Evaluation of normal measurements of fourth ventricle by computed tomography

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Submission: 25-01-2023 Revision: 02-04-2023 Publication: 01-05-2023

ABSTRACT

Background: Size of fourth ventricle varies in different pathologies, in the context of enlarged brain ventricles size observed in routine clinical practices, knowledge of the usual range of exact measurement is required. **Aims and Objectives:** This study is hospital-based observational study to derive normal measurement range of fourth ventricle and correlating it with measurements of cerebrum and age of patients. **Materials and Methods:** Hospital-based prospective study was conducted in the department of radiodiagnosis in a teaching medical college. Patients with virtually normal study on unenhanced head CT scan of both sex and age groups from 2 year to 60 years, were included in the study. Patients with CT scans showing gross pathological changes affecting the normal anatomy of ventricles were excluded from the study. **Results:** The mean age of the cases was 37.0±16.88 years. Mean fourth ventricle anterioposterior dimension is 7.5±2.5 mm and transverse dimension is 12±3.1 mm. Anteroposterior diameter of fourth ventricle showed non-significant correlation (r=0.06, P=0.56) with anteroposterior diameter of skull and no significant correlation with (r=0.07, P=0.45) transverse diameter (TD) of skull. AP diameter of fourth ventricle showed a positive correlation with age, which was statistically significant (r2=0.698, P=0.01). TD of fourth ventricle showed slight positive correlation (r=0.202 P=0.048) with anteroposterior diameter of skull and (r=0.142, P=0.168) TD of skull whereas nil with. TD of fourth ventricle showed a positive correlation with age, which was statistically non-significant (r2=0.659, P=0.01). It increases with age. **Conclusion:** Knowledge of normal measurements helps in assessing, dilated fourth ventricle in various pathologies.

Key words: Fourth ventricle; Cerebrum; Age; Normal measurements; Correlation

Access this article online

Website:

http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v14i5.51778

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

The fourth ventricle, which drains directly into the spinal cord's central canal, is the ventricle that is most inferiorly situated. The cerebral aqueduct of Sylvius, a narrow channel, connects it superiorly to the third ventricle. It is encircled inferiorly by the spinal canal and spinal cord, posteriorly by the cerebellum, and anteriorly by the pons and medulla. Two channels drain cerebrospinal fluid (CSF) into the surrounding neural tissue at its superolateral regions. These are referred to as the foramina of Luschka or the lateral openings. The median aperture, also known as the Magendie foramen, is located inferiorly. The spinal cord and the nearby neuronal structures are better surrounded by CSF thanks to these openings. The central canal of the brain receives all of the CSF that does not drain out of these openings.[1]

The inferior cerebellar peduncles, together with the cuneate and gracile tubercules, wrap the lateral wall of the fourth ventricle inferolaterally. The superior cerebellar peduncle surrounds the lateral wall superolaterally as well. Two cerebellar peduncles serve as the dorsal wall and ceiling of the fourth ventricle, and they are connected by a thin white sheet known as the superior medullary velum. The superior medulla and the posterior surface of the pons combine to produce the fourth ventricle's floor.[2]

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Table 1: Frequencies of data

Parameter	Age	FV AP dimension	FV transverse dimension	CER AP dimension	CER transverse dimension
Mean	37.07	0.7536	1.2888	14.562	12.386
SD	16.889	0.25166	0.31388	0.6711	0.6985
Minimum	3	0.30	0.66	12.8	10.9
Maximum	60	1.60	2.10	16.3	13.9

Table 2: T- Test

Parameter	Sex	n	Mean	SD	P-value
FV AP dimension	M	112	0.7671	0.25973	0.471
	F	71	0.7279	0.23722	
FV transverse dimension	M	112	1.3029	0.34910	0.496
	F	71	1.2618	0.23497	
CER AP dimension	M	112	14.713	0.6721	0.002
	F	71	14.276	0.5766	
CER transverse dimension	M	112	12.562	0.6627	0.001
	F	71	12.052	0.6491	
Age	M	112	35.03	18.115	0.075
	F	71	40.97	13.678	

Size of fourth ventricle varies in different pathologies. Clinical diseases affecting the fourth ventricle typically manifest as an increase in CSF fluid levels in that ventricle. The fourth ventricle choroid plexus may produce more CSF fluid than usual, or the ventricle may become blocked, causing this condition. In individuals who experience a sudden loss of consciousness, it is crucial to rule out fourth ventricle compression or obstruction. Ependymomas, non-communicating hydrocephalus which indicates an obstruction in the flow of CSF, which causes it to become trapped in the ventricles and cause dilatation of the ventricles close to the lesion,[3] psychological changes, epilepsy, meningoencephalitis, migraine, spinal cord injuries, and neurocysticercosis, among other conditions, its measurements may change.[4]

Aims and objectives

This study is hospital-based observational study to derive normal measurement range of fourth ventricle and correlating it with measurements of cerebrum and age of patients.

MATERIALS AND METHODS

Hospital-based prospective study was conducted for 3 months in the Department of Radiodiagnosis of Sri Devaraj Urs Medical College from September 2022 to November 2022. Institutional human ethical committee clearance was obtained and informed written consents were signed by all participants. Patients with virtually normal study on unenhanced head CT scan of both sex and age groups from 2 years to 60 years, were included in the study. Patients with CT scans showing gross pathological changes affecting the normal anatomy of ventricles were excluded from the study.

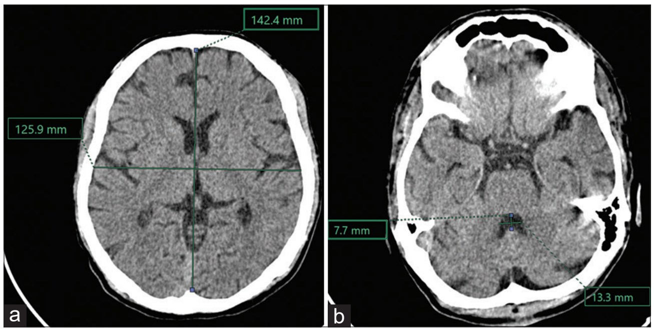

Figure 1: (a) Axial image at the level of head of caudate nucleus for measurements of cerebrum, (b) Axial view for 4th ventricle measurements

Image selection: Two images were selected for each patient for the present study (Figure 1).

1. Axial view at the level of head of caudate nucleus: In this view, anteroposterior diameter of cerebrum (AP) was measured, as the maximum distance between the inner tables of skull in midline. The transverse diameter (TD) was measured at the midpoint of AP
2. Axial view for 4th ventricle measurements: The view was selected in which pons, cerebellum, petrous bone, mastoid antrum, and temporal lobes were visible clearly along with the widest part of fourth ventricle.

Sample size calculation

Meshram and Hattangdi had reported the maximum standard deviation of the fourth ventricle morphometry to be 0.338 (vertical distance).

Assuming the expected population standard deviation to be 0.338 for 4th ventricle morphometry, and employing t-distribution to estimate sample size, the study required a sample size of 183 subjects to estimate a mean with 95% confidence and a precision of 0.05.[5]

Statistical analysis

All the data were checked by Levene's Test for Equality of Variances for normal distribution. Mean, standard deviation, ranges, and 95% confidence intervals were calculated for all the parameters. Two sample independent Student's *t*-test was used to find the difference in males and females in these indices. Correlations with diameters of cerebrum/skull were found by calculating Pearson's correlation coefficient. Correlation with age was found by studying regression statistics. The level of significance was taken as 0.05.

Table 3: Correlation

Parameter	Age	FV AP dimension	FV transverse dimension	CER AP dimension	CER transverse dimension
Age					
Pearson correlation	1	0.698**	0.659**	-0.084	-0.077
P-value		0.001	0.001	0.414	0.455
n	183	183	183	183	183
FV AP dimension					
Pearson correlation	0.698**	1	0.705**	0.060	0.077
P-value	0.001		0.001	0.562	0.453
n	183	183	183	183	183
FV transverse dimension					
Pearson correlation	0.659**	0.705**	1	0.202*	0.142
P-value	0.001	0.001		0.048	0.168
n	183	183	183	183	183
CER AP dimension					
Pearson correlation	-0.084	0.060	0.202*	1	0.280**
P-value	0.414	0.562	0.048		0.006
n	183	183	183	183	183
CER transverse dimension					
Pearson correlation	-0.077	0.077	0.142	0.280**	1
P-value	0.455	0.453	0.168	0.006	
n	183	183	183	183	183

FV- fourth ventricle, AP- anterio-posterior, CER- cerebrum, *correlation is significant at the 0.05 level, **correlation is significant at the 0.01 level

RESULTS

Frequencies

Mean age of the patients was 37.07 years with standard deviation of 16.8 ranging from 3 to 60 years. Mean fourth ventricle anterio-posterior dimension was 0.75 cm with standard deviation of 0.25 cm ranging from 0.3 to 1.6 cm. Mean fourth ventricle transverse dimension was 1.28 cm with standard deviation of 0.31 cm ranging from 0.66 to 2.1 cm. Mean cerebrum anterio-posterior dimension was 14.56 cm with standard deviation of 0.67 cm ranging from 12.8 to 16.3 cm. Mean cerebrum transverse dimension was 12.38 cm with standard deviation of 0.69 cm ranging from 10.9 to 13.9 cm (Table 1).

t-test

P values were calculated for all parameters (Table 2). P value < 0.05 is statistically significant.

Correlations

AP diameter of fourth ventricle showed non-significant correlation with anteroposterior and transverse diameter of cerebrum. AP diameter of fourth ventricle showed positive correlation with age. TD of fourth ventricle showed slight positive correlation with anteroposterior diameter of cerebrum and positive correlation with age (Table 3).

DISCUSSION

AP diameter of fourth ventricle

The present study showed mean anteroposterior length of fourth ventricle as 7.5±2.5 mm, the maximum value being 16.0 mm. Akbari et al.,[6] by plastination method found the mean height of fourth ventricle as 2.29±0.30 cm (range 1.9–2.7 cm), D'Souza et al.,[7] Gawler et al.,[8] reported height as 1.18 cm, 1.08 cm, and 3.83 cm by CT, ventriculography and MRI, respectively. Gameraddin et al.,[9] found maximum mean height as 9.68±2.155 mm in Saudi population by CT. My findings are in accordance with those of D'Souza et al., and Gameraddin et al. Mean length of fourth ventricle was higher in males than in females, but the difference was non-significant. Range and variation were also higher in males than in females The finding are in accordance with those of study by Singh et al.,[10] (mean height: 12.18±1.54 [males]; 12.13±1.41 [females]) by CT and by Meshram and Hattangdi[5] by CT (mean height 1.06±0.146 cm in males, and 0.94±0.217 cm in females), where the height of the fourth ventricle was larger in males as compared to females. AP diameter of fourth ventricle showed non-significant correlation (r=0.06, P=0.56) with anteroposterior diameter of skull and no significant correlation with (r=0.07, P=0.45) TD of skull. AP diameter of fourth ventricle showed positive correlation with age, which was statistically non-significant (r^2=0.698, P=0.01). It increases with age.

TD of fourth ventricle

The present study showed mean width as 12.8±3.1 mm in the studied population. The maximum value being 21.1 mm. The findings are in accordance with those of Akbari et al.,[6] [2.38±0.44 cm (range 1.75–3.0 cm)], Duffner et al.,[11] (1.25 cm), D'Souza et al.,[7] (1.31 cm) and Gameraddin et al.[9] (12.15±2.032 mm). The width of fourth ventricle was higher than the anteroposterior length of it. Analyzing the gender variations, we found that width was higher in males than in females. TD of fourth ventricle showed slight positive correlation (r=0.202 P=0.048) with anteroposterior diameter of skull and (r=0.142, P=0.168) TD of skull whereas nil with. TD of fourth ventricle showed a positive correlation with age, which was statistically non-significant ($r2=0.659$, P=0.01). It increases with age.

Limitations of the study

As the same co-o investigator conducted all measurements, it was not able to evaluate inter and intra- observer variability.

CONCLUSION

In many obstructive lesions, such as brain stem tumors, blockages of the Luschka and Magendie foramen, Arnold Chiari malformations, and autism the size of the ventricles increases. It can also alter depending on the patient's level of hydration. It rises over the first 48 h of dehydration before falling again. Although partial volume averaging or changes in ventricle shape caused by slight variations in angulation in specific patients due to subjective body build up make the ventricle margins on CT less sharply defined, it is still the most accessible, affordable, and widely available investigation for brain imaging in India.

Before making the right decisions for continued therapy in the context of enlarged brain ventricle size observed in routine clinical practices, knowledge of the usual range of exact measurement is required.

ACKNOWLEDGMENT

We would like to express our deepest gratitude to all faculty, postgraduate residents and technicians, Department of Radio-Diagnosis, Sri Devaraj Urs Medical College, Kolar, Karnataka.

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Source of Support: Nil, **Conflicts of Interest:** None declared.