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Original Research Article

Role of MRI in measurement of fourth ventricle diameter

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Abstract

Background: The fourth ventricle is an essential component of the ventricular system, connected to the third ventricle via the cerebral aqueduct and central medullary canal. Structural and functional alterations of this ventricle may occur due to obstructive pathologies, tumors, or neurological disorders. Magnetic Resonance Imaging (MRI) is a valuable modality to assess ventricular dimensions with high precision.

Objectives: The present study aimed to measure the dimensions (length and width) of the fourth ventricle in different age groups and both sexes using MRI, and to evaluate the relationship of these measurements with demographic variables.

Materials and Methods: This prospective observational study was conducted in the MRI unit, Department of Radiology, CSSH, Subharti Medical College Hospital, Meerut, Uttar Pradesh. A total of 100 patients (59 males, 41 females) referred for MRI brain with neurological indications were included from January 2023 to May 2023. Patients with first-trimester pregnancy, previous neurosurgery, metallic implants, or inability to cooperate were excluded. MRI was performed using GE HDE 1.5 Tesla scanner. Standard patient positioning and scanning protocols were followed. Data were analyzed using SPSS v26. Descriptive statistics, independent sample t-test, Chi-square/Likelihood ratio test, and one-way ANOVA were applied. A p value < 0.05 was considered significant.

Results: Participants' ages ranged from 2–77 years (mean 39.8 ± 19.2). Nearly half (49%) belonged to the 30–59 year group. Mean length of the fourth ventricle was 9.4 ± 2.9 mm, and mean width was 12.5 ± 1.9 mm. Male and female comparisons showed no significant differences in either length ($p = 0.413$) or width ($p = 0.830$). However, ANOVA revealed a significant variation in ventricular length across age groups ($p = 0.042$), particularly between <15 years and 30–59 years. Width did not vary significantly with age ($p = 0.203$).

Conclusion: MRI provides reliable measurements of the fourth ventricle. While gender does not influence ventricular dimensions, age-related changes significantly affect ventricular length, highlighting the importance of age consideration in neuroimaging assessments.

Keywords: MRI, Fourth ventricle, MRI brain, Ventricle measurement, Brain diameter

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1. Introduction

The brain's main interhemispheric commissure, the corpus callosum (CC), is made up of more than 200 million fibers that connect the cerebral hemispheres.[1-4] Variations in the dimensions of the corpus callosum are therefore seen in various neurological diseases such as Alzheimer's and bipolar affective disorder.[5-7] while the dimensions differ based on gender, age, and ethnicity, pathological variations are seen with some diseases such as vascular dementia, leukoaraiosis, stroke, and carotid artery stenosis.[5-8] The corpus callosum is made of five parts namely the body, isthmus, genu, rostrum, and splenium.[11] The cerebral aqueduct and the central medullary canal connect the fourth ventricle of the brain to the third ventricle, making it a crucial component of the ventricular system. Obstructive disease of the brain's limbic system is rather prevalent. Many cases are brought on by tumors coming from the fourth ventricle or the brain matter around the ventricular cavity. The majority of cases require surgical intervention. The ventricle's structure and the system's fluid circulation are altered by these tumors. There is a wealth of information in the literature about how patients with mental health conditions, particularly those with schizophrenia, modify the ventricular system's capacity and alter the shape and symmetry of the ventricles. According to

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a study, thalamic shrinkage, particularly in the medial nuclei and the surrounding striatum and insular cortex in schizophrenia patients, appears to be a significant factor in ventricular enlargement.[12] A medical imaging technology called magnetic resonance imaging (MRI) creates images of the anatomy and physiological functions of the body in both health and sickness. It creates images of the inside organs of the body using a magnetic field and radio wave energy pulses. In contrast to what may be observed with an X-ray, ultrasound, or computed tomography (CT) scan, MRI provides diverse information on the architecture of the body. Additionally, it could reveal issues that conventional imaging techniques are unable to detect. Strong magnetic fields, radio waves, and field gradients are used by MRI scanners to produce images of the body's organs.[13]

2. Objectives

1. To measure the fourth ventricle of the brain in different age group individuals of both gender by MRI.
2. To identify the age and sex distribution of fourth ventricles diameter in MRI.

3. Materials and Methods

This prospective observation study was conducted in the MRI unit of Department of Radiology, Subharti Medical College Hospital, Swami Vivekanand Subharti University, and Meerut UP. The source of data for this study are patients referred to the Department of Radio-diagnosis imaging for MRI brain for Measurement of Fourth Ventricle diameter from OPD/IPD of C.S.S Hospital from January 2023 to May 2023. Patients with clinically suspected nervous system diseases of all age group were the inclusion criteria of the study. First trimester pregnancy, operated case, with suspected metallic implant or uncooperative patients was excluded. For each participant, after obtaining clinical history, relevant clinical examinations; the patients were subjected to modality, after an informed consent for confirmation of diagnosis. MRI examination was done on GE HDE 1.5 Tesla. Imaging and diagnosis of measurement of fourth ventricle was made for each patient. Any blood clot in the brain, brain aneurysm, brain hemorrhage, brain infections (encephalitis); brain damage associated with epilepsy or brain tumors and cysts were the indications. Before patient preparation, complete history for each patient was checked. If indications were unclear, the referring physician was contacted. All metallic objects were removed from patient's body to ensure that artifacts were not created during scanning. Disposable ear plugs were provided to the patient to avoid repeated noises during scanning. Also, the patients were instructed to avoid coughing, wriggling or producing other large motion during or in between the scans. Each patient was ensured the IV line prior to the pre contrast acquisition preferably with 20 or 22 gauge IV Cannula.

Patient positioning included were supine with head placed within the coil, arms beside the trunk, inter papillary line parallel to the couch and the head should be straight, longitudinal alignment line in the midline, horizontal alignment line through the nation and straps and foam pads for immobilization. The study population comprised patients referred for MRI brain with various neurological indications. The most common clinical presentations included headache, vertigo, seizure disorders, cerebrovascular accidents (stroke), and evaluation of space-occupying lesions. Additional indications involved dizziness, facial palsy, ataxia, demyelinating disorders, and head injury follow-up**.**

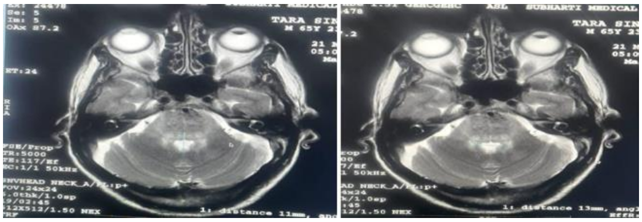

Figure 1: Shows the measurement of ventricle diameter

3.1. Statistical analysis

The collected data were summarized by using the Descriptive Statistics: frequency, percentage, mean and S.D. The Independent sample "t" test was used to compare length and width according to gender. The One way ANOVA test was used to compare length and width according to age groups. For the multiple comparison of length according to age groups, the post hoc analysis, Tukey test was used. The difference in proportions was analyzed by using Chi square or Likelihood ratio test. The p value < 0.05 was considered as significant. Data were analyzed by using the SPSS software (SPSS Inc.; Chicago, IL) version 26.0.

4. Results

A total of 100 patients were included in this study in which 59 (59 %) patients were male and 41 (41%). Age of the participants ranged from 2 years to 77 years with mean 39.8 $\pm$ 19.2 years. The majority (49%) of the cases were in the age group of 30 to 59 years followed by 20% within the age group 15 to 29 years 19% were above 60 years of age and 12% were under the age of 15 years.(**Table 1**)

The length ranged from 4 to16 mm with mean 9.4 $\pm$ 2.9 and width ranged from 8 to18 with mean 12.5 $\pm$ 1.9 mm.(**Table 2**)

The Chi square or Likelihood ratio test was used to compare age and investigation according to gender. There was an association ($p < 0.05$) between investigation and gender.(**Table 3**)

The Independent sample "t" test was used to compare length and width according to gender. There was no difference ($p > 0.05$) in length and width between males and females.(**Table 4**)

Table 1: Demographic characteristics of the subjects

(n =100)		**Percentage (%)**
Age	< 15	12
	15-29	20
	30-59	49
	60+	19
Gender	Male	59
	Female	41
Investigation	MRI Brain	96
	MRI Brain (Contrast)	4

Table 2: Descriptive Statistics for length and width

(n =100)	**Minimum**	**Maximum**	**Mean**	**Median**	**S.D.**
Length (Mm)	4	16	9.4	9.0	2.9
Width (Mm)	8	18	12.5	12.2	1.9

Table 3: Comparison of age and investigation according to gender

		Gender				**Chi square / Likelihood ratio#**	**p value**
		Male		**Female**			
		n	**%**	**n**	**%**		
Age	< 15	10	16.9	2	4.9	5.02	0.170
	15-29	10	16.9	10	24.4		
	30-59	26	44.1	23	56.1		
	60+	13	22.0	6	14.6		
Investigation	MRI Brain	55	93.2	41	100	4.34#	0.037*
	MRI Brain (Contrast)	4	6.8	0	0		

(* Significant)

Table 4: Comparison of length and width according to gender

		n	**Mean**	**S.D.**	**"t"**	**Df**	**p value**
Length (Mm)	Male	59	9.6	2.8	0.82	98	0.413
	Female	41	9.1	3.0			
Width (Mm)	Male	59	12.5	1.8	0.22	98	0.830
	Female	41	12.4	2.0			

("t" = Independent sample "t" test; *Significant)

Table 5: Length and width according to age groups

		n	**Mean**	**S.D.**	**Minimum**	**Maximum**
Length (Mm)	< 15	12	11.4	3.2	6	16
	15-29	20	9.8	2.9	6	16
	30-59	49	8.8	2.6	4	16
	60+	19	9.4	2.9	4	16
Width (Mm)	< 15	12	12.5	2.1	10	16
	15-29	20	11.8	1.7	8	15
	30-59	49	12.5	2.0	9	18
	60+	19	13.0	1.6	10	16

Table 6: Comparison of length and width according to age groups

	"F"	**Df_1**	**Df_2**	**p value**
Length (Mm)	2.84	3	96	0.042*
Width (Mm)	1.57	3	96	0.203

("F" = One way ANOVA; * Significant)

Table 7: Multiple comparison of length (Mm) according to age groups

Multiple comparisons		Mean Difference	p value
< 15	15-29	1.64	0.379
	30-59	2.57	0.026*
	60+	2.01	0.213
15-29	30-59	0.93	0.593
	60+	0.37	0.976
30-59	60+	-0.56	0.880

(* Significant)

Table 8: Flowchart of study schemata

Patients referred for MRI Brain

- (January 2023 – May 2023)
- N = 120

Screening for Eligibility

Exclusion Criteria (n = 20)

- First-trimester pregnancy (n = 3)
- Previous neurosurgery (n = 5)
- Metallic implants / pacemaker (n = 6)
- Unable to cooperate during MRI (n = 6)

Eligible Patients Included

- N = 100

MRI Examination & Data Collection

- GE HDE 1.5 Tesla MRI scanner
- Standard brain protocol
- Measurement of 4th ventricle length and width (axial/sagittal
- Demographic and clinical data recorded

Statistical Analysis (SPSS v26)

Descriptive statistics, t-test, ANOVA, Chi-square

p < 0.05 considered statistically significant

Results

- Final analyzed cases: N = 100
- Mean 4th ventricle length: 9.4 ± 2.9 mm
- Mean width: 12.5 ± 1.9 mm
- No gender difference; significant age-related variation
- No ventricular aberrations detected

In the present study, Descriptive statistics for Length (Mm) and Width (Mm). The Length ranged from Above – 15 with mean 11.4±3.2mm and 15 – 29 with mean 9.8± 2.9 mm, 30 – 59 with mean 8.8 ± 2.6 mm,60+ with mean 9.4 ± 2.9mm , And Width -Above – 15 with mean12.5± 2.1 mm ,15 – 29 with mean 11.8± 1.7 mm,30 – 59 with mean 12.5 ±2.0mm , 60+ with mean 13.0 ± 1.6 mm.(**Table 5**)

The One way ANOVA test was used to compare length and width according to age groups. There was a difference ($p < 0.05$) in length (Mm) according to age groups.(**Table 6**)

The Post hoc analysis, Tukey test was used for the multiple comparison of length according to age groups. There was a difference ($p < 0.05$) in the length between the age groups: < 15 and 30-59.(**Table 7**)

5. Discussion

In this prospective MRI study of 100 patients (2–77 years), the fourth ventricle (FV) showed a mean anteroposterior (AP) length of 9.4 ± 2.9 mm and a mean transverse width of 12.5 ± 1.9 mm. Length differed across age groups ($p = 0.042$), while neither length nor width differed by sex. These values align closely with contemporary regional normative data: a 2025 North Indian MRI study reported mean FV AP width ~8.6 mm and transverse width ~13.1 mm, with minimal sex effects—supporting our observations of modest age-linked variation and limited sexual dimorphism in FV size.[14]

Age effects in our cohort (greater FV length in <15 vs 30–59 years) are consistent with broader lifespan imaging showing CSF space expansion with age—most prominently in lateral ventricles but detectable across the ventricular system as parenchymal volumes decline. Large longitudinal cohorts report annual ventricular volume increases of ~1–

2.5% with advancing age, providing biological plausibility for our ANOVA result even within a clinically referred sample.[15]

Pathology adjacent to the fourth ventricle (posterior fossa tumors, aqueductal stenosis) can distort FV morphology; our inclusion of clinically indicated scans mirrors real-world case-mix and underscores the utility of simple FV linear metrics in triage and follow-up. Emerging techniques such as 4D-flow MRI quantify CSF dynamics through the aqueduct and outlets and are increasingly used to complement morphometry in obstructive hydrocephalus, offering mechanism-level assessment beyond diameter measurements.[16]

Our sex-null findings echo several MRI morphometry series reporting negligible sex differences in FV dimensions after intracranial volume control, even when subtle sex effects appear for other ventricles (e.g., third ventricle). Recent North Indian normals also found sex differences primarily in the third ventricle width, not the fourth, again mirroring our data.[17]

Neuropsychiatric literature provides relevant context: ventricular enlargement—driven in part by thalamic and striatal tissue loss—is a robust imaging feature in schizophrenia. Classic voxel-based work linked ventricular size to thalamic (particularly medial nuclei), insular, and striatal shrinkage; newer nuclei-resolved analyses confirm reduced medial thalamic volumes across the schizophrenia spectrum. While our cohort was not designed to parse psychiatric subgroups, these mechanisms highlight how disease-specific parenchymal loss can secondarily influence ventricular measurements.[18]

Clinically, FV measures can help distinguish obstructive from communicating hydrocephalus, monitor response to CSF diversion (e.g., endoscopic third ventriculostomy), and provide baseline context when interpreting posterior fossa masses. Longitudinal work shows that ventricular dimensions evolve after CSF diversion, reinforcing the value of standardized, reproducible linear metrics alongside volumetry and flow imaging in follow-up pathways.[19]

5.1. Strengths

Include a wide age span and standardized 1.5 T protocol.

5.2. Limitations

Include single-center design, clinical (not population) sampling, and reliance on linear (rather than volumetric) metrics without intracranial volume adjustment—factors that can modulate apparent age or sex effects. Future studies should pair FV linear measures with automated volumetry and 4D-flow across healthy and disease-specific cohorts to refine normative curves and mechanistic interpretation.

7.3. Importance of study

The measurement of the fourth ventricle diameter using Magnetic Resonance Imaging (MRI) is clinically important for evaluating conditions in the posterior fossa and understanding cerebrospinal fluid (CSF) dynamics. Assessing the size of the fourth ventricle offers insights into issues like hydrocephalus, Chiari malformations, tumors, cerebellar atrophy, and brainstem disorders. MRI is a non-invasive, radiation-free imaging method that provides high-resolution images. It allows clear visualization of the ventricular system and surrounding areas. Compared to CT, MRI has better soft-tissue contrast and can capture images in multiple planes, making it the preferred choice for evaluating the fourth ventricle both quantitatively and qualitatively. Clinically, measuring the fourth ventricle diameter helps with:

1. Diagnosing different types of hydrocephalus (communicating vs. non-communicating).
2. Monitoring changes after surgeries like shunt placement or posterior fossa decompression.
3. Assessing variations in ventricular shape based on age or gender.
4. Linking imaging results to symptoms such as gait disturbance, ataxia, or problems with cranial nerves.

To improve diagnostic accuracy, gathering normal data for fourth ventricle sizes across various age groups and populations helps doctors identify abnormal enlargement or compression more confidently. Standardizing MRI measurements allows for multicenter studies, comparative research, and applications of machine learning in neuroimaging.

6. Conclusion

In this study, the mean length of the fourth ventricle was 9.4 ± 2.9 mm and the mean width was 12.5 ± 1.9 mm as measured on MRI. No statistically significant difference was observed in ventricular dimensions between males and females, indicating that sex does not influence fourth ventricular size. However, age-related changes were significant for ventricular length, particularly between the pediatric (<15 years) and adult (30–59 years) groups, while width remained relatively stable across age groups. These findings suggest that the fourth ventricle undergoes measurable anatomical variation with age but not with gender. MRI serves as a reliable tool for accurate assessment of these changes, which may aid in clinical evaluation of neurological diseases involving ventricular system abnormalities.

6.1. Ventricular aberrations encountered

During this study, we did not find any major ventricular issues like hydrocephalus, fourth ventricular compression, or distortions from mass effect among the participants. All cases showed a normal shape of the fourth ventricle with no signs of structural changes, cysts, or lesions in the posterior fossa.

Any slight variations in shape were normal and did not indicate any pathological issues. The lack of significant ventricular abnormalities meant that the measurements captured typical anatomical differences based on age and sex, not changes caused by disease. This reinforced the reliability of the standard data collected in this study.

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8. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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