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Original Article

Anatomy Section

Evaluation of Evan's Index by Computed Tomography in Hydrocephalic Children in Tertiary Hospital of Telangana

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ABSTRACT

Introduction: Hydrocephalus is one of the important clinical scenario seen in pediatric age group, which, if left untreated can lead to many complications. Mortality caused by hydrocephalus is between 0-3%. Obstruction in the circulation of CSF leads to accumulation of fluid within the ventricular system which causes compression of brain. Ventricular size can be studied by linear or volumetric measurements, out of which linear ratios of the width of the ventricles to the width of skull or brain is the easiest reproducible method; Evan's index is one such Ventriculographic index.

Aim: To evaluate Evan's Index in hydrocephalic children by Computed Tomography (CT) attending tertiary hospital Telangana.

Materials and Methods: CT-scans of 50 normal and 50 hydrocephalic children between 0-12 years attending the Department of Radiology, Niloufer Hospital Hyderabad Telangana, India, between November 2013 to August 2014 were analyzed retrospectively. Maximum frontal horn width and maximum inner diameter of skull were measured and Evan's index was calculated. The data was analyzed by using Z-test.

Results: Out of 50 hydrocephalic cases 24 (48%) were males and 26 (52%) were females, 31 were below 3 years and 19 were above three years. Mean Evan's index in cases (0.44±0.12) is more than in controls (0.16±0.05) with Z=15.23; p<0.0001. The mean Evan's index of males (0.45±0.12) was higher than of females (0.43±0.12) which shows no significant results (Z=0.58; p=0.556). The mean Evan's Index in children below three years (0.47±0.13) was found to be higher than in children above three years (0.38±0.08) where Z=3.03; p=0.002.

Conclusion: The mean Evan's Index was found to be more in males (0.45) than in females (0.43). The mean Evan's Index was found to be more in hydrocephalic children below three years (0.47) than in above three years (0.38).

Keywords: Brain, Frontal horn, Skull, Ventricles

INTRODUCTION

Hydrocephalus is one of the important clinical scenario seen in pediatric age group, which if left untreated can lead to many complications. Much of research has been done on paediatric hydrocephalus, its complications, neurological outcomes and mortality rate which ranges from 0-3% [1]. Obstruction in the circulation of CSF leads to accumulation of fluid within the ventricular system which causes compression of brain. Conventional view is that obstruction within the subarachnoid space impair CSF circulation and lead to CSF malabsorption causing either obstruction or communicating hydrocephalus [2]. Obstruction in the flow of CSF, growth and aging lead to changes in the brain which can be studied by morphometric analysis of the ventricular system [3]. CT being non invasive becomes safe type of investigation commonly preferred by the radiologist in paediatric age group [4].

Ventricular size can be analyzed by linear measurements [5]. Evan's index is the ratio of the maximum width of the frontal horn to the maximum inner diameter of the skull [6].The present work was undertaken to evaluate Evan's Index in hydrocephalic children by CT scan, attending Tertiary Hospital in Telangana.

MATERIALS AND METHODS

The retrospective study was carried out in the Department of Radiology, Niloufer Hospital for Women and Children, Hyderabad Telangana, India between the period of November 2013 to August 2014. Total 100 subjects of age group 0-12 years were analyzed for the study. All the subjects were divided into two groups cases and controls.

Total 50 CT-scans of children in the age group of 0-12 years which were reported normal by the radiologist were randomly selected as control group.

Total 50 CT-scans of hydrocephalic children in the age group of 0-12 years who were clinically diagnosed by the pediatrician and presented to our Radiology Department were selected as cases.

Consent was taken from the parents of all the 100 subjects prior to the study. Approval from Ethical Committee of Osmania Medical College Koti Hyderabad Telangana was taken prior to the study.

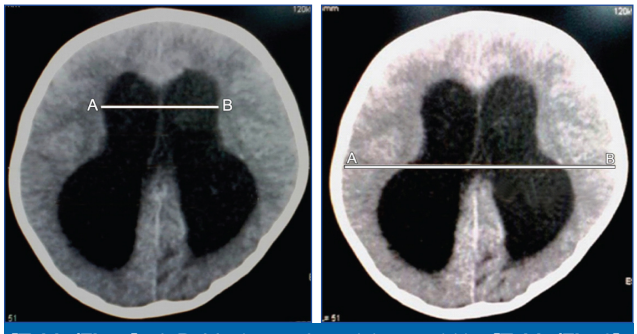
CT-scans of patients with head injury, trauma , intracranial haemorrhage, previous head injuries and of adults were excluded from the study.

CT brain of all the subjects were performed in Toshiba, Aquilion, Tsx-101 A, multislice detector CT scanner with slice thickness of 5 mm and a scan time of 0.5 sec. Axial sections were obtained and analyzed. The maximum frontal horn width and maximum inner diameter of skull were measured with the help of in built linear calipers in the machine. The following CT-scan parameters were used in the study:

1. Maximum Frontal Horn Width.

2. Maximum Inner Diameter of Skull.

Evan's index: It is the ratio of the maximum width of the frontal horns to the maximum inner diameter of skull [Table/Fig-1,2].



[Table/Fig-1]: A-B Maximum frontal horn width. **[Table/Fig-2]:** A-B Maximum inner diameter of skull.

STATISTICAL ANALYSIS

Statistical analysis of the data was performed by using SPSS software version 22. The mean and Standard Deviation (SD) of all measurements were estimated and 95% Confidence Interval (CI) both upper and lower were calculated for all. The data was also analysed by using Z-test for significance of difference of the measurements between males and females. One-way-ANOVA was used to check for differences in ventricular dimensions across age groups. The p-value <0.001 was considered as statistically significant.

RESULTS

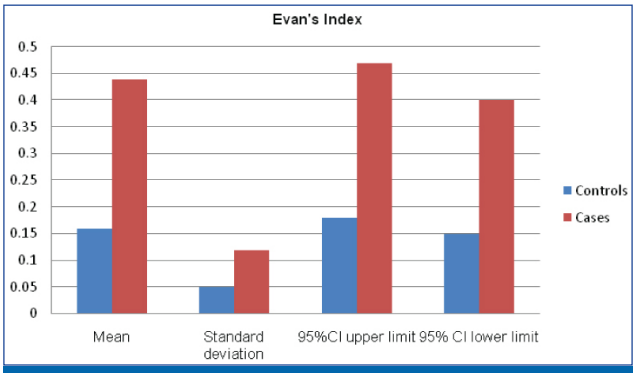
Total 100 subjects of age group 0-12 years coming from different districts of Telangana state to the Niloufer Hospital for Women and Children, Hyderabad Telangana during the study period were considered for the study. CT-scans of all the above subjects were obtained from the Department of Radiology with the parents consent.

Mean Evan's index in cases (0.44±0.12), was more than in controls (0.16±0.05). Z=15.23 shows significant difference in two groups in terms of mean [Table/Fig-3,4] .

The mean Evan's index of males (0.45±0.12), was higher than of females (0.43±0.12). Z=0.58 shows no significant difference in Evan's index between males and females [Table/Fig-5].

Parameters	Cases	Control
Mean	0.44	0.16
Standard Deviation	0.12	0.05
95% Confidence Interval (upper limit)	0.47	0.18
95% Confidence Interval (lower limit)	0.40	0.15

[Table/Fig-3]: Measurement of Evan's index.
*Z=15.23; p<0.0001



[Table/Fig-4]: Shows the measurement of Evan's index.

Parameters	Males	Females
	Cases	Cases
Mean	0.45	0.43
Standard Deviation	0.12	0.12
95% Confidence Interval (upper limit)	0.51	0.48
95% Confidence Interval (lower limit)	0.40	0.37

[Table/Fig-5]: Evan's index in hydrocephalic children according to gender.
*Z=0.58; p=0.556

Parameters	Below 3 yrs	Above 3 yrs
	Cases	Cases
Mean	0.47	0.38
Standard Deviation	0.13	0.08
95% Confidence Interval (upper limit)	0.49	0.41
95% Confidence Interval (lower limit)	0.44	0.34

[Table/Fig-6]: Measurements of Evan's index in hydrocephalic children according to age.
*Z=3.03; p=0.002

The mean Evan's Index in children below three years (0.47±0.13) was found to be higher than in children above three years (0.38±0.08). p=0.002; shows significant difference of Evan's index in hydrocephalic children according to age [Table/Fig-6].

DISCUSSION

The Evan's index is the most commonly used parameter for the evaluation of ventricular dilatation.

Synek V et al., defines Evan's index as the ratio of maximal width of the frontal horns to the maximal width of the inner skull [7].

Pedersen H et al., in a study including 155 normal children below age of 15 found that the Evan's index (0.35) was larger in the younger group (<3 years) than Evan's index (0.31) in the older (>3 years) children [8].

Mesiwala AH et al., in a study on recurrent hydrocephalus found the Evan's index of 0.42 in a child of age of 1.6 years with congenital hydrocephalus, and a Evan's index of 0.31 in a child of age five years with congenital hydrocephalus [9].

Idowu O et al., in a prospective study including 137 hydrocephalic children below age of six years found the mean Evan's index as 0.56 (range 0.43-0.70) [10].

Skiftesvik JF et al., in retrospective cohort study including 27 hydrocephalic children below age of seven years found the mean Evan's index 0.40. They also stated Evan's index is more sensitive to dilatation of the anterior horn and Evan's index increases with the dilatation of the lateral ventricles [11].

Erol FS et al., in a study including 27 hydrocephalic children below age of 6 months found the mean Evan's index as 0 45 [12].

In the present study, mean Evan's index in cases (0.44±0.12) is more than in controls (0.16±0.05) which shows significant difference of Evan's index in two groups (p <0.0001).

The mean Evan's index of males (0.45±0.12) was higher than of females (0.43±0.12). The p-value was 0.556 which shows no significant difference of Evan's index in males and females.

The mean Evan's index in hydrocephalic children below three years (0.47±0.13) was found to be higher than in children above three years (0.38±0.08). This shows significant difference (p=0.002) of Evan's index in hydrocephalic children according to age.

The findings in the present study were in consistent with the findings of Mesiwala AH et al., Skiftesvik JF et al., Erol FS et al., [9,11,12]. The mean Evan's index (0.56) of Idowu O et al., is higher than the present study which may be due to ethnicity of the Nigerian population [10]. Hence, Evan's index has an important role in making a decision on the treatment and follow-up of infants with hydrocephalus [Table/Fig-7].

S. No	Authors	Age Group	Mean of Evan's Index
1.	Mesiwala AH et al., [9] (2002)	Below 2 years	0.42
2.	Idowu O et al., [10] (2011)	Below 6 years	0.56
3.	Skiftesvik JF et al., [11] (2013)	Below 7 years	0.40
4.	Erol FS et al., [12] (2013)	Below 6 months	0.45
5.	Present Study (2014)	Below 12 years	0.43

[Table/Fig-7]: Comparison of Evan's Index in the present study with other previous studies.

LIMITATION

The study was conducted only in a small sample. The sample size should be increased to get more significant data. In addition to the parameters and index used in the study other parameters could be used in predicting the disease outcome.

CONCLUSION

The mean Evan's index in control group was found to be 0.16. The mean Evan's index in hydrocephalic children below three years (0.47) and above three years (0.38). The mean Evan's index was found to be more in males (0.45) than in females (0.43). Our study supports the international guidelines cut off value of Evan's index >0.30 in the diagnosis of hydrocephalus children. Thus, Evan's index can be used as reliable parameter in diagnosis of hydrocephalus in children. The above study will be helpful to the pediatricians in diagnosing the hydrocephalus in its early stages and to the neurosurgeons to make necessary intervention at an earlier stage for the better outcome and follow-p.

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