Original Article

Study on Volume of Cerebellum in Bangladeshi Cadaver

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Abstract:

This cross sectional descriptive study was done by using nonprobability sampling technique and performed by examining 63 (sixty three) cerebellum. Out of them 40 postmortem human cerebellum collected from Bangladeshi cadavers of both sexes (male 25 and female 15) age ranging from 5 to 60 years and 23 cerebellums from caesarian section of intrauterine death cases of both sex (male 14 and female 9) age ranging from 34 wks to 41 wks. of gestation. Specimens were collected from dead bodies autopsied on different dates from April' 2009 to September' 2009 at the autopsy laboratory of department of Forensic Medicine and prenatal cases from Gynaecology and Obstetrics Department of Mymensingh Medical College, Mymensingh. The collected specimens were grouped into three age groups like Group A (28 to 42 weeks of gestation), Group B (5 to 30 years) and Group C (31 to 60 years) and, two sex groups (male and female). Volume of the cerebellum was measured by applying the principle of fluid displacement method (Brown et al 1986) with the help of a 1000 ml beaker and 1000 ml cylinder. After placing the cerebellum in the beaker, water was gradually added to it from a measuring cylinder which was previously filled with 500 ml of water and then the beaker was filled exactly up to 500 marking. The remaining portion of water in the cylinder, which indicates the amount of displaced fluid by the cerebellum, was exactly recorded and was expressed in milliliter (ml). The measurement was taken after fixation into 10% formol saline. The mean (±SD) volume was in Group A 15.48±2.85 ml, B 117.74±15.01ml and C 108.60±15.59 ml respectively and it was also observed that the mean volume of the cerebellum increased with age upto certain level then slightly decreased in the late age Group C. The mean volume was maximum in Group B (117.74 ml) and was minimum in Group A (15.48 ml).The mean difference of the cerebellar volume between Groups A&B, A&C was statistically highly significant but differences between B&C was also statistically significant at $p < 0.05$ level.

Key words: *Cerebellum, Volume, Bangladeshi cadaver.*

Introduction

The cerebellum is a very important part of central nervous system. It unconsciously controls the smooth contraction of voluntary muscle and carefully coordinates their action.[1] The cerebellum is the portion of brain lying behind and below the cerebrum, it serves to coordinate both voluntary movements and muscle functions in the maintenance of normal posture.[2]

The human cerebellum is an enormously impressive organ.[3] Cerebellum is the largest part of hindbrain, situated in the posterior cranial fossa, behind the pons and the medulla oblongata.[4,5,6,7] The cerebellum is a central part of the major circuit that links sensory to motor areas of the brain and is required for the coordination of fine movement. In health, it provides corrections during movement, which are the basis for the precision and accuracy and it is critically involved in motor learning and reflex modification. It receives sensory information through spinal, trigeminal and vestibulocerebellar pathways and via the pontine nuclei, from the cerebral cortex and the tectum. Cerebellar output is mainly to those structures of the brain that control movement. Cerebellum enlarges enormously during first year of life after then the rate of growth is slow. The increase in volume is partly due to increase in the size and not in number of the nerve cells and partly by the growth of the blood vessels, but it is mainly affected by the progressive myelination of the nerve fibres.[7] Cerebellar cortex consists of three layers - outer molecular, intermediate Purkinje and inner granular.[7] Four pairs of deep cerebellar nuclei in the medullary

core of white matter form the output neurons, which are named from medial to lateral side as the nucleus fastigii, nucleus globosus, nucleus emboliformis and nucleus dentatus[7]. These nuclei consist of multipolar neurons and receive axon terminals of Purkinje cells from the cerebellar cortex and collaterals from climbing and mossy fibres. The axons of the deep cerebellar nuclei are projected as the final efferent pathways, through the superior and inferior cerebellar peduncles to the thalamus, red nucleus, brain stem reticular nuclei, inferior olivary and vestibular nuclei. Such output fibres do not provide collaterals to the neurons of the cerebellar cortex. Each dentate nucleus presents a crenated nuclear mass with the hilum directed ventro-medially. It belongs to the neocerebellum and receives projections from the hemispheric or lateral cortex. The axons of dentate nucleus leave through the hilum and the superior cerebellar peduncles and form dentato-rubrothalamic fibres, which decussate in the tegmentum of the lower mid brain and connect with the intermediate (lateral) ventral nucleus.

It contains more nerve cells (neurons) than all the rest of the brain combined, on an average 50 billion neurons.[3,5,7] Purkinje cells form the center of a functional unit of the cerebellar cortex. The total number of neurons in human cerebellum during development decreased significantly from early maturity to old age.[8] Studies of the structural-functional organization of different parts of the cerebellum continue to be relevant. The variety of cerebellar functions and the conditions associated with their impairments have led to multilateral studies of this organ. The neuronal organization of the cerebellum has been studied in detail by a number of authors. However, despite the significant number of reports addressing the structural organization of the cerebellum, most of these have been performed on animals but volume of the cerebellum in humans remains inadequately studied. It has been observed by various workers that dimensions of different organs in Bangladeshi population vary from those of Western population. With the above evidences, the aim of the present work was done on volume of cerebellum to make a standard for Bangladeshi population.

Materials and Methods

The study was done by examining 63 (sixty three) cerebellum out of them 40 postmortem human cerebellum collected from Bangladeshi cadavers of both sexes (male 25 and female 15) age ranging from 5 to 60 years and 23 cerebellums from caesarian section of dead fetuses of both sexes (male 14 and female 9) age ranging from 34 wks to 41 wks. of gestation. Specimen containing cerebellum was collected from dead bodies autopsied on different dates from April'2009 to September'2009 at the autopsy laboratory of department of Forensic Medicine and Gynaecology and Obstetrics Department of Mymensingh Medical College, Mymensingh. All the collected specimens of postnatal cases were from medico-legal cases (suicidal, homicidal, or accidental death) and the specimen of foetus from intra-uterine death cases (eclampsia, ante-partum haemorrhage, obstructed labour). Grossly injured cases involving head-neck region and cerebellum of decomposed bodies were excluded. The specimen was labeled with a specimen number, recording age and sex of the cadaver and then fixed in 10% formalin solution, by floating freely in a suitable container with a lid. The specimen was allowed to fix for a period of one or two weeks. The present study was done with these fixed specimens in spite of some hardening and shrinking of tissue brought about by fixation. These could not be avoided at the brains, because in fresh state, they were too soft to handle. It took one to two weeks for them to get sufficiently hard to allow normal handling and dissection to be carried out. The collected sample was grouped into three age groups like Group A (34 to 41 weeks of gestation), Group B (5 to 30 years) and Group C (31 to 60 years). The measurement was taken after fixation into 10% formol saline. Volume of the cerebellum was measured by applying the principle of fluid displacement method (Brown et al 1986) with the help of a 1000 ml beaker and 1000 ml cylinder.

After placing the cerebellum in the beaker, water was gradually added to it from a measuring cylinder which was previously filled with 500 ml of water and then the beaker was filled exactly up to 500 marking. The remaining portion of water in the cylinder, which indicates the amount of displaced fluid by the cerebellum, was exactly recorded and was expressed in milliliter (ml).

Mean values were put down in a tabulated form for convenient processing which led to a conclusion. Appropriate statistical analysis was done using computer based statistical package, SPSS (Statistical Package for Social Science) to evaluate the significance of variance between the different findings.

Observation and Result

The maximum volume of the cerebellum was in Group A 19, B 142 and C 131 ml respectively.

The minimum volume of the cerebellum was in Group A 8, B 82 and C 68 ml respectively.

The mean (±SD) volume was in Group A 15.48±2.85, B 117.74±15.01 and C 108.60±15.59 ml respectively (Table- I,II, figure- 2) and it was also observed that the mean volume of the cerebellum increased with age upto certain level then slightly decreased in the late age Group C.

The mean volume was maximum in Group B (117.74 ml) and was minimum in Group A (15.48 ml).

The mean difference of the cerebellar volume between Groups A&B, A&C was statistically highly significant but differences between B&C was also statistically significant at $p < 0.05$ level.

Discussion

In present study, it was found that the mean (±SD) volume of the cerebellum were in Group A (28 to 42 weeks of gestation) 15.48±2.85 ml, B (upto 30 years) 117.74±15.01ml and C (31 to 60 years) 108.60±15.59 ml respectively.

The maximum value was found in Group B. Pal et al (2003) studied on 6 (six) Indian cadavers and found the mean volume (±SD) of cerebellum in man was 104.1±8.38 ml. It was measured by water displacement method in cadaver, but they did not mention the age of the study population. If it is taken as adult value, the range of findings of present study of age Group C is conformed to their observation. Srinivasan et al (2006) described the mean volume of cerebellum of >28-weeks-gestation infants are 25.9 cm^3 (ml). It was measured by MRI method in living body. This value is more than the present study of Group A (28 to 42 weeks of gestation) as 15.48±2.85 ml may be due to racial factor or formalin fixed preserved specimen. Raz et al (2001) estimated that within the age span 20 to 80 years; shrinkage of the cerebellar hemispheres was about 2% per decade. In present study it was observed that the mean volume of the cerebellum increased with age upto certain level then slightly decreased in the late age Group C (31 to 60 years).

In present study it was also seen that the mean volume of the cerebellum in male (79.00±7.98 ml) was higher than that of female (75.83±10.07 ml) and this difference was statistically not significant. Szabó et al (2003) observed that there were no significant differences between cerebellar volumes regarding handedness or sex.

Conclusion

The result of the present study will enrich the information pool on volume of the cerebellum of Bangladeshi people. To establish a standard for Bangladeshi people, further study is required by using large number of samples from different parts of Bangladesh.

References

1. Snell R S. Clinical Neuroanatomy, 8th ed. Baltimore: Lippincott Williams and Wilkins, 2008; p. 219-40. 2. Ross M H, Kaya I G, Pawlina W. Histology: A Text And Atlas, 5th ed. Philadelphia: Lippincott Williams & Wilkins, 2006; pp. 322-3,360.
3. Leiner H C and Leiner A L, 'The Treasure at the Bottom of the Brain', New Horizons for Learning, 1997; http://www.newhorizons.org.
4. FitzGerald Turlough M J, Neuroanatomy. In: Gray's anatomy: the anatomical basis of clinical practice, 39th ed, London: Churchill Livingston, 2005; p. 353-368.
5. Chaurasia B D, Human Anatomy Regional and Applied, Vol. 3, 4th ed, Bangalore: CBS Publishers and Distributor, 2007; p. 233-6.
6. Sinnatamby C. S. Last's Anatomy: regional and applied, 11th ed, London: Harcourt Publishers Limited, 2006; p. 479-81.
7. Datta A K, Essentials of Neuroanatomy, Part-4. 4th ed, Kolkata: Current Books International, 2005; p. 159-73.
8. Khutoryan B. M. 'Quantitative Characterization of the Cellular Elements of Human Cerebellar Nuclei at Different Ages', Springer Science + Business Media, Inc. 2003; 124(4), p. 35 -7.

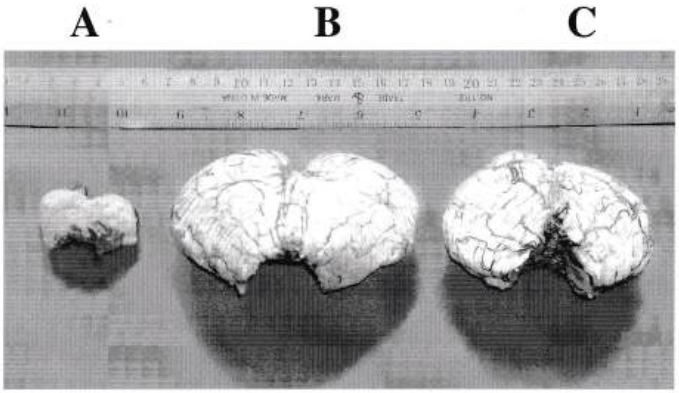

Figure 1: Photograph of Cerebellum A=Group A (34 to 41 weeks of estation), B=Group B (5 to 30 years) and C=Group C (31 to 60 years)

Figure 2: Line diagram showing Mean Volume of whole cerebellum in different age Groups

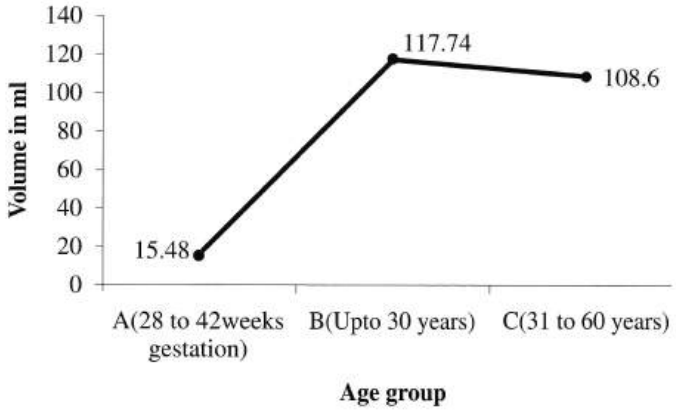

Table I: Volume of the Cerebellum in Different Age Groups

Age Group	Number of specimen	Volume (ml) Mean ± SD (Minimum - Maximum)
A (28-42 weeks of gestation)	23	15.48 ± 2.85 (8 - 19)
B (Upto 30 years)	23	117.74 ± 15.01 (82 - 142)
C (31 to 60 years)	17	108.6 ±15.59 (68 - 131)

Comparison of volume among the age Groups

Table II: Mean Volume of Cerebellum in Different Sex

Age Group	Sex of the person	Number of specimen	Mean volume in ml	(±)SE
A (28 to 42 weeks of gestation)	Male	14	14.86	2.88
	Female	9	16.44	2.85
B (Upto 30 years)	Male	13	118.23	4.38
	Female	10	117.10	4.68
C (31 to 60 years)	Male	12	111.33	3.05
	Female	5	100.20	10.56

Comparis on between Variables		Mean Difference	Std. Error	P	Level of significance
A	B	102.26	3.62	.000	Highly Significant
A	C	92.58	3.93	.000	Highly Significant
B	C	9.68	3.93	.016	Significant

Comparison of volume between both sexes

Age Group	Mean difference between sex	Std. Error difference	t	p	Level of significance
A	1.59	1.20	1.33	.198	Not significant
B	1.13	6.46	0.18	.863	Not significant
C	11.13	8.08	1.38	.188	Not significant

Table-VI depicts that the mean volume of cerebellum was higher in female of Group A (16.44 ± 2.85 ml) than that of in male of Group A (14.86 ± 2.88 ml) and was statistically not significant, where for Group A t = 1.33 and p = .198 but the mean volume of cerebellum was higher in male of Group B (118.23 ± 4.38 ml) & Group C (111.33 ± 3.05 ml) than that of in female of Group B (117.10 ± 4.68 ml) & Group C (100.20 ± 10.56 ml) and was statistically not significant, where for Group B t = 0.18 and p = .863 and Group C t = 1.38 and p = .188.