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Original Research Article

A study of third and fourth ventricular sizes in Bangladeshi adults using computed tomography scan

Mehreen Mustafiz[1]*, Nabil Zunayed Sidney[2], Shaila Sharmin Shahnewaz[3]

[1]Department of Radiology and Imaging, Shaheed Monsur Ali Medical College, Uttara, Dhaka, Bangladesh
[2]Department of Orthopedic and Trauma Surgery, Shaheed Monsur Ali Medical College, Uttara, Dhaka, Bangladesh
[3]Department of Physical Medicine and Rehabilitation, Shaheed Monsur Ali Medical College, Uttara, Dhaka, Bangladesh

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***Correspondence:**
Dr. Mehreen Mustafiz,
E-mail: mehreen.mustafiz@gmail.com

ABSTRACT

Background: The assessment of normal measurements of cerebral ventricles in living humans holds significant importance for diagnosing and monitoring various pathologies. Current digital computed tomography (CT) scan machines enable the direct visualization of ventricles in cross-sectional images, allowing real-time measurement of different ventricular dimensions, thereby aiding in comprehending their anatomy. This research aims to create baseline reference values for the sizes of the third and fourth ventricles in normal Bangladeshi adults using CT scans.
Methods: This was a retrospective study conducted in the department of radiology and imaging, Shaheed Monsur Ali Medical college hospital, Dhaka, Bangladesh, from January 2023 to December 2023. A total of 408 adult patients with clinical symptoms or history suggestive of neurological ailment were analyzed. CT scans of the brain of all the patients were performed in Supria 128 Fujifilm multi-slice CT scanner and the studies were analyzed retrospectively on Synapse 3D workstation. Measurements were taken with inbuilt linear calipers. The greatest width of the third ventricle (3V) and fourth ventricle (4V) on axial images using a linear approach were measured. Statistical analysis was performed by SPSS version 22.0.
Result: The study found that the mean measurements of the 3V were 4.27±1.22 mm in males and 3.73±1.03 mm in females, with an overall mean of 3.92±1.13 mm. For the 4V, the mean measurements were 11.73±1.27 mm in males and 10.67±1.07 mm in females, resulting in an overall mean of 11.03±1.25 mm. The largest dimensions in both ventricles were consistently observed in individuals aged 60 years and above, regardless of gender. Additionally, on average, the measurements of both ventricles were higher in males compared to females. Statistical analysis revealed significant differences in the sizes of both ventricles between male and female subjects.
Conclusions: This study concludes normal third and fourth ventricular sizes in Bangladeshi adults using CT scans. These can serve as baseline reference values in our hospital in routine practice.

Keywords: 3V, 4V, CT, Adults

INTRODUCTION

The brain cerebrospinal fluid (CSF) spaces include both the ventricular system and subarachnoid spaces (SAS). The ventricular system consists of four interconnected CSF-filled cavities lined by ependymal cells, located deep within the brain. The paired lateral ventricles communicate with the 3V through the Y-shaped foramen of Monro. Additionally, the communication between the 3V and the 4V takes place through the cerebral aqueduct, also known as the aqueduct of Sylvius. In turn, the 4V communicates with the SAS through its outlet foramina, including the midline foramen of Magendie and the two lateral foramina of Luschka.[1] Assessing the typical measurements of cerebral ventricles in living individuals is crucial for diagnosing and monitoring various

pathologies.[2] Recent scholarly attention has been directed towards morphometric studies of human brain ventricles. This focus is driven by the connection between ventricular measurements and evidence of pathologies such as hydrocephalus, schizophrenia, tumors, trauma, among others. Additionally, these studies explore the influence of gender and aging, which may contribute to conditions like dementia and brain geriatric.[3,4] Historically, older techniques such as pneumoencephalography and ventriculography were employed to visualize the ventricular system. These methods involved injecting air or contrast material through lumbar puncture under local anesthesia, but they were considered indirect and invasive.[5,6] In children, the ventricular system can be examined using two-dimensional ultrasonic studies conducted through the fontanelle.[7] In contemporary practice, the study of the ventricular system has transitioned to the use of advanced imaging techniques such as CT scans and magnetic resonance imaging (MRI), replacing the older methods.[2] Currently, digital CT scan machines allow for the direct visualization of ventricles in cross-sectional images, enabling real-time measurements of various dimensions of the ventricular system. This capability contributes to a better understanding of its anatomy.[8] Relying on the reviewer's subjective experience or observation regarding changes in ventricular size and shape can be inherently subjective, underscoring the importance of establishing normal values for more objective assessments.[9] Generalized atrophy of the brain is a routine concomitant of the ageing process and is a normal finding in the elderly, increasing with age. The loss of neural tissue in the senile brain occurs in a cranium of unchanged size and is therefore, compensated by an increased volume of CSF, which occupies the resulting enlarged ventricles, sulci and SAS.[10] Evaluating the normal dimensions of cerebral ventricles is crucial for the early detection of changes caused by intrinsic and extrinsic pathology leading to ventriculomegaly.[8] Establishing normal measurements of the cerebral ventricular system across various age groups and both sexes are imperative for accurate diagnosis.[11] The primary aim was to establish baseline reference values for the sizes of the third and 4Vs in normal Bangladeshi adults, employing CT scans as the diagnostic imaging modality.

Objectives

General objective

General objectives were to establish baseline reference values for the sizes of the third and 4Vs in normal Bangladeshi adults utilizing CT scans.

Specific objectives

Specific objectives were to assess the age and gender distribution of the study subjects and to observe mean third and fourth ventricular measurements by age groups in males and females.

METHODS

This was a retrospective study conducted in the department of radiology and imaging, Shaheed Monsur Ali medical college hospital, Dhaka, Bangladesh, from January 2023 to December 2023. A total of 408 adult patients with clinical symptoms or history suggestive of neurological ailment but with a normal CT brain were analyzed. Patients who reported to the emergency, outdoor, and indoor facilities of the hospital with complaints of head injury or neurological symptoms but with a normal CT brain were considered as study subjects. CT scans of the brain of all the patients were performed in Supria 128 Fujifilm multi-slice CT scanner. Axial sections were obtained at 5-mm slice thickness from the skull base to the vertex along the orbitomeatal plane. Studies were analyzed on Synapse 3D workstation. Measurements were taken with inbuilt linear calipers. The greatest width of the 3V and 4V on axial images using a linear approach were measured (Figures 1 and 2).

Figure 1: Axial CT image showing 3V measurement.

Figure 2: Axial CT image showing 4V measurement.

The observations were tabulated in Microsoft excel 2016. Statistical package for social sciences (SPSS) 22 was used for statistical analysis. The study employed an unpaired t-test to analyze the differences in sizes of both ventricles based on gender. A probability value (p value) below 0.05 was considered statistically significant. After analysis, the data were presented in tables and charts. Ethical clearance was taken from the ethical committee of Shaheed Monsur Ali medical college hospital.

Inclusion criteria

Patients with complaints of head injury or neurological symptoms but with a normal CT and patients of 18 years old and above were included in study.

Exclusion criteria

Patients with any history, clinical, or imaging findings indicative of intracranial or intraventricular pathology and patients with a proven case of a neurological disorder were excluded from study.

RESULTS

A total of 408 adult patients were chosen and analyzed for this study. They consisted of 142 males and 266 females, with a male-to-female ratio of 1:1.87. In our study, the youngest patient was 18 years old, whereas the oldest was 78 years old. The average age for the study population was 45.45±14.60 years. Majority of the subjects were in the age 40-49 years age group (Table 1).

In this series, there were 266 (65.19%) female cases and 142 (34.80%) male cases (Figure 3).

The study demonstrates a notable upward trend in the measurements of both ventricles as age increases, observed in both sexes. The highest dimensions for both ventricles were consistently found in the age group of ≥60 years for both genders (Table 2).

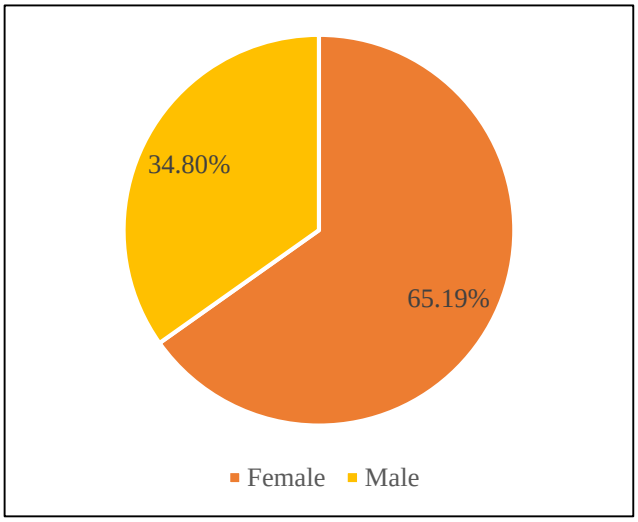

Figure 3: Gender distribution of the respondents, (n=408).

Table 1: Age and sex distribution of the patients, (n=408).

Age group (In years)	Males	Females	Total	Percentage (%)
<20	5	10	15	3.7
20-29	22	37	59	14.5
30-39	25	43	68	16.7
40-49	35	67	102	25.0
50-59	28	58	86	21.1
≥60	27	51	78	19.1
Total	142	266	408	100.0

Table 2: Mean third and fourth ventricular measurements by age groups in both genders, (n=408).

Age group (In years)	Male 3V (mm)	Female 3V (mm)	Male 4V (mm)	Female 4V (mm)
<20	3.10±0.14	2.99±0.10	10.6±0.10	9.0±0.41
20-29	3.24±0.26	3.11±0.30	10.75±0.55	9.05±0.52
30-39	3.48±0.13	3.21±0.23	10.88±0.74	10.58±0.50
40-49	3.83±0.12	3.35±0.27	11.21±0.60	10.74±0.46
50-59	4.35±0.58	3.56±0.34	12.28±0.87	11.06±0.64
≥60	6.52±0.53	5.46±1.18	13.6±0.78	11.67±1.08

Table 3: Mean third and fourth ventricular measurements by gender, (n=408).

Ventricle	Male ± female (mm)	Male (mm)	Female (mm)	P value
3V	3.92±1.13	4.27±1.22	3.73±1.03	0.001
4V	11.03±1.25	11.73±1.27	10.67±1.07	0.001

In this study, the mean measurements of the 3V were 4.27±1.22 mm in males and 3.73±1.03 mm in females, resulting in an overall mean of 3.92±1.13 mm. Meanwhile, the mean measurements of the 4V were 11.73±1.27 mm in males and 10.67±1.07 mm in females, with an overall mean of 11.03±1.25 mm. Notably, the mean measurements of both ventricles were found to be greater in males compared to females.

These differences were statistically significant for both the 3V (p=0.001) and the 4V (p=0.001) in both sexes (Table 3).

DISCUSSION

In this series, we noted a significant statistical variance in the mean measurements of both the third and 4Vs when comparing males and females. This finding aligns with the research conducted by some authors, who previously reported variations in human brain anatomy influenced by age, sex, and BMI. Their study highlighted that, women tend to exhibit smaller brains and lateral ventricles compared to men, even after accounting for height differences. These results emphasize the importance of considering sex-related differences when examining brain anatomy and ventricular sizes. Furthermore, the influence of factors such as age and BMI on these variations underscores the complexity of understanding human brain structures. This knowledge holds implications for diverse fields, including neuroscience and clinical research.[12,13] Additionally, Skullerud noted a decline in brain weight, likely commencing around the age of 55 years. He suggested that the reduction in brain mass results in an enlargement of ventricular sizes, acting as a compensatory mechanism in response to cerebral atrophy. This phenomenon is considered a natural physiological process associated with aging.[12] Likewise, in our investigation, we observed a consistent increase in the measurements of the third and 4Vs with advancing age. The highest measurements for both the 3V and 4V were recorded in the age group of ≥60 years for both genders. These findings align with the study carried out by an author who studied 100 individuals without any physical or neurological deficits. Celik et al reported a correlation between age and the sizes of cerebral ventricles in both genders. Additionally, their observations indicated that, in comparison to women, men tended to have a larger size of the 3V.[14] According to Kanakaraj et al the standard size of the 3V was reported as 4.06±2.41 mm for males and 3.25±1.80 mm for females. In terms of the 4V, the normal size was documented as 12.16±2.05 mm in males and 11.38±1.06 mm in females. Their observations also highlighted variations in ventricular dimensions between the two sexes. Specifically, females exhibited smaller ventricular dimensions compared to males, and these differences were significant for both the third and 4V measurements.[15] These findings mirror our own study. In the research conducted by Hamidu et al the mean widths of the 3V were reported as 4.23±1.25 in males and 3.81±0.87 in females. Whereas, the mean widths of the 4V were noted as 7.87±1.30 in males and 7.54±1.33 in females. Notably, the highest dimensions for both the 3V and 4V were observed in the highest age group of more than 60 years for both sexes. These results underscore the consistency in the observed patterns of ventricular dimensions across different studies. These findings align with our own study. Similarly, Hamidu et al. also observed that the mean sizes of both ventricles were greater in males compared to females, with statistical significance noted only in the case of the 3V. This emphasizes a consistent trend in the observed differences in ventricular sizes between genders, with a notable statistical significance for the 3V in particular.[9] These results exhibit partial correlation with our study, as our current research has identified significant differences between males and females in the measurements of both ventricles. Kumar et al. noted that the highest dimension in the 3V occurred in the age group of ≥60 years for both genders, displaying a consistent increase across age groups until the seventh decade. These observations align with our study. Furthermore, Kumar et al reported that the mean sizes of the third and 4Vs were bigger in males compared to females; however, in their case, the differences did not reach statistical significance.[16] In our study, these differences were statistically significant.

Limitations

It was a retrospective analysis in a single hospital for a short duration. So, the results may not represent the whole community.

CONCLUSION

This study has shown the normal sizes of third and 4V in Bangladeshi adults using CT scans. These can serve as baseline reference values in our hospital in routine practice.

Recommendations

Indeed, a multicenter analysis could enhance the robustness of cutoff indices and contribute to more reliable conclusions. By incorporating data from multiple centers, the study can capture a broader and more diverse sample of the population, reducing the potential impact of local variations or biases. In this study, all the study subjects were adults. A further study including pediatric population can be undertaken in the future.

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