International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 9; Issue 09(A); September 2020; Page No.23068-23071
DOI: http://dx.doi.org/10.24327/ijcar.2020.23071.4562

Research Article

LATERAL VENTRICLES OF BRAIN: A MORPHOMETRIC STUDY BY COMPUTERIZED TOMOGRAPHY

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A R T I C L E I N F O

Article History:
Received 12th June, 2020
Received in revised form 23rd July, 2020
Accepted 7th August, 2020
Published online 28th September, 2020

Key words:

The lateral ventricular system of the brain undergoes changes with age and varies with gender

A B S T R A C T

Background: Understanding the normal and abnormal anatomy of the lateral ventricular system of brain is helpful for clinicians, neurosurgeons, and radiologists in day-to-day clinical practice[1].The two major changes that may occur in elderly individual without neurologic deficits is enlargement of ventricles and cortical atrophy[2]. The lateral ventricular system of the brain undergoes changes with age and varies with gender[3]. Accurate assessment of lateral brain ventricular size is important for evaluating changes due to growth, ageing, intrinsic and extrinsic pathologies[4]. Present study was carried out with the objectives of determining Normal Lateral ventricular size based on age and sex on brain CT which may help in defining the normal range of lateral ventricles and diagnosis of disease.

Aims and Objectives: Lateral ventricular measurements were taken to establish baseline reference values, linear dimension and their relationship with age and sex on Computed Tomography so that it can help in day to day clinical practice and can rule out changes due to intrinsic and extrinsic pathologies.

Materials and Methods: This study was conducted in the Postgraduate Department of Anatomy in collaboration with the Department of Radiodiagnosis and Imaging of Government Medical College and Associated Hospitals, Srinagar for a period of 18 months, on patients presenting for CT brain. Total of 300 cases were studied. Data obtained from the study was analyzed and results were calculated.

Observations and Result: The left lateral ventricle was larger than the right one and both were larger in males and largest in sixth and seventh decade.

Conclusion:

The present study has defined the morphometric measurements of the brain ventricles which is not only of academic interest, but also important to help radiologists on the correct interpretation of image examinations and for clinicians to diagnose conditions like Alzheimer's, schizophrenia, hydrocephalus and Parkinson's disease.

INTRODUCTION

In the adult human brain there are four connected ventricles: two lateral ventricles within the cerebrum, a third ventricle within the diencephalon and a fourth ventricle lying between the cerebellum and the pons[5,6]. The lateral ventricles, which lie within each cerebrum are connected to the third ventricle (via interventricular foramina of Monro) and inturn third ventricle is linked to the fourth ventricle via the cerebral aqueduct of Sylvius.

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The fourth ventricle joins to the spinal cord canal and the subarachnoid space that envelops the brain and the spinal cord through foramina of central canal, Luschka and Magendie[5,7,8].There are two lateral ventricles situated one in each cerebral hemisphere and are the largest cavities of the brain ventricular system which occupy large areas of the cerebral hemispheres[5].Each lateral ventricle resembles a C-shaped structure that begins at an inferior horn in the temporal lobe, travels through a body in the parietal lobe and frontal lobe, and ultimately terminates at the interventricular foramina where each lateral ventricle connects to the single, central third ventricle. Along the path, a posterior horn extends backward into the occipital lobe, and an anterior horn extends farther into the frontal lobe. Each lateral ventricle has three horns also

called cornus. Measurements of the size of the lateral cerebral ventricles provide useful indices of cerebral asymmetry and atrophy.the left lateral ventricle is normally larger than the right[9]. Various studies clearly shows an increase in the CSF spaces in dementia especially in Alzheimer's disease and Parkinson's disease. This was due to reduction in size of the nerve cells[10]. Studies show there was enlargement of the lateral ventricles in epilepsy and also in depression[11].To understand these changes the knowledge of normal morphometry and size of normal ventricular system of brain is important. In order to detect changes in the size of brain ventricles, normal anatomic values should be known. Comparisons of these values produce data that can be used for diagnosing specific diseases. These data allow the clinician to identify the grade of atrophy or hypertrophy of an organ. Any deviations from the normal have led to diagnosis or prediction of pathological conditions. Accurate assessment of brain ventricular size is used in the clinical treatment of patients[8].

MATERIALS AND METHODS

This study was conducted in the Postgraduate Department of Anatomy in collaboration with the Department of Radiodiagnosis and Imaging of Government Medical College and Associated Hospitals, Srinagar for a period of 18 months, on patients presenting for CT brain. It was a cross-sectional observational type of study. Informed and written consent was taken from all the subjects who participated in the study. A brief history and physical examination was done to exclude various pathological conditions affecting the dimensions of brain ventricles. The subjects included in this study were of Kashmiri ethnicity. The size of the brain ventricles in centimeters (cms) were measured based on age and sex.

Inclusion Criteria

The in and out-patients, of either sex, between age groups (20-40) years, (41-60) years, (61-75) years, (76 years and above) who after the routine clinical evaluation, were to undergo CT examination in the Department of Radiodiagnosis, due to various indications for the brain CT. Only those patients were included in the study whose brain CT was labeled as normal by an experienced radiologist

METHOD

Non Contrast CT examination of brain was done using Siemens Emotion 16 Slice Multi-detector Spiral CT scan and 256-slice SOMATOM Definition Flash CT scan at SMHS hospital Srinagar. The patient was placed on the CT table and the head was centralized and supported for correct alignment and to reduce blurring of images. A lateral image was taken to confirm correct position of patient. Canthomeatal line was drawn and a line at an angle of 15 – 20 degrees to and 1 cm above it was drawn, representing the lowest tomographic section, which passed through the base of skull.All other technical parameters. (Time in ms, potential in kv, current in mA) of the scans were as per the established standards. A total of 8 to 10 axial image slices of the brain were obtained without any overlap with a slice thickness of 8-10mm.The data was meticulously chosen by the radiologist. Only those CT images, which were declared as normal by the radiologist were included in this study. Brain ventricular size was measured after identification and analysis of normal brain ventricles on CT scan.

Measurement of lateral ventricle of right and left side

1. Length of frontal horns of right lateral ventricle in cms (measured from its tip to the interventricular foramen).
2. Length of frontal horns of left lateral ventricle in cms (measured from its tip to the interventricular foramen).
3. Length of right lateral ventricular body in cms inclusive of level of interventricular foramen (measured from tip of frontal horn to the atrium).
4. Length of left lateral ventricular body in cms inclusive of Frontal horn (measured from tip of frontal horn to the atrium).

All measurements were taken in axial plane.

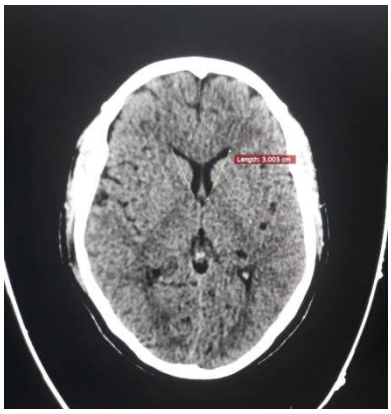

Fig 1 measurement of right and left frontal horns of lateral ventricle

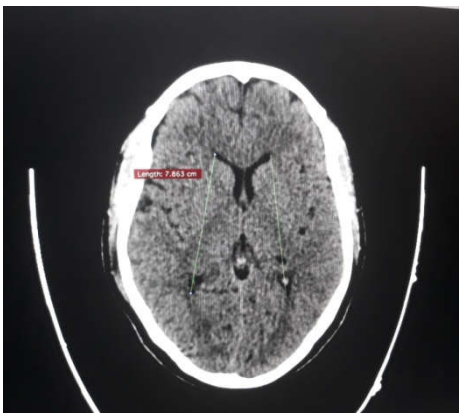

Fig 2 measurement of right and left ventricular body of lateral ventricles

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA).

RESULTS AND DISCUSSION

Table 1 Showing baseline reference values for length of right frontal horn of lateral ventricle on brain CT as per age

Age (years)	N	Mean	SD	95% CI for Mean		Min	Max
20-40	116	2.75	0.314	2.69	2.81	1.71	3.56
41-60	108	2.80	0.341	2.73	2.86	1.8	3.74
61-75	61	3.04	0.380	2.94	3.13	2.38	3.7
≥ 76	15	2.75	0.239	2.62	2.88	2.55	3.23
Total	**300**	**2.82**	**0.351**	**2.79**	**2.86**	**1.71**	**3.74**

The mean baseline refrence values for length of right frontal horn of lateral ventricle in (20-40)yrs of age group was 2.75±0.314cms, in (41-60)yrs of age group was 2.80±0.341cms,in (61-75)yrs of age group was 3.04±0.380cms and ≥76 yrs of age group mean was 2.75±0.239cms. The overall mean baseline refrence value in all age groups for length of right frontal horn of lateral ventricle was 2.82±0.351cm.

Table 2 Showing baseline reference values for length of left frontal horn of lateral ventricle on brain CT as per age

Age (years)	N	Mean	SD	95% Cl for Mean		Min	Max
20-40	116	2.86	0.343	2.80	2.92	1.7	3.7
41-60	108	2.87	0.353	2.80	2.93	1.94	3.6
61-75	61	3.24	0.896	3.01	3.47	2.36	3.91
≥ 76	15	3.09	0.086	3.04	3.13	2.97	3.2
Total	**300**	**2.95**	**0.524**	**2.89**	**3.01**	**1.7**	**3.91**

The mean baseline refrence values for length of left frontal horn of lateral ventricle in (20-40)yrs of age group was 2.86±0.343cms, in (41-60)yrs of age group was 2.87±0.353cms,in (61-75)yrs of age group was 3.24±0.896cms and ≥76 yrs of age group mean was 3.09±0.086cms. The overall mean baseline refrence value in all age groups for length of right frontal horn of lateral ventricle was 2.95±0.524cms

Table 3 Showing baseline reference values for length of body of the right ventricle on brain CT as per age

Age (years)	N	Mean	SD	95% Cl for Mean		Min	Max
20-40	116	7.23	1.089	7.03	7.43	4.8	11.36
41-60	108	7.30	0.974	7.11	7.48	4.5	11.17
61-75	61	8.03	1.033	7.77	8.30	6	11
≥ 76	15	7.67	0.626	7.32	8.01	6.6	8.2
Total	**300**	**7.44**	**1.062**	**7.31**	**7.56**	**4.5**	**11.36**

The mean baseline refrence values for length of body of the right ventricle in (20-40) yrs of age group was 7.23±1.089cms, in (41-60)yrs of age group was 7.30±0.974cms,in (61-75)yrs of age group was 8.03±1.033cms and ≥76 yrs of age group mean was 7.67±0.626cms. The overall mean baseline refrence value in all age groups for length of body of the right ventricle was 7.44±1.062cms.

Table 4 Showing baseline reference values for length of body of the left ventricle on brain CT as per age

Age (years)	N	Mean	SD	95% Cl for Mean		Min	Max
20-40	116	7.46	1.305	7.22	7.70	4.4	11.47
41-60	108	7.56	1.051	7.36	7.76	4.8	11
61-75	61	8.42	1.112	8.14	8.71	6.75	11.2
≥ 76	15	8.15	0.883	7.66	8.64	6.75	9
Total	**300**	**7.72**	**1.217**	**7.59**	**7.86**	**4.4**	**11.47**

The mean baseline refrence values for length of body of the left ventricle in (20-40)yrs of age group was 7.46±1.305cms, in (41-60)yrs of age group was 7.56±1.051cms,in (61-75)yrs of age group was 8.42±1.112cms and ≥76 yrs of age group mean was 8.15±0.883cms. The overall mean baseline refrencevalue in all age groups for length of body of the left ventricle was 7.72±1.217cms.

Table 5 Showing baseline reference values for lateral ventricular dimensions on brain CT as per gender.

Gender		N	Mean	SD	95% Cl for Mean		Min	Max
Length of right frontal horn of lateral ventricle	Male	156	2.95	0.320	2.90	3.00	2.3	3.74
	Female	144	2.69	0.335	2.64	2.75	1.71	3.43
Length of left frontal horn of lateral ventricle	Male	156	3.03	0.331	2.98	3.08	2.1	4.00
	Female	144	2.86	0.664	2.76	2.97	1.7	3.91
Length of body of the right ventricle	Male	156	7.73	1.037	7.57	7.90	5.6	11.36
	Female	144	7.12	0.997	6.95	7.28	4.5	11.17
Length of body of the left ventricle	Male	156	8.04	1.151	7.86	8.22	5.6	11.47
	Female	144	7.38	1.196	7.18	7.58	4.4	11.00

The mean baseline refrence value for the length of right frontal horn of lateral ventricle in males was 2.95±0.320 cms and in females was 2.69±0.335cms. Mean baseline refrence value for the length of left frontal horn of lateral ventricle in males was 3.03±0.331cms and in females was 2.86±0.664cms. For the length of body of the right ventricle mean baseline refrence value in males was 7.73±1.037cms and in females was 7.12±0.997cms. For the length of body of the left ventricle mean baseline refrence value in males was 8.04±1.151cms and in females was 7.38±1.196cms

Table 6 Comparison of length of right frontal horn of lateral ventricle as per gender in various age-groups

Age (years)	Male			Female			P-value
	N	Mean	SD	N	Mean	SD	
20-40	58	2.82	0.252	58	2.68	0.353	0.013*
41-60	53	2.93	0.288	55	2.67	0.346	<0.001*
61-75	38	3.21	0.331	23	2.76	0.279	<0.001*
≥ 76	7	2.76	0.166	8	2.75	0.302	0.941
Total	**156**	**2.95**	**0.320**	**144**	**2.69**	**0.335**	**<0.001***

Mean length of right frontal horn of lateral ventricle was larger in males than in females in our study population and was largest in (61-75)yrs of age group in both males and females. The results were statistically significant (p<0.05). However in ≥76 yrs of age results were not statistically significant.

Table 7 Comparison of length of left frontal horn of lateral ventricle as per gender in various age-groups

Age (years)	Male			Female			P-value
	N	Mean	SD	N	Mean	SD	
20-40	58	2.93	0.253	58	2.79	0.405	0.032*
41-60	53	2.96	0.318	55	2.78	0.364	0.007*
61-75	38	3.28	0.360	23	3.17	1.402	0.665
≥ 76	7	3.08	0.078	8	3.09	0.097	0.903
Total	**156**	**3.03**	**0.331**	**144**	**2.86**	**0.664**	**0.006***

Mean length of left frontal horn of lateral ventricle was larger in males than in females in our study population and was largest in (61-75)yrs of age group in both males and females. The results were statistically significant (p<0.05). However in (61-75) yrs of age and ≥76 results were not statistically significant.

Table 8 Comparison of length of body of the right ventricle as per gender in various age-groups

Age (years)	Male			Female			P-value
	N	Mean	SD	N	Mean	SD	
20-40	58	7.60	1.100	58	6.86	0.953	<0.001*
41-60	53	7.39	0.778	55	7.21	1.132	0.334
61-75	38	8.41	1.022	23	7.41	0.709	<0.001*
≥ 76	7	7.80	0.683	8	7.55	0.593	0.461
Total	**156**	**7.73**	**1.037**	**144**	**7.12**	**0.997**	**<0.001***

Mean length of body of the right ventricle was larger in males than in females in our study population and was largest in (61-

75)yrs of age group in males and ≥76 yrs of age in females. The results were statistically significant ($p<0.05$). However in (41-60) yrs of age and ≥76 yrs results were not statistically significant.

Table 9 Comparison of length of body of the left ventricle as per gender in various age-groups

Age (years)	Male			Female			P-value
	N	Mean	SD	N	Mean	SD	
20-40	58	7.91	1.115	58	7.00	1.334	<0.001*
41-60	53	7.62	0.991	55	7.50	1.112	0.574
61-75	38	8.77	1.105	23	7.84	0.865	0.001*
≥ 76	7	8.40	1.030	8	7.94	0.734	0.333
Total	**156**	**8.04**	**1.151**	**144**	**7.38**	**1.196**	**<0.001***

Mean length of body of the left ventricle was larger in males than in females in our study population and was largest in (61-75)yrs of age group in males and ≥76 yrs of age in females. The results were statistically significant ($p<0.05$). However in (41-60) yrs of age and ≥76 yrs results were not statistically significant.

DISCUSSION

The right frontal horn showed an increase with increasing age and was larger in males compared to females in our study population and was largest in sixth and seventh decade in both males and females. The left frontal horn also showed an increase with increasing age and was larger in males compared to females in our study population and was largest in sixth and seventh decade in both males and females. Thus both right and left frontal horn sizes showed a significant positive correlation between age and gender for the total study population. The mean length of the left frontal horn was slightly larger than the right frontal horn.

In conclusion the left lateral ventricle was larger than the right one and both were larger in males and largest in sixth and seventh decade.

CONCLUSION

In conclusion, this study was conducted to establish a local reference of values for the lateral, third and fourth ventricular dimensions and compute linear ventricular brain ratios of the Kashmiri adult population.

Acknowledgements

I express my heartfelt gratitude to professor dr Bashir ahmad shah my mentor and guide, my co guide- dr Shabir , my family, my husband dr Basit Aslam, my daughter Hibba Basit, DR Shaheen Shahdad ,without whose help and guidance this study would not have been complete.

Conflicts of interests: none.

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How to cite this article:

Maheen Nazir *et al* (2020) 'Lateral Ventricles of Brain: A Morphometric Study by Computerized Tomography', *International Journal of Current Advanced Research,* 09(09), pp. 23068-23071. DOI: http://dx.doi.org/10.24327/ijcar.2020.23071.4562

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