



EVALUATION OF NORMAL VALUES OF EVANS INDEX IN SOUTH KERALA POPULATION USING COMPUTERIZED TOMOGRAPHY OF BRAIN

Anatomy

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ABSTRACT

Introduction In the adult human brain, there are four connected ventricles - two lateral ventricles within the cerebrum, a midline third ventricle between the right and left thalami, and a midline fourth ventricle lying between the cerebellum posteriorly and the pons and medulla anteriorly¹. Evans index is the ratio of the maximum width of the anterior horn of the lateral ventricle to the maximum transverse diameter of the inner table of the skull. A clear understanding of the normal values of Evans index and variations of the ventricular system of brain is useful for clinicians, radiologists and neurosurgeons in their daily clinical practice². **Aims And Objectives** To determine the normal values of Evans index using Computerized tomography of brain in South Kerala population. **Materials And Methods** The study was conducted in individuals who attended the Department of Radiodiagnosis in Government Medical College, Thiruvananthapuram. Those patients whose brain CT scans were read as normal by the radiologist were taken up for the study, during the period from January 2019 to June 2020. A total of 200 CT brain of individuals above 10 years of age were taken. 100 males and 100 females were included in the study group. **Results** The mean Evans index in the study was found to be 0.258 ± 0.05 in males, 0.255 ± 0.03 in females and an overall mean of 0.256 ± 0.04 was calculated. **Conclusion** The present study shows that Evans index was more in individuals who were above 60 years in both males and females. Knowledge of Evans index will help in the diagnosis of idiopathic normal pressure hydrocephalus and in the assessment of outcome of patients with ventriculoperitoneal shunt placement.

KEYWORDS

Evans index, Computerized tomography, Lateral ventricles

INTRODUCTION

As ageing progresses, the brain undergoes many gross and histopathological changes along with regression of the brain tissue, leading to the enlargement of the ventricles³. Both imaging and autopsy studies have revealed that there is a correlation between increase in cerebrospinal fluid spaces and reduction in cerebral volume, that accompanies normal human ageing^{4,5}.

Hydrocephalus is caused by the enlargement of the ventricles of the brain due to imbalance in the production and absorption of cerebrospinal fluid.

Enlargement of cerebrospinal fluid spaces during ageing is generally diffuse⁶. Various studies clearly show that there is an increase in the CSF spaces in dementia, especially in Alzheimer's disease and Parkinson's disease⁷. This is due to a reduction in the size of the nerve cells⁸. Ventricular enlargement has been found to be a more sensitive indicator of cortical atrophy due to increasing age and dementias⁹.

Computerized Axial Tomography is a safe and non-invasive investigative technique by which morphometric evaluation of the ventricles of brain can be done, which was developed by Hounsfield GN. It is an imaging modality which utilizes X-rays, to provide images of transverse slices of brain without the use of contrast media. It can be used as a screening procedure for many diseases. The ventricular systems of brain have been studied in detail routinely using MRI and CT scan¹⁰.

The international guidelines for the diagnosis of normal pressure hydrocephalus defines Evans index as greater than or equal to 0.3. Evans suggested the normal range of the index as between 0.20 and 0.25 as the most common¹¹. Knowledge of Evans index will help in the diagnosis of idiopathic normal pressure hydrocephalus and in the assessment of outcome of patients with ventriculoperitoneal shunt placement. It also helps in identifying visual complications in children with hydrocephalus.

Materials And Methods

The present study was a descriptive cross-sectional study conducted in Department of Radiodiagnosis, Government Medical College, Thiruvananthapuram during the period from January 2019 to June 2020. CT brain of 200 individuals above 10 years of age, with normal radiological findings, were taken. The study group included 100 males and 100 females.

Methodology

The patient was placed on the CT table and the head was centralized for correct alignment in order to reduce blurring of images. A lateral image was taken for confirming correct position of patient. A line was drawn at an angle of $15-20^\circ$ and about 1 cm above the canthomeatal line. This line represents the lowest tomographic section which passes through the base of the skull. The lateral ventricles were seen in 3-4 contiguous slices in CT scan images. From the CT scan of brain, Evans index was calculated by measuring maximum anterior horn width to the maximum transverse diameter of inner table of skull, in the same section.



Figure 1: Ct Image Showing Method Used To Measure Evans Index: 1 - Maximum Anterior Horn Width, 2 - Maximum Biparietal Diameter.

Inclusion Criteria

Among all the patients with neurological complaints who were referred for CT brain to the Department of Radiodiagnosis during the study period, only those patients whose CT scans were read as normal by the radiologist, were included in the study.

Exclusion Criteria

CT scans of patients, with history of head injuries, previous intracranial surgeries or showing local mass lesion or cerebral infarctions, were excluded from the study.

Statistical Analysis

The statistical analysis of the study was performed using SPSS Software. All the data collected were entered as mean and standard deviation, and expressed in tables and graphs. p value less than 0.05 was considered as statistically significant.

OBSERVATION AND RESULTS

In the present study, 200 normal CT scans in the age group of 10 to 90 years were taken for the study and analyzed. Among these, 100 were CT scans of males and 100 were CT scans of females.

Table 1: Agewise And Genderwise Distribution Of Ct Scans

Age group	Sex		Total	
	Male	Female	Number	%
10-19	12	20	32	16.0
20-29	26	21	47	23.5
30-39	17	13	30	15.0
40-49	15	15	30	15.0
50-59	15	20	35	17.5
60-69	9	8	17	8.5
70-79	3	3	6	3.0
80-89	3	0	3	1.5
TOTAL	100	100	200	100.0

Majority of the CT scans belong to the 20 - 29 years age group. Least number of CT scans were in the 80 - 89 years age group.

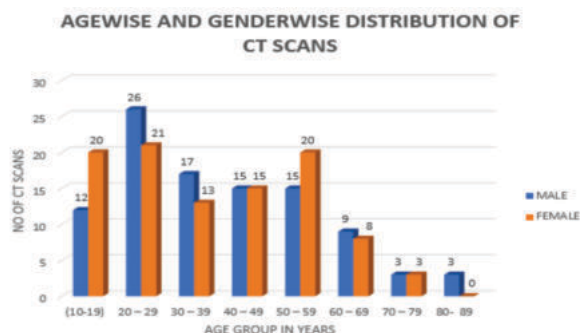


Figure 2 - Agewise And Genderwise Distribution Of Ct Scans

Table 2: Showing Comparison Of Evans Index With Age Group And Gender

VENTRICULAR PARAMETERS (MEAN ± SD)				
AGE	GENDER	TAHW	MICD	EI
10-19	MALE	28.2 ±4.5	119±7.5	0.25±0.4
	FEMALE	29.1±2.4	116±5.8	0.25±0.2
20-29	MALE	30.8±2.2	120±4.8	0.27±0.15
	FEMALE	29.8±2.4	118±4.5	0.25±0.17
30-39	MALE	31.7±3.0	121±5.8	0.27±0.23
	FEMALE	30.3±1.9	122±5.7	0.26±0.19
40-49	MALE	32.1±2.0	124±5.8	0.27±0.17
	FEMALE	31.6±2.4	122±5.5	0.27±0.16
50-59	MALE	33.6±2.5	124±5.8	0.28±0.21
	FEMALE	31.4±2.7	123±6.6	0.27±0.16
60-69	MALE	34.8±3.5	127±6.9	0.29±0.25
	FEMALE	32.7±0.9	124±9.4	0.28±0.16
70-79	MALE	34.9±2.9	127±6.8	0.29±0.25
	FEMALE	32.9±2.4	125±5.9	0.28±0.17
80-89	MALE	35.1±3.1	128±6.7	0.29±0.26
	FEMALE	33.1±2.5	126±5.8	0.28±0.16

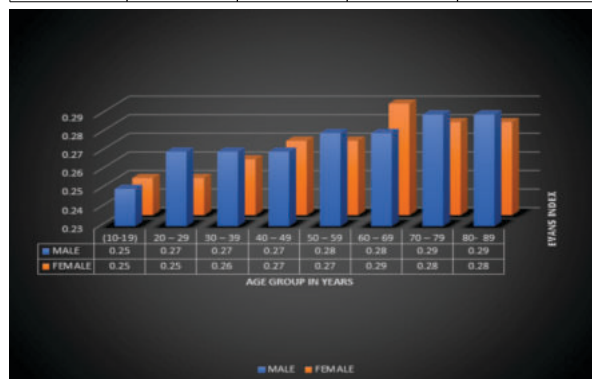


Figure 3 - Showing Distribution Of The Mean Values Of Evans Index Across Age Groups And Gender

DISCUSSION

With the availability of Computerized tomography, Evans index has become a good modality for measuring the size of the ventricular system of brain. Evans considered the value between 0.20 to 0.25 as normal. Gawler et al12 calculated the mean of Evans index as 0.18 to 0.30 in normal subjects. Gyldensted C et al13 observed that there was a slight increase in Evans index with increasing age. The mean value of the younger age group (17 to 40 years) was 0.26 and in the older age group (41 to 86 years) was 0.275. Jacoby RJ et al14 observed the value of Evans index to be 0.31 in healthy elderly people. D' Souza et al15 found that mean Evans index was 0.26 in females and 0.27 in males. Mean Evans index was calculated as 0.27 in a CT scan study by Patnaik P et al16. Reddy V U et al17 found it to be 0.25 in the CT scans of 326 normal Indian individuals between 1 to 99 years. Hamidu et al18 found Evans index to be 0.25 in 448 Nigerian individuals between 18 to 84 years of age by CT scans. They also observed an increase in Evans index values in subjects >60 years.

CONCLUSION

Evans index is a reliable indicator of volume of the lateral ventricles of brain in healthy adults. In the present study, it was observed that Evans index value was 0.258±0.05 in males, 0.255±0.03 in females. An overall mean of 0.256±0.04 was calculated. By our study, the normal range of Evans index of healthy adult males and females of South Kerala population was identified. This could be of great use in the routine clinical practice and in the diagnosis of conditions with ventriculomegaly.

Abbreviations

CT: Computerized Tomography

TAHW: Total Anterior Horn Width

MICD: Maximum Intracranial Diameter

SD: Standard Deviation

Conflicts Of Interest – None

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