Original Research Article

Relationship of Sex with the size of the Cerebral Aqueduct Dimensions using Computerized Tomographic Scan from Sokoto North-Western Nigeria.

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ABSTRACT

Aim: To determine the relationship of sex with the size of the cerebral aqueduct dimensions in normal adults using computerized tomographic scan in Sokoto North-Western Nigeria..
Study design: Retrospective cross- sectional
Place and duration of study: Department of Anatomy UsmanuDanfodiyo University Sokoto and Department of Radiology UsmanuDanfodiyo University Teaching Hospital Sokoto, between January, 2020 and January, 2022.
Methodology: The images were analysed on a viewing monitor and the measurements were made using a computer software program Radiant DICOM Viewer version 4.0. The anterior-posterior diameter of the cerebral aqueduct was measured as the distance between the posterior end of the third ventricle to the upper part of the fourth ventricle in sagittal plane. While, the transverse diameter was measured as the distance between the lateral margins of the aqueduct at the midpoint of the anterior posterior diameter in sagittal plane.
Results: The range of anterior posterior diameter of Aqueduct observed in males was 24.25mm to1.64mm and 24.3mm to32.27mmin females. While the range of width of the aqueduct was 2.18mm to 3.79mm in males and 2.16mm to 3.51mm in females. The largest length 32.32mm of the aqueduct was observed in the age group 51-60years for and 32.27mm in females seen in the age group 51-60 and 61-70years.
Conclusion: The anterior-posterior and transverse diameter of the cerebral aqueduct shows no sexual dimorphism and changes slightly in the first decade of life, but thereafter, progressively increased with advancing age**.**

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Key words: Brain, cerebral, aqueduct, dimensions, CT scan, Nigerians.

1. INTRODUCTION

Cerebral aqueduct represents the primitive mesencephalic cavity. Since the course of the aqueduct is concave ventral, the length of the aqueduct was described as cranial and caudal parts. The angulation of its course is taken as point of division of both parts.[1]

Studies have been conducted in postmortem specimens, cadavers, and plastic cast to determine the morphometry of cerebral aqueduct.[2] Due to shrinkage of the ex vivo specimen, the dimensions obtained by those methods are considered equivocal. Nowadays, CT and MRI are mostly considered as the investigation of choice for preoperative planning for brain operative procedure. CT morphometric evaluation of cerebral aqueduct may provide precise knowledge about anatomy and help to diagnose aqueductal stenosis. [2]

The digital CT scan machines currently in use also allow direct visualization of ventricles in cross sectional images and direct real time measurement of various dimensions of the ventricular system thus assisting in understanding its anatomy.[3] Morphometric analysis of cerebral ventricular system is essential for evaluating changes due to ageing, growth, and the various intrinsic and extrinsic pathologies.[3]

Neuroimaging studies have identified several forms of age-related change in brain structure that are relevant as potential mediators of age-related changes in cognitive performance. [4] Prominent among these is age-related decline in the volume of cerebral gray matter, particularly in prefrontal regions.[4] Cephalometry of the brain ventricles has revealed variations in the size of the brain with certain parameters such as age and sex. [5] This therefore placed high premium of accuracy in the technique and equipment used in obtaining a good CT of the brain, from which measurements could be made.[5]

Both imaging and autopsy studies revealed that there is correlation between cerebrospinal fluid spaces and reduction in cerebral volume accompanying normal human ageing.[6,7]Age-related decline is also evident in cerebral white matter volume, although with a different trajectory.[8] whereas, the age-related decline in gray matter volume is relatively linear from younger adulthood, the corresponding decline in white matter tends to be nonlinear, with a plateau in middle-age and additional decline, beyond that of gray matter, in later adulthood.[8]

Various studies clearly show an increase in the cerebrospinal fluid spaces in dementia especially in Alzheimer's disease and Parkinson's disease.[9,10] This increase in the cerebrospinal fluid is due to reduction of nerve cells.[11,12] Ventricular enlargement is a sensitive indicator of cortical atrophy due to increasing age and dementias.[13]

2. MATERIALS AND METHODS

All available brain CT scans (580) of subjects done in the Radiology Department of the UsmanuDanfodiyo University Teaching Hospital (UDUTH) Sokoto, from 20th June 2020- 20th June 2022 (a 2-year period) and reported as normal by the Neuro- Radiologist, were retrieved. Two hundred and sixty (162 males and 98 females) Brain CT scan tomograms satisfied the inclusion criteria and were recruited for the study. The age range of the subjects was between 10- 70 years.

2.1 Inclusion Criteria

1- The Participants are Nigerians.
2- They were aged between 10 and 70 years.
3- The brain CT scans were described as normal by a radiologist with respect to:

a. Normal cerebral ventricular size, form, shape and periventricular translucency.
b. Brain parenchyma appears normal with no evidence of space occupying lesions.
c. Passage of the lowest tomographic section through a line 15–20 degrees to and 1cm above the cantho-meatal line which represent the base of the skull.
d. The cerebral aqueduct and inter ventricular foramen are well outline

Exclusion Criterion

1-Tomograms of non- Nigerian citizens by birth.
2 - Tomograms as normal but, without comments on cerebral aqueduct
3 - Evidence of space occupying lesions
4 - Presence of cerebral hemorrhage
5 - All brain Tomograms with poor quality of the scan images

The images were analysed on viewing monitor and the measurements were made using Radiant DICOM Viewer version 4.0. The measurement was calibrated to 0.1 millimeters. Measurements were made using the Radiant viewer software which provides a ruler for which the anterior-posterior diameter and width of the cerebral aqueduct were measured in (mm) as follows: The anterior-posterior diameter was obtained by measuring the distance between the posterior end of the third ventricle to the upper part of the fourth ventricle in sagittal plane (A-B) see fig 1 and fig 2. While, transverse diameter was obtained as the distance between the lateral margins of the aqueduct at the midpoint of the anterior posterior diameter in sagittal plane see Fig 2 (C-D).

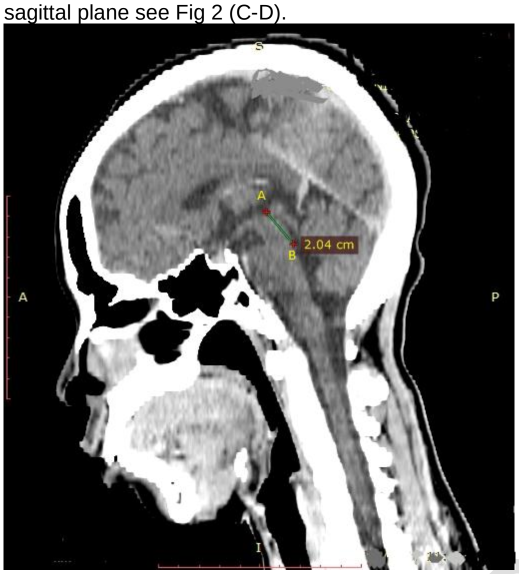

Figure 1: A CT image showing measurement of the anterior-posterior diameter (A-B) of cerebral aqueduct.

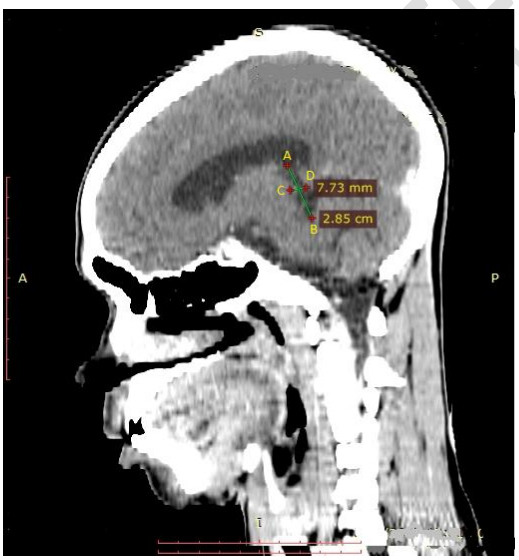

Figure 2: A CT image showing measurement of the anterior-posterior diameter (A-B) and transverse diameter (C-D) of cerebral aqueduct.

3. RESULT AND DISCUSSION

3.1 RESULT

Table 1: Mean of Anterior-Posterior and Transverse Diameters (width) of Cerebral Aqueduct of the Different Age Groups in Males and Females

Age Group	Aqueduct Dimensions	Males	Females	P value
	AQ length	27.03	27.01	0.142
10-20	AQ diameter	2.25	2.51	0.321
	AQ length	27.12	27.04	0.147
21-30	AQ diameter	3.37	3.38	0.346
	AQ length	29.36	29.25	0.722
31-40	AQ diameter	3.55	3.51	0.641
	AQ length	30.42	30.31	0.227
41-50	AQ diameter	3.58	3.52	0.526
	AQ length	32.32	32.27	0.149
51-60	AQ width	3.64	3.59	0.212
	AQ length	31.64	32.27	0.732
61-70	AQ diameter	3.79	3.51	0.211

AQ= aqueduct, N= number

There was no statistical significant difference between sexes and same age groups as p>0.05

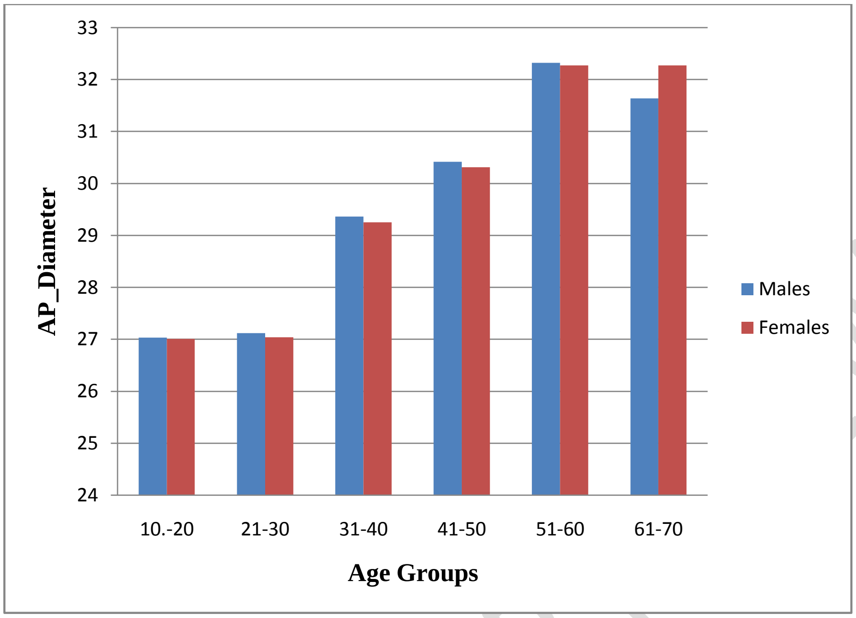

Figure 3: Bar Chart of Mean Anterior-Posterior Diameter of the Cerebral Aqueduct of the Different Age Groups in Both Male and Female

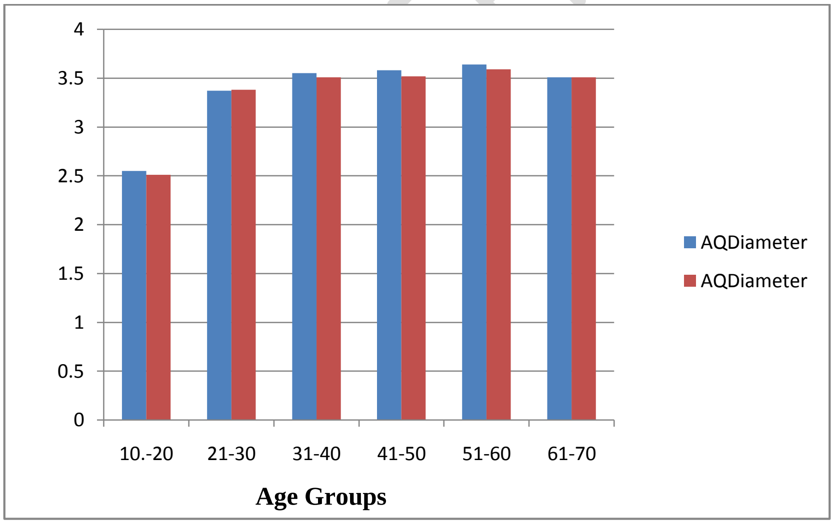

Figure 4: Bar Chart of Mean Transverse Diameter of the Cerebral Aqueduct of the Different Age Groups in Both Male and Female.

3.2 DISCUSSION

The shape of the cerebral aqueduct varies from the third to fourth ventricle. The morphology of the cerebral aqueduct shows two constrictions with an ampulla in between the constrictions. [14,15,] The constrictions are considered very significant for the ease of endoscopic advancement during neurosurgical procedure, in addition to determining the size of the cerebral aqueduct. Minimal collection of blood or debris can lead to blockage of aqueduct which, in turn, leads to hydrocephalus or ventriculomegaly. [16,17]
Post hemorrhagic ventricular dilation affects approximately 75% of preterm infants following a severe germinal matrix-intraventricular hemorrhage and represents a potential threat to the developing neonatal brain.[18] To diagnose post hemorrhagic ventricular dilation and evaluate the need for intervention, measurement of ventricular size by means of cranial ultrasonography has been shown to be superior to measurement of head circumference or assessment of clinical symptoms of raised intracranial pressure.[19,20] Measurement of the cerebral aqueduct offers a sensitive tool to detect ex vacuo ventriculomegaly in preterm infants due to periventricular white matter loss.[21,22]
The anterior- posterior and transverse diameter of the cerebral aqueduct was observed to increase with advancing age. The parameters were generally larger in males than in females but the differences were statistically insignificant across the age group (p> 0.05). The range of AP diameter of Aqueduct observed in males was 24.25mm to 31.64mm and 24.3mm to 32.27mm in females. While the range of width of the aqueduct was 2.18mm - 3.79mm in males and 2.16mm to 3.51mm in females. The largest length 32.32mm of the aqueduct was observed in the age group 51-60years for males. while, in females the largest length was 32.27mm seen in the age group 51-60 and 61-70years. In the current study the least width of cerebral aqueduct observed was 2.16mm in females and 2.18 in males and this was seen in the age group 10-20years. While, the largest AP diameter was 32.32mm in male and 32.27 in female, seen in the age group 51-60 years. Matys et al reported a mean value of the length of the cranial and caudal part of aqueduct in males as 6.9 cm and 8.6 cm and in females 6.5 cm and 8.0 cm, respectively. The length was more in males than females with significance (p = 0.006 and 0.02, respectively). [23] Mean total length of aqueduct in our study was less, compared to the study by Matys et al. However, in our study we measured the overall length without division of the aqueduct into cranial and caudal parts.[23]

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The least width of cerebral aqueduct observed was 2.16mm in females and 2.18 in males and this was seen in the age group 10-20years. While, the largest AP diameter was 32.32mm in male and 32.27 in female, seen in the age group 51-60 years. Our findings are in agreement with those of Haslam that reported the width and length of aqueduct ranged between 1.7 ± 0.75 to 2 ± mm and 2.8 ± 0.66 to 4 ± 1.05 mm, respectively.[24] They also reported the approximate width and length of aqueduct to be 2mm and 3mm, respectively.[24] The distance between foramen of Monro and aqueduct increases when there is dilatation of third ventricle due to blockage of aqueduct.[24]
The length and diameter of the cerebral aqueduct was observed to change slightly in the first decade of life. But steep increment was noticed in the second decade and this continued up to the seventh decade in both male and females. Although the values in males are slightly higher than those of the female across the different age groups but this differences are not statistically significant. Our findings are similar to those reported by Akyer et al.They observed the length of the cerebral aqueduct to be larger in males than females. There was significant difference between the lengths of the two parts (cranial part was more). [27] However, their reported values are higher and unlike in our study where we measured the whole length of the cerebral aqueduct, they measured the cranial and caudal parts of the cerebral aqueduct seprately.[27]

4. CONCLUSION

The length and diameter of the cerebral aqueduct shows no sexual dimorphism and changes slightly in the first decade of life. The morphometric measurements of aqueduct based on CT Scan enhances precise knowledge about anatomy of the cerebral aqueduct. It also helps the radiologist to diagnose the pathology involving the aqueduct like stenosis, narrowing, or developmental anomaly which causes increased intracranial pressure. It also provides a basic morphological data to the surgeons that can be helpful in endoscopic neurosurgeries, in order to minimize the intraoperative complications, thereby avoiding the postoperative morbidity and motality

REFRENCE

1- Standring S, Gray's Anatomy (2016): The anatomical basis of clinical practice. 21st ed. New York, Elsevier;
2- da Silva LR, Cavalheiro S, Zymberg ST (2007). Endoscopic aqueductoplasty in the treatment of aqueductal stenosis. Childs Nerv Syst;23(11):1263–1268
3- Jacoby, R.J., Levy, R., Dawson, J.M. (1980). Computed tomography in the elderly. The normal population. British Journal of Psychiatry,1;136, (3): 249-55.
4- LeMay, M. (1984). Radiologic changes of the aging brain and skull. American journal of roentgenology, 143: 383-89.
5- Marner, L., Nyengaard, J.R., Tang, Y. and Pakkenberg, B. (2003). Marked loss of myelinated nerve fibers in the human brain with age. Journal of Comparative Neurology, 462: 144–52.
6- Haaga, J.R. Lanzieri, C.F. and Gilkenson, R.C. (1994). "CT and MRI imaging of the whole Body" fourth edition, volume 1, chapter 4, Mosby, Inc. Philadelphia, USA, P. 88-123 and 351.
7- Morel, F. and Wildi, E. (1953). The capacity of cerebral ventricles in relation to age and the presence of senile plaques and Alzheimer's modifications. Archives for Neurologist and Psychiatrist, 72: 211-17
8- Tomlinson, B.E., Blessed, G. and Roth, M. (1970). Observations on the brains of demented old people. Journal of the Neurological Sciences, 11: 205-42.
9- Raz, N., Dupuis, J.H., Briggs, S.D., Mc Gavran, C. and Acker, J.D. (1998). Differential effects of age and sex on the cerebellar hemispheres and the vermis: A prospective MR study, American Journal Neuroradiology, 19: 65-71.
10- Andreasen, N.C., Smith, M.R., Jacoby, C.G., Dennert, J.W. and Olsen, S.A. (1982). Ventricular enlargement in schizophrenia: definition and prevalence. The American journal of psychiatry,139: 292-96.
11- Kido, D.K., Caire, E.D. and Le May, M. (1989). Temporal lobe atrophy in patients with Alzheimer's disease: A CT study. American Journal of Neuroradiology, 10: 551-555.
12- Huber, S.J., Chakeres, D.W. and Paulson, G.W. (1990). Magnetic resonance imaging in Parkison's disease. Archives Neurology. 47, 735-737.
13- Corsellis, J. (1976). Aging and the dementias. Greenfield's Neuropathology, 3rd ed. (W Blackwood and JANCorsellis, Eds), Edward Arnold, Edinburgh, 796
14- Creasy, H. and Rapoport, S. I. (1985). The human brain. Annals of neurology, 17: 2-10
15- Gur, R.C., Gunning, D.F., Turetsky, B.I., Bilker, W.B. and Gur, R.E. (2002). Brain region and sex differences in ageassociation with brain volume. American Journal of Geriatric Psychiatry; 10, (1): 72-80.
16- Zhang,Y., Londos., E., Minthon, L., Wattmo, C., Liu, H., Aspelin, P. and Wahlund, L. (2008). Usefulness of computed tomography linear measurements in diagnosing alzheimer's disease. Acta Radiologica, 49(1):91–97.
17- Barker-Collo, S., Kahan, M. and Starkey, N. (2011). Computerised tomography indices of raised intracranial pressure and traumatic brain injury severity in a new zealand sample. The New Zealand medical journal, 125, (1360): 92.
18- Walkins, J. (2004). Prediction of neurodevelopmental impairment at four years from brain ultrasound appearance of very preterm infants. Developmental Medicine Child Neurology, 30: 711-22.
19- González-Reimers, E. and Santolaria-Fernández, F. (2012). Brain atrophy in alcoholics. Handbook of Behavior, Food and Nutrition, pages 2993–3010.
20- Volpe, J.J. (2008). Intracranial hemorrhage: germinal matrix-intraventricular hemorrhage of the premature infant. Neurology of the newborn. 5th ed. Philadelphia, Pa: Saunders Elsevier.
21- Liao, M.F., Chaou, W.T., Tsao, L.Y., Nishida, H., Sakanoue, M. (1986) Ultrasound measurement of the ventricular size in newborn infants. Brain Development, 8,(3): 262–268.
22- Müller, W.D. and Urlesberger, B. (1992). Correlation of ventricular size and head circumference after severe intra-periventricular haemorrhage in preterm infants. Childs Nervous System, 8,(1): 33–35.

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23- Matys T, Horsburgh A, Kirollos RW, Massoud TF. The aqueduct of sylvius (2013): Applied 3-T magnetic resonance imaging anatomy and morphometry with neuroendoscopic relevance. Oper Neurosurg (Hagerstown);73: ons132–140
24- Haslam, R.H., Behrman, R.E., Kliegman,, R.M., Nelson, W.E., Vaughan, V.C. and Philadelphia,W.B. (1992). Hydrocephalous. Nelson Text Book of Pediatrics, 14th edn. Eds.. Saunders Co, p 1487.
25- Soul, J.S., Eichenwald, E., Walter, G., Volpe, J.J. and du Plessis, A.J. (2004). CSF removal in infantile posthemorrhagic hydrocephalus results in significant improvement in cerebral hemodynamics. Pediatric Research, 55(5): 872–876.
26- Van Alfen V, Velden, A.A., Hopman, J.C., Klaessens, J.H., Feuth, T., Sengers, R.C. and Liem, K.D. (2007). Cerebral hemodynamics and oxygenation after serial CSF drainage in infants with PHVD. Brain Development, 29, (10):623–629.
27- Akyer SP, Cagirici S, Ozdemir MB (2014). Relationship of age with the size of the interventricular foramina and aqueductussylvii: a morphometric evaluation. Neurol Res;36(10):878–881