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Anatomical differences of Cerebellar vermis measurement values in healthy adult men and women using MRI images.

Anatomy

KEYWORDS: Vermis, gender, MRI.

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ABSTRACT

Background: The cerebellum is divided into two hemispheres and contains a narrow midline zone called the vermis. A set of large folds are conventionally used to divide the overall structure into ten smaller "lobules". The vermis receives fibres from the trunk and proximal portions of limbs, But the question is that does the cerebellum have the same measurement values in males and females of the same age?

Material and method: The present study used 80 sectional brain MRI images (40: males, 40: females); 35-50 years old as indices of size for the vermian structures of the Cerebellum. This middle age group was taken because as known generally it could be neither an age of growth as in the young nor of atrophy as in old individuals. The aim regarding the gender differences was whether, in the healthy middle age individuals, the cerebellar vermis and its lobules show different height and width measurements in the males and the females.

Results and discussion: The results revealed that there is a strong significant difference in which the males' vermis is larger than the females' in this specific sectional MRI study. Moreover, these results might help to address controversies in the study of sexual dimorphisms and asymmetric patterns in human cerebellum.

Introduction

Human cerebellum is the second largest structure attributed to the brain located in the posterior cranial fossa (1). It consists of a tightly folded and crumpled layer of cortex, with white matter underneath (arbor vitea), several deep nuclei embedded in the white matter, and a fluid-filled ventricle in the middle. It has portion of the brainstem called the pons in front of it and separated from the overlying cerebrum by a layer of leathery dura mater called tentorium cerebelli (2, 3). Like the cerebral cortex, the cerebellum is divided into two hemispheres and contains a narrow midline zone called the vermis. A set of large folds are conventionally used to divide the overall structure into ten smaller "lobules". The vermis receives fibres from the trunk and proximal portions of limbs (4, 5). Structural sexual dimorphism and asymmetry in human cerebellum have been described in previous researches, but results remain inconclusive or even conflicting. Biological and behavioral differences between genders are widely recognized, and a large number of postmortem anatomical and in vivo morphological studies on sexual dimorphisms have been dedicated to the human brain (6). Thus far, the reported findings about gender-related cerebellar differences in postmortem anatomical or magnetic resonance imaging (MRI) studies are anatomically unspecific and inconsistent. So the effect of gender pattern is still in a state of dispute for not only the cerebellum taken in its entirety but also taken regionally; those issues need to be further explored (7). The purpose of the present study is not only to assess the gender-related morphological differences in the cerebellar vermis, but to provide a more objective and re-evaluation of the anatomical organization in the human cerebellum.

Materials and Methods

This study was carried out during the period from March 2011 till July 2012. Eighty cases were included in the present study: 40 males and 40 females. They were apparently middle age healthy normal individuals ranging from 35-50 years old attended the Radiology Department of Tikrit Teaching Hospital; send to take Brain Magnatic Resonance Imaging (MRI) and appeared to be normal. MRI Phillips machine 1.5 Tessla closed type took the anatomical images which were acquired routinely with 1 mm3 resolution slice thickness and optimal contrast using specially tailored sequences (8). To reach the exact image of the Cerebellum with no tilting; the Midsagittal section of the brain was seen at first in which the Cerebral aqueduct is obviously seen running vertically between the third and fourth ventricles and at that level the Cerebeller image is clearly identified as the vermis (anterior vermis, posterior vermis and the declive, folium and tuber lobules are in between) (9, 10) (Figure 1). The width and height measurements of the Cerebellum were measured manually in millimeters on these exact image slices on the MRI Philips DICOM Viewer R2.5. The values for each measurement were described by the mean ± standard deviation.

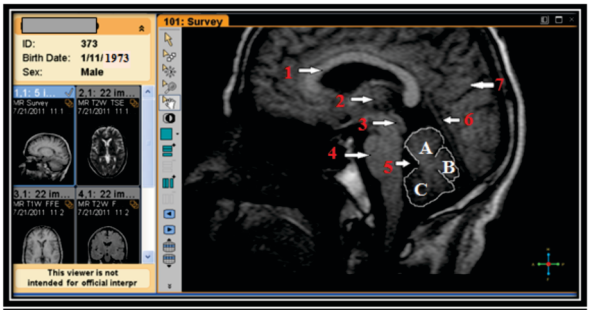


Figure (1) Brain MRI image in midsagittal view showing the vermis of Cerebellum with its lobules and relations. (A: anterior vermis; B: declive, folium and tuber; C: posterior vermis; 1: corpus collosum; 2: third ventricle; 3: cerebral aqueduct; 4: ventral pons; 5: fourth ventricle; 6: tentorium cerebelli; 7: cerebrum).

Result

The calculated measurements on the image sections were classified into males and females (Figure 2 & 3).Then the minimum, maximum, mean values with their standard deviations and P values of the cerebellar vermis height and width were calculated as shown in Table (1). The data was also plotted in point value graphic presentations for the both parameters revealing that the males had higher measurement values than the females (Graph 1 & 2). Statistically P values of both the height and width parameters were less than 0.05. So in the present MRI study there was a strong significant difference in which in middle age groups; the males' vermis is larger than the females'.

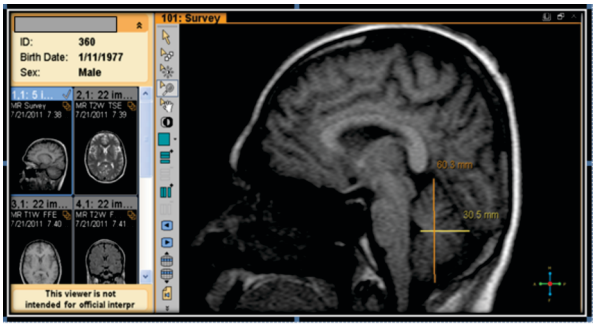


Figure (2) Brain MRI image of middle age Male with Cerebellar measurements.

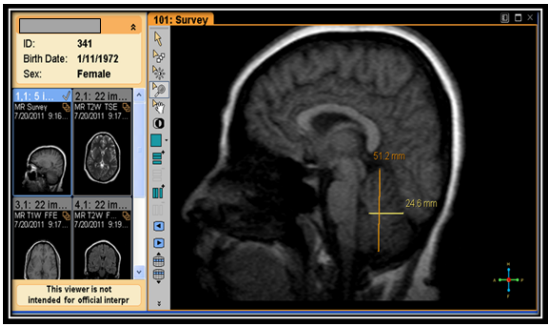
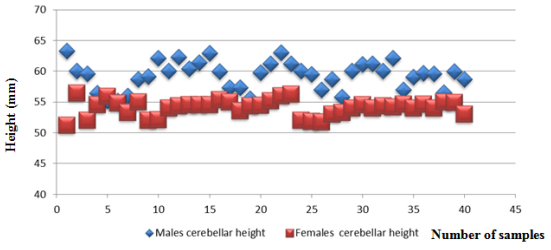


Figure (3) Brain MRI image of middle age Female with Cerebellar measurements.

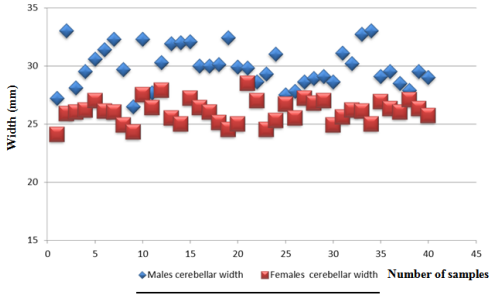
Table (1) Cerebellar measurement values at the vermis region in males and females.

Measurement	Gender	Minimum	Maximum	Mean ± sd	P value
Height (mm)	♂*	55.6	63.1	59.3 ± 2.3	0.005***
	♂*	51.2	56.4	54.0 ± 1.3	
Width (mm)	♂	27.2	33.0	29.9 ± 1.7	0.001***
	♀	24.3	28.7	26.0 ± 1.0	

* ♂: Male ** ♀: Female *** Significant difference because P value is less than 0.05.



Graph (1) Point value presentation of the Cerebellar height at the vermis region of males and females.



Graph (2) Point value presentation of the Cerebellar width at the vermis region of males and females.

Discussion

In this study, gender differences in regional cerebellum morphometric measurements were estimated in an age-matched individuals. These differences in cerebellar neuroanatomy have been observed in several studies. In gross anatomy samples, in comparison to women, men had larger cerebellar hemispheres, cerebellar vermis, anterior vermis (5, 7, 11). By using neuroimaging techniques, many studies have shown that men had larger cerebellar hemispheres, cerebellar vermis, as compared with women approved by Chung et al.(12) Escalona et al.(13), Filipek et al.(14) Luft et al.(15), Raz et al.(16,17). Regarding the cerebellar vermis this was agreed with the present study. However, the differences do not always favor men. One report suggested that women might show steeper age-related decline in the area of the vermis than do their male counterparts (11). In another study, women evidenced greater volume of medial cerebellar hemisphere after adjustment for the total cerebellar size (9).

The results in the present study might be explained by some researchers who speculated that sexual dimorphism in cerebellar size can be attributed to the effects of sex hormones although empirical support for that supposition is still lacking (10, 12). We have no data to strengthen or negate these speculations. Also the cerebellar grey matter volume was significantly larger in the anterior and posterior lobes of male group and in an earlier postmortem morphologic study the researchers reported that the total number of Purkinje cells in the male was 6–8% higher than in the female (18, 19); these might explain the results in this study. Conversely, in another MRI study, women evidenced a higher proportion of cerebellar grey matter after adjustment for brain size as mentioned by Hutchinson et al.(20). However, Henery and Mayhew (21) study reported no significant gender interaction effects involving the cerebellum. Nevertheless, Luft et al. (15), Nopoulos et al., (22) Szabo et al. (23) studies reported no gender difference in cerebellar volume when the volume was corrected by brain size. Several previous studies concluded that the gender differences in human behavior and function were probably accompanied by a biologically unusual targeted enlargement of related regions. Such alterations in the neural tissue volumes between the genders may contribute to the gender related differences in facilitating an efficient processing of information transformation during motor or cognitive abilities (18). For instance, Gur et al. (24) reported that men had relatively higher metabolism than women in the cerebellum when at rest. The neurobiological underpinnings of the gender effects on cerebellum remain unclear. It has been suggested that the hormonal effects, such as neurosteroids via estrogen and progesterone receptors could be responsible for the gender differences of cerebellar function and development formation as said by Dean and McCarthy (25) Perez et al. (26) and Tsutsui (19). In another functional MRI study, men exhibited more cerebellar activation than women when both were trying to perform a task involving remembering specific pitches proved by Gaab et al. (27). However, Hantz et al. (28), Kansaku et al. (29), Sanders and Wenmoth (30) mentioned that the correspondence between anatomical landmarks and functional areas within the cerebellum is poorly understood, and gender effects on specific cerebellar functions have not been examined. Furthermore, gender-related asymmetric cerebellar activation patterns were observed during various emotions in previous studies. Men showed significantly increased blood flow compared to women in the left cerebellum and cerebellar vermis during positive and negative mood induction as reported by Hofer et al. (31).

However, more precise structure–function relationships in human cerebellum still needed to be clarified in future research. Thus, to a clinician, volumetric examination of the brain in general and of the posterior fossa in particular, brings no benefits beyond heightening the awareness of individual differences associated with the gender of the patient.

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