Original Article

Anatomical Study of Size Variability of Temporal and Occipital Horns of Lateral Ventricle of Human Brains: A Magnetic Resonance Imaging Study

Abstract

Introduction: The lateral ventricles lie in each cerebral hemisphere with its three horns and body. The study of normal and variant anatomy of the ventricles of brain is very useful for clinicians and neurosurgeons in their routine practice. This study is directed to look for changes in the size of occipital and temporal horns of the lateral ventricle as per age and sex of the brain by magnetic resonance imaging (MRI) study. **Material and Methods:** MRI scans of 55 patients (25 females and 30 males) with age ranging from 1 to 90 years were studied and the diameters of occipital and temporal horns were measured. Data were analyzed with respect to age and sex of individuals. **Results:** It was observed that the mean diameter of both horns decreases from 1 to 10 years of age group and increases from then to advancing age. No significant gender difference in the dimensions of both the horns of lateral ventricle was observed. **Discussion and Conclusion:** The present study showed that the age factor is responsible for change in the size of occipital and temporal horns of the lateral ventricle. The present study will be helpful to radiologists and neurosurgeons to differentiate the enlarged size of occipital and temporal horns by aging from that of other pathological conditions.

Keywords: *Lateral ventricle, occipital horns, temporal horns*

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Introduction

The ventricular system is set of four interconnected cavities in the brain, where cerebrospinal fluid is produced and circulated. Among all ventricles of the ventricular system, lateral ventricles are the largest one. Each lateral ventricle has three horns, i.e. frontal horn in the frontal lobe, occipital horn in the occipital lobe, and temporal horn in the temporal lobe, and body in the parietal lobe.

The utility of normal and variant anatomy of ventricles of the brain for clinicians and neurosurgeons in their routine practice is very important.[1] The development of lateral ventricles itself is a forecaster for whole brain development and remains a unique marker for the same.[2] Neurosurgeons as well as radiologists faced challenges regarding size of lateral ventricles being within normal limit or due to aging of individuals.

The cortical atrophy in neurodegenerative conditions and hippocampal size alternation in Alzheimer's disease shows ultimate affection over the lateral ventricle size, especially temporal horn of lateral ventricles. The other pathological conditions such as Balint's syndrome and Gestermann's syndrome also find cortical atrophy.[1,3]

5%–12% of the population in the world shows asymmetry in size of the lateral ventricle. Similarly, handedness of a particularly individual also determines the size of lateral ventricle in the sense that of left-handed person having longer occipital horn of the lateral ventricle in comparison with right-handed person.[4]

The goal of the study is to look for changes in the size of temporal and occipital horn of both lateral ventricles as per age and sex of individual. This magnetic resonance imaging (MRI) study is comparatively useful for surgeons as temporal and occipital horns are surrounded by important functional areas.

Objectives

1. To measure and analyze variable parameters of temporal and occipital horn in the MRI scan image
2. To compare and contrast the available finding of the present study with that of previous study.

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Anatomy and development of lateral ventricle

Each lateral ventricle is C-shaped cavity structure begins at temporal horn in the temporal lobe of cerebral hemisphere, then travels as body in the parietal lobe, and terminates at interventricular foramina of Monro into the third ventricle. Each lateral ventricle has extension in occipital lobe as posterior horn and in frontal lobe as frontal horn.[4,5]

The lateral ventricles develop from the central canal of the neural tube. The portion of tube in developing prosencephalon during 3 months of prenatal life gives origin to lateral ventricle by expansion of central canal. Later, the choroid plexus appears which produces cerebrospinal fluid.[6]

Material and Methods

The present study is based on an MRI scan of 55 patients (25 female and 30 male) of known age taken retrospectively over 3 years from May 2015 to 2018. This retrospective study conducted on the patients who were referred for MRI scanning of brain from the clinicians as optional investigation.

Mostly, patients referred were road accident victims. The MRI suggested for something else as grey or white matter disruption, internal vascular accidents, and any internal injury. Their proper consent was taken for the same.

The radial width of temporal horn and occipital horn of lateral ventricle were measured with precision caliper at the tip of the horn on high-quality MRI.

Hence, in this way, both the highest horizontal and vertical diameters were measured in centimeters. The measurements obtained as per age and sex were tabulated for further study.

MRI gives better soft tissue contrast. Hence essentially, T2-weighted sequence was taken to examine ventricular system.

Results

The mean horizontal and vertical diameters of the temporal and occipital horns of both right and left sides were calculated as per age group 1–10, 11–20, 21–30, 31–40, 41–50, 51–60, 61–70, 71–80, and 81–90 years. Further, the findings were grouped under male and female categories [Tables 1-3].

The mean horizontal diameter of temporal horn of both side were decreasing from age group 1 to 10 [Figure 1] to 31-40 [Figure 2] while it show increase in diameter from 31-40 age group [Figure 2] to 81-90 age group [Figure 3].

Furthermore the mean vertical diameter of bilateral temporal horn shows hike from age group 1-10 [Figure 4] to 31-40

Table 1: Mean diameters (cm) of bilateral temporal and occipital horn as per age group

Age group	Number of patient studied	Temporal horn				Occipital horn			
		Right		Left		Right		Left	
		Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)
1-10	7	0.64	0.42	0.56	0.44	0.96	1.10	1.12	1.00
11-20	5	0.60	0.46	0.63	0.44	0.87	0.91	0.98	1.07
21-30	7	0.72	0.35	0.76	0.34	0.89	1.14	1.03	2.05
31-40	4	0.71	0.39	0.73	0.44	0.74	1.19	1.00	1.34
41-50	4	0.58	0.43	0.58	0.35	1.00	1.49	0.97	1.27
51-60	13	0.76	0.55	0.75	0.48	1.25	1.57	1.25	1.42
61-70	8	0.72	0.57	0.83	0.96	1.26	1.44	1.54	1.71
71-80	6	0.73	0.63	0.79	0.61	1.56	1.76	1.57	1.77
81-90	1	0.93	0.46	0.96	0.53	1.62	2.13	2.14	1.87

Table 2: Mean diameter (cm) of bilateral temporal and occipital horn as per age group in male

Age group	Number of patient studied	Temporal horn				Occipital horn			
		Right		Left		Right		Left	
		Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal cm)	Vertical (cm)
1-10	5	0.51	0.38	0.58	0.34	0.82	0.99	1.01	0.93
11-20	2	0.47	0.37	0.63	0.39	0.93	0.75	0.88	0.83
21-30	3	0.75	0.28	0.83	0.35	0.83	0.94	0.78	1.03
31-40	2	0.73	0.43	0.64	0.53	0.64	1.32	1.08	1.56
41-50	3	0.66	0.50	0.62	1.61	0.97	1.61	0.98	1.4
51-60	7	0.48	0.63	0.73	0.53	1.36	1.81	1.38	1.54
61-70	4	0.51	0.38	0.48	0.42	1.19	1.16	1.16	1.41
71-80	3	0.56	0.46	0.61	0.46	1.33	1.65	1.42	1.85
81-90	1	0.93	0.46	0.96	0.53	1.62	2.13	2.14	1.87

Table 3: Mean diameter (cm) of bilateral temporal and occipital horn as per age group in female

Age group	Number of patient studied	Temporal horn				Occipital horn			
		Right		Left		Right		Left	
		Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)	Horizontal (cm)	Vertical (cm)
1-10	2	0.72	0.52	0.51	0.69	1.29	1.38	1.39	1.16
11-20	3	0.62	0.52	0.62	0.46	0.82	1.02	1.03	0.84
21-30	4	0.69	0.39	0.70	0.34	0.93	1.29	1.21	1.31
31-40	2	0.69	0.35	0.81	0.35	0.84	1.08	0.91	1.11
41-50	1	0.35	0.21	0.44	0.20	1.09	1.11	0.96	0.86
51-60	6	0.73	0.45	0.77	0.41	1.13	1.29	1.09	1.28
61-70	4	0.92	0.75	1.18	1.48	1.33	1.71	1.91	2.00
71-80	3	0.89	1.79	0.97	0.76	1.71	1.85	1.71	1.69

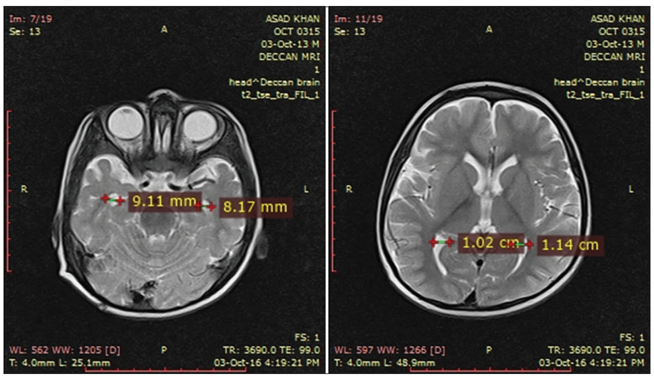

Figure 1: Magnetic resonance imaging of 1 yr old boy showing temporal and occipital horn horizontal diameter

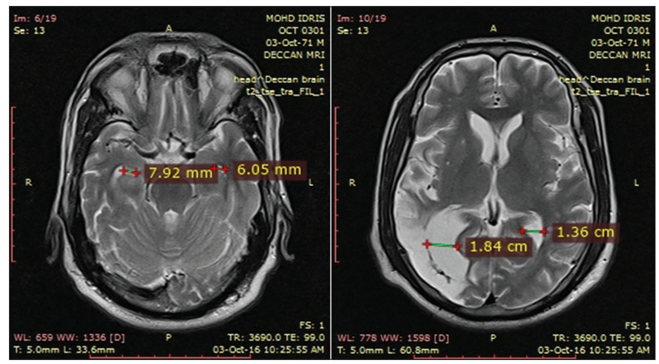

Figure 2: Magnetic resonance imaging of 45 yr old male showing temporal and occipital horn horizontal diameter

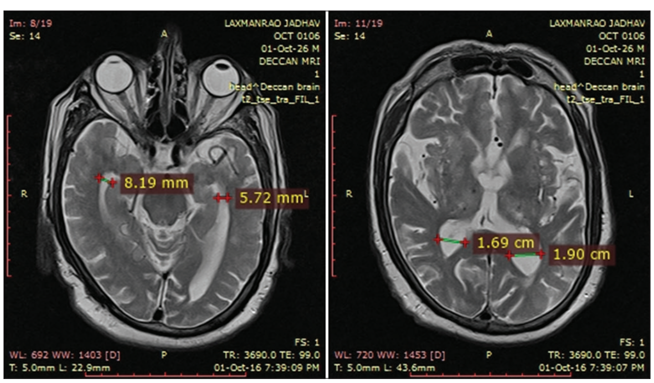

Figure 3: Magnetic resonance imaging of 90 yr old male showing temporal and occipital horn diameter

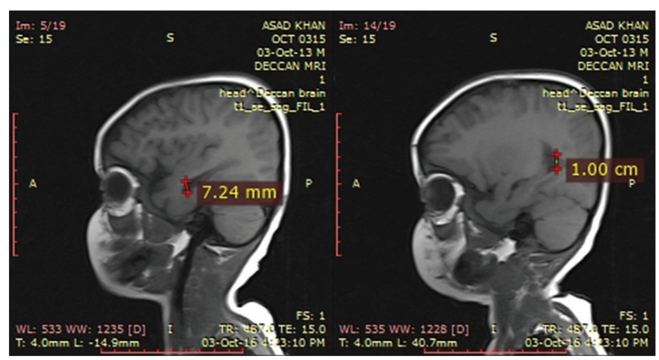

Figure 4: Magnetic resonance imaging of 1 yr old boy showing temporal and occipital horn vertical diameter

age group [Figure 5] while decrease in diameter from 31-40 age group [Figure 5] to 81-90 age group [Figure 6].

In occipital horn mean horizontal diameter of both sides show decrease from 1-10 age group[Figure 1] to 31-40 age group [Figure 2] and shows increase in diameter from age group 31-40 [Figure 2] to 81-90 age group [Figure 3]. But the mean vertical diameter of both occipital horns showed consistent increase from age group 1-10 [Figure 4] to 81-90 age group [Figure 6].

Similarly mean diameter of temporal and occipital horn showed no gross difference in male and female cases. Thus the difference in size of both horns in male and female was insignificant [Figures 2, 5, 7 and 8].

Discussion and Conclusion

The increased volume of ventricular system in infant is because of hydrocephalus where there is abnormal accumulation of cerebrospinal fluid which is of two types communicating or noncommunicating.

Larger lateral ventricles in the parietal region were related to poorer motor development at 2 years. Similarly, increased ventricular measurements were also related to slower early language development. Hence, surrounding brain growth and

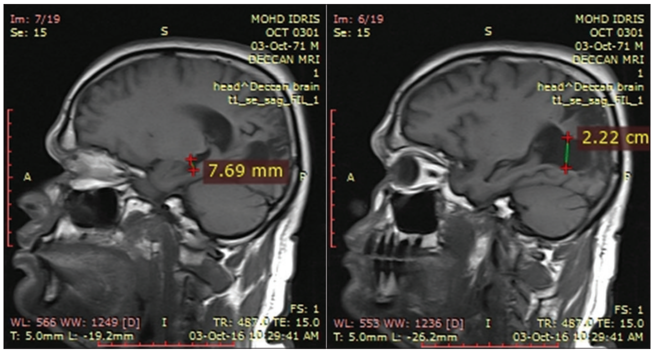

Figure 5: Magnetic resonance imaging of 45 yr old male showing temporal and occipital horn vertical diameter

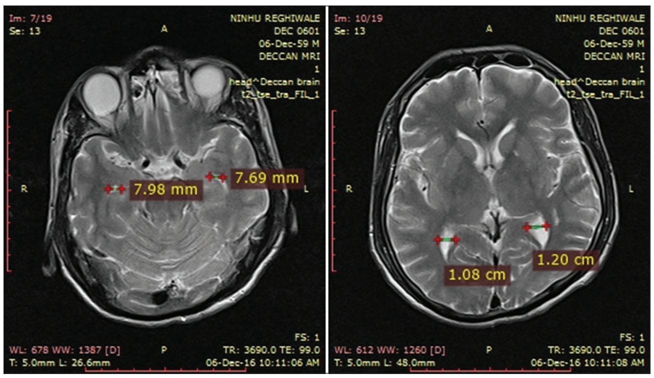

Figure 7: Magnetic resonance imaging of 57 yr old female showing temporal and occipital horn horizontal diameter

intellectual enhancement may be responsible for decrease in temporal and occipital horn diameters in young age groups.[7,8]

The pathological conditions such as Alzheimer's disease cause posterior cortical atrophy which is neurodegenerative condition. This produces dilatation of posterior horn of lateral ventricle. Similarly, enlargement of posterior and temporal horns of the lateral ventricle results into development of structural and functional changes in the respective areas of involvement.[9,10]

The picture of fairly symmetrical ventricular system of two sides was not clear in many articles, so frequent asymmetry between both sides of the normal ventricle is less appreciated. The variant anatomical dimension of lateral ventricles is of great academic interest regarding CSF circulation and also for clinical, radiological, and surgical interventions. The volume of cerebral ventricles is determined by nuclei and white matter tracts that abut them, and the rate of ventricular expansion is accelerated with age. Aging is responsible for loss of white matter integrity. The changes occur in white and grey matter volume in occipitoparietal and temporal region due to aging or pathological causes ventricular expansion.[11,12]

The temporal horn enlargement was seen in the hydrocephalus due to increased intraventricular pressure.

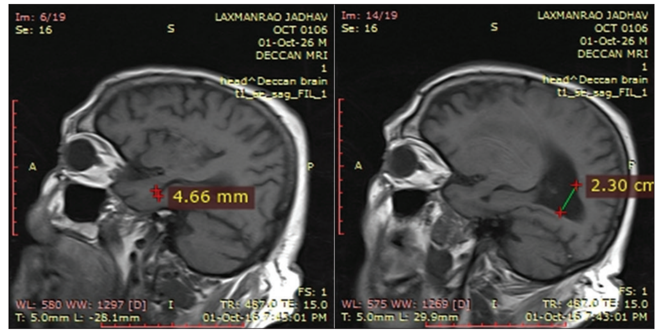

Figure 6: Magnetic resonance imaging of 90 yr old male showing temporal and occipital horn vertical diameter

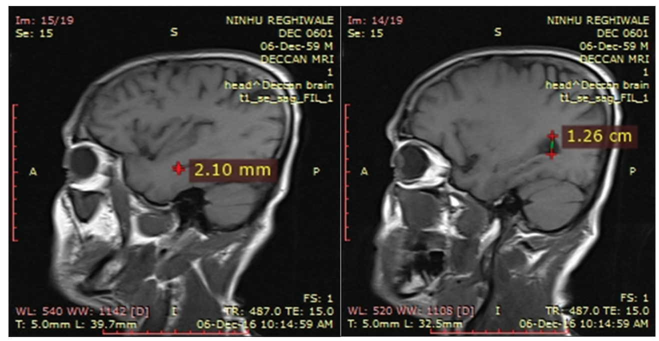

Figure 8: Magnetic resonance imaging of 57 yr old female showing temporal and occipital horn vertical diameter

Similarly, congenital anomalies showed agenesis of corpus callosum with enlarged temporal horn. Incomplete inversion of hippocampal formation during the development showed the configuration of enlarged temporal horn. These findings were also found in premature infants who have incomplete sulcation. In dogs, the ventricular enlargement was found to be related with aging process.[13,14]

Baker *et al.* analyzed that 75% of patients with brain anomalies had enlarged temporal horn mostly involving inferolateral aspects of ventricle. The patient with hydrocephalus has also shown temporal horn enlargement in the superolateral region. The ventricular enlargement was as result of increased intraventricular pressure.

The rate of ventricular volume change is highly correlated with an increase in senile plaques due to old age.[9,15]

Nagatarnam K [Kunjan] studied on 12 patients retrospectively. He noted changes in grey and white matter in parieto-occipital region and ventricular expansion due to recurrent falls. He also mentioned age, hypertension and diabetes could be the factor which aggravates above condition.[1,16] Torkirlson shows greatest variations of occipital and temporal horn size between right and left ventricle. The size of posterior horn of lateral ventricle measured average 1.39 cm in 11 brains and that of temporal horn 4.08cm in left side. On right side occipital horn measured 1.45cm and temporal horn measured 3.97 cm. He measured these horns by ventriculography.[4]

Hence, the normal intact size of occipital horn and temporal horn is not mentioned in any earlier studies.

By taking into consideration of fact that visual area surrounding the occipital horn and hippocampal area around temporal horn, the enlargement of both occipital and temporal horn ultimately shows disturbance and compression symptoms in nearby and surrounding structures of both horns.

To summarize, we have compared the pattern of temporal horn and occipital horn enlargement in different age groups individuals. The distinct morphology and size of temporal and occipital horn were noticed with remarkable differences as per age of individuals.

As the study was done on brain MRI scans of the patients, with the detailed clinical history, our next goal is to measure and analyze occipital and temporal horn size in cadaveric brain and compare it with the present study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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