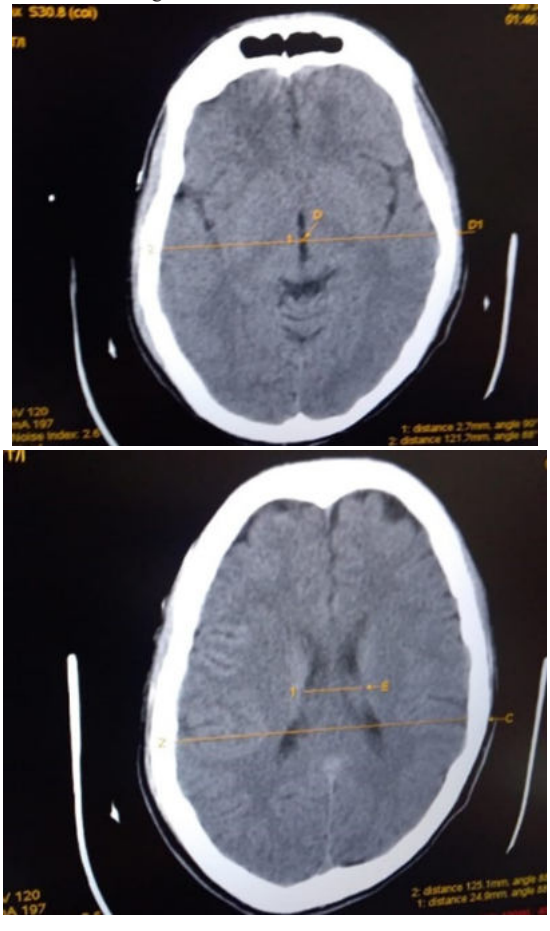


Fig.: Showing the parameters that were measured.

Bifrontal index

$$= \frac{\text{the transverse distance by a line connecting 2 anterior corners of frontal horn (A)}}{\text{First transverse diameter of the brain (A1)}}$$

$$\textit{Bicaudate index} = \frac{\textit{minimum width of lateral ventricles (B)}}{\textit{the transverse diameter of the brain at the level of B (B1)}}$$

Evans Index

$$= \frac{\text{The transverse distance defined by a line connecting two anterior corners of the frontal horns (A)}}{\text{Maximum inner skull diameter (C)}}$$

$$\text{Ventrical index} = \frac{\text{Minimum width of lateral ventricles (B)}}{\text{The maximum bifrontal diameter diameter (A)}}$$

HuckmansIndex

$$= \textit{Minimum width of lateral ventricles (B)} \mid \textit{The maximum bifrontal diameter (A)}$$

$$\textit{Cella media index} = \frac{\textit{Width of both cella media(E)}}{\textit{maximum inner skull diameter (C)}}$$

Third ventricle ratio

$$= \frac{\textit{The greatest distances between each lateral margin of the third ventricle (D)}}{\textit{The transverse diameter of the brain measured at the level of D (D1)}}$$

RESULT

Statistical analysis of the data was performed using the IBM SPSS 20.0 package. The Shapiro-Wilk test for normality was used to check normality of data distribution. Since none of the calculated parameters were normally distributed differences between the groups were calculated by the Mann-Whitney U/ KruskalWalis test in two tailed analysis. A p -value≤0.05 was considered as statistically significant.

Table - 1

1. All together (n=126)

Statistics		Bifrontal Index	Bicaudate Index	Evans Index	Ventricular Index	Huckmans Index	Cella Media Index	Third Ventricular ratio/ index
Median		.296	.105	.245	.376	40.15	.186	.030
Minimum		.220	.052	.187	.194	28.8	.113	.011
Maximum		.404	.285	.323	.823	78.4	.356	.088
Percentiles	25	.276	.082	.226	.307	35.78	.166	.023
	75	.313	.134	.263	.484	45.98	.215	.040

Table - 2

Table showing the correlation between age and morphological indices

Indices	Spearman's rho	Sig. (2-tailed)
Bifrontal Index	.217*	.015
Bicaudate Index	.657**	.000
Evans Index	.142	.114
Ventricular Index	.696**	.000
Huckmans Index	.461**	.000
Cella Media Index	.408**	.000
Third Ventricular ratio/index	.596**	.000

** Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table - 3

Table showing sex wise summary parameters of morphological indices

Sex			Bifrontal Index	Bicaudate Index	Evans Index	Ventricular Index	Huckmans Index	Cella Media Index	Third Ventricular ratio/ index
Female (n=74)	Median		.291	.089	.239	.349	38.15	.183	.029
	Minimum		.220	.053	.187	.202	28.8	.130	.011
	Maximum		.404	.257	.726	.726	68.0	.320	.086
	Percentiles	25	.272	.078	.222	.288	34.08	.163	.022
		75	.307	.112	.257	.427	41.08	.202	.038
Male (n=52)	Median		.303	.116	.254	.436	44.6	.197	.035
	Minimum		.238	.052	.200	.194	32.8	.113	.014
	Maximum		.396	.285	.323	.823	78.4	.356	.088
	Percentiles	25	.285	.099	.235	.374	40.33	.168	.023
		75	.323	.152	.277	.505	48.7	.222	.054

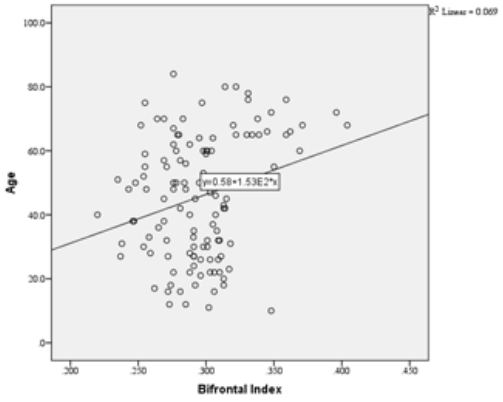
Table – 4

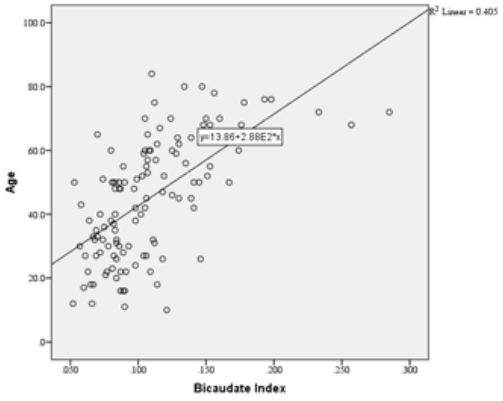
Comparison of morphological indices between males and females

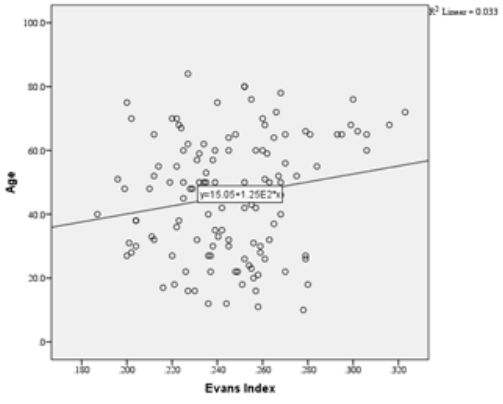
Statistics	Female	Male	Significance#
Bifrontal Index	.291	.303	0.010*
Bicaudate Index	.089	.116	0.000*
Evans Index	.239	.254	0.001*
Ventricular Index	.349	.436	0.000*
Huckmans Index	38.15	44.6	0.000*
Cella Media Index	.183	.197	0.046*
Third Ventricular ratio/index	.029	.035	0.065

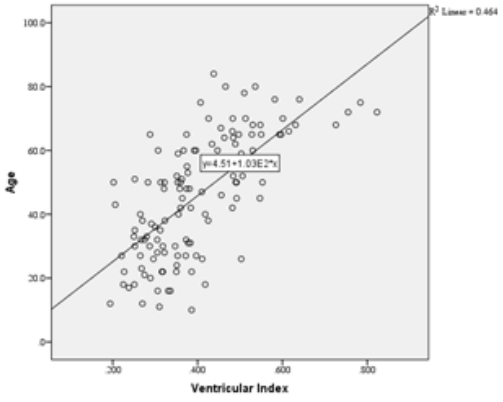
Since the data was non-normally distributed comparisons were done using the Mann Whitney U test

*statistically significant









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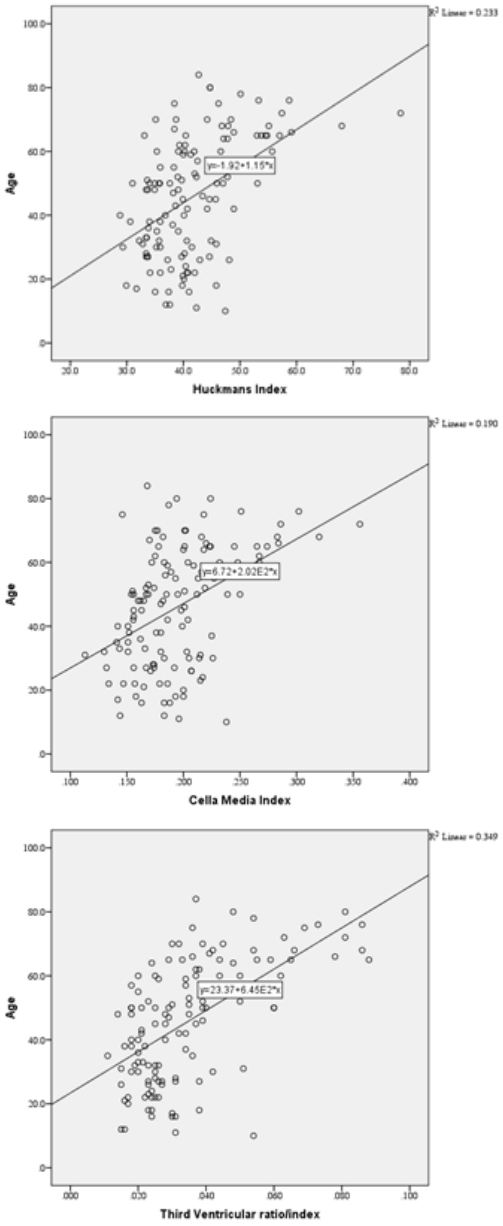
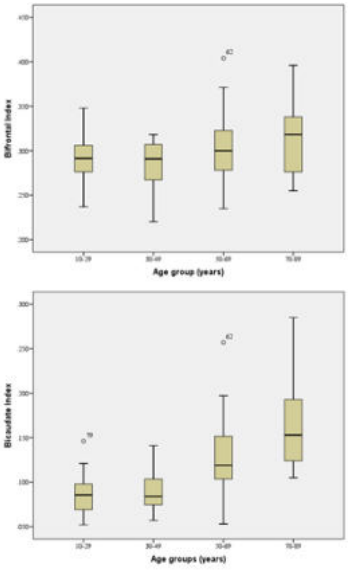


Figure 1: Scatter plots showing the linear correlations between age and morphological indices



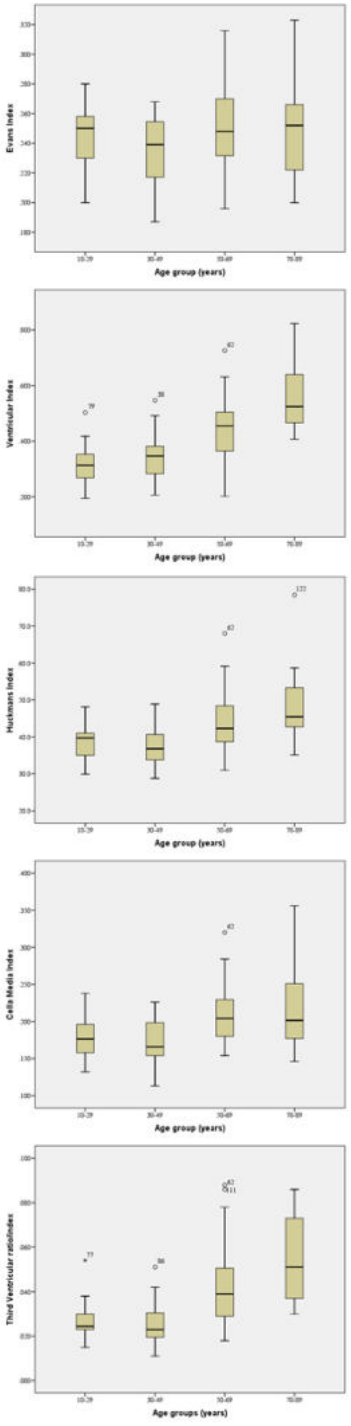


Figure 2: Box and whisker plots showing summary statistics of morphological indices in terms of age groups

Table 5: Table Showing Comparison Of Median Values Of Morphological Indices Based On Age Groups

Statistics	10-29 (n=30)	20-49 (n=35)	50-69 (n=47)	70-89 (n=14)	Significance#
Bifrontal Index	.292	.291	.300	.318	0.068
Bicaudate Index	.086	.084	.119	.153	0.000*
Evans Index	.250	.239	.248	.252	0.084
Ventricular Index	.313	.347	.455	.525	0.000*
Huckmans Index	39.8	36.8	42.3	45.5	0.000*
Cella Media Index	.177	.166	.204	.202	0.000*
Third Ventricular ratio/index	.025	.023	.039	.051	0.000*

Median values

Since the data was non-normally distributed comparisons were done using the Kruskal- Wallis test
*statistically significant

DISCUSSION

Brain is a very complex organ and study in different fields shows structural changes with advancement of age and is different in the two sexes. [6] Recent advances in imaging technique like CT and MRI are noninvasive study without significant complications. In many diseases like hydrocephalus, normal pressure hydrocephalus, and diffuse cerebral atrophy ventricles are enlarged. These provokes an urgent need to define normal range of ventricular measurements with an uniform method of measurement so that any deviation from normal size of the ventricles can be estimated.

The median value of Evans index in our present study is 0.245 which is 0.27±0.035 by Patnaik P etal and 0.252±0.04 by Jehangir Majid et al [7] and 0.264±0.03 by Hamidu A et al(8). Difference in the values of Evans ratio can be due to racial difference in skull size.

In our study, Evans index is more in males than in females which shows statistically significant difference (p=0.001). This is in concordance with previous study of Patnaik etal and Haugh et al.. In our study we found Evans index increased with age which is in concordance with the findings by Jehangir Majid et al and the probable reason is that brain parenchyma shrinks with age.

Many studies conclude that if Evans index is more than 0.30, it suggests ventricular enlargement [8].In a study, on patients with Alzheimer's disease, Brix et al reported that 29% of the controls had an Evan's Index 0.3 on MRI images. They suggested new cut offs based on age for male/female as follows:

65-69 years 0.34/0.32, 70-74 years 0.36/0.33, 75-79 years 0.37/0.34 and 80-84 years 0.37/0.36.[9]

The median value of Bicaudate ratio in our present study is 0.105 ranging from 0.052 to 0.285 and in more in males, which closely correlates to the findings of Patnaik etal who declared the upper limit of bicaudate ratio as 0.21. Our study showed significantly higher values in males than in females (p=0.000). Increase in bicaudate ratio is closely related to frontal horn ventricular enlargement associated with atrophy of deep frontal subcortical white matter. Our study showed a statistically significant increase with age (p=0.000). BCR helps to measure subcortical frontal atrophy and explains conginitive dysfuntion in patients.

Cella media index is ratio of biparietal diameter to maximum external diameter of lateral ventricles at cella media, that is central point of lateral ventricles. The cella media index in our present study ranges from 0.113 to 0.356 and its median value is 0.186, which is 0.227 in a study by Patnaik etal. Haug et al reported cella media index to be 0.295 which gradually increases with age. In our present study cella media index was more in male patients (p=0.046) and linear increase with age (p=0.000). On the contrary Jehengir Majid et al found no statistically significant difference between male /female.

Huckmans index, ventricular index and third ventricular index was rather of more diagnostic value than prognostic. All parameters showed a clear age dependence. There was statistically increase in the index with age.[9,10]

In our study ,the median value of Huckman index is 40.15 ranging from 28.8 to 78.4. Statistically significant difference was found between male and female(p-0.000) and an increase in value was seen with age.

Third ventricular ratio in our present study ranged from 0.011 to 0.088 and median value 0.30 which is similar to findings of Kolsur Namrata et al. An increase in the value was seen with increase in age(p-0.000)

CONCLUSION

Our study comprises of combination of several ventricular indices which will provide a baseline data for normal change in ventricular size and any deviation from it which will be a valuable guide for neurosurgeons clinicians and radiologists.[11,12,13]

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