ORIGINAL ARTICLE

ESTIMATION OF PITUITARY GLAND VOLUME BY MAGNETIC RESONANCE IMAGING AND ITS CORRELATION WITH SEX AND AGE

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ABSTRACT

OBJECTIVE: To determine measurements of pituitary gland volume in subjects with normal pituitary gland ages 10 to 70 years presenting at Radiology department, Ziauddin hospital, Clifton, Karachi. **METHODS:** Total 290 subjects of different age groups with normal pituitary gland volume were evaluated using T1weighted Magnetic Resonance Imaging. Mid-sagittal and coronal planes were used to measure the height, width, and depth of the pituitary gland, while the volume was calculated using these parameters. Data was stratified into nine groups on the basis of age and sex to observe the differences. **RESULTS:** We recruited 290 subjects (152 males, 138 females). Females had significantly greater pituitary width and volume compared to males. The height of the gland was minimum (0.53 cm) in first decade of life, maximum (0.60 cm) in the second decade and progressively decreased till the sixth decade. The volume of the gland was least in the first decade of life (0.36 ± 0.11cm^3) and maximum in the third decade (0.49 ± 0.111cm^3). **CONCLUSION:** We have provided reference values for the normal pituitary gland dimensions in a population of Karachi which will aid in assessment and diagnosis of patients with abnormalities in pituitary function.

Introduction

Belgian scientist Andreas Vesalius in 1543 for the first time described the normal anatomy of pituitary gland.[1] Pituitary gland is the master endocrine gland of human body.[2] It controls other glands and secretes important hormones.[3] The gland is located at the base of skull in the sella turcica which is a concavity within the sphenoid bone. It is inferiorly related to the hypothalamus and optic chiasm. In conventional radiography, increase in the size of the sella turcica is considered to be indicative of enlargement of the gland. However, this would be misleading as the superior surface of the gland could either be flat, concave, or convex, depending on the hormonal status, age, sex, and even race of the individual.[3]

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Magnetic Resonance Imaging (MRI)is safer than computed tomography scan and conventional radiographs as it does not use any harmful ionizing radiations.[4] It allows detailed visualization of the anterior and posterior lobes, pituitary infundibulum, optic chiasma, and other parasellar structures. The coronal image is considered to be the best single view for imaging the pituitary gland, while the sagittal image is best to assesses the relationship with midline structures.[5] Various studies for the evaluation of size and shape of the pituitary gland indicate variations due to by age, sex, and hormonal environment.[6,7]
The volume of the gland changes according to the hormonal status of the individual. Usually, young adults have larger glands.[3,8] Hormonally active states such as puberty and pregnancy results in increase

in the volume of the gland. Younger people have a upper border that is convex and a fossa that is completely filled, whereas older people will have a pituitary fossae that are largely empty. In children who are younger than 12 years, the maximum height of the gland is 6 mm. The upper border of the gland is either flat or slightly concave. At puberty, the height increases up to10 mm with the upper surface convex. Young adult male and females have a reported height of 8 mm and 9 mm respectively. In pregnancy the gland may be as high as 12 mm.[8]

In literature, he maximum height of pituitary gland is reported in the third decade of life.[9] However some researchers report that this is achieved earlier in second decade of life.[9,10] This could be due to difference in onset of puberty and variations in the degree of hormonal activity specially gonadotropins.[11]

Patients and Methods

This study was conducted at the Department of Radiology, Ziauddin University Hospital, Clifton Campus, Karachi. Study design was cross-sectional.

290 patients between age groups10 to 70 years with no history of neuroendocrine or neuropsychiatric disease and who had normal pituitary gland on brain MRI scan were included in the study. Patients with congenital craniofacial anomalies, suspected or diagnosed cases of hormonal imbalance, patients with epilepsy, pregnant females, females with postpartum period of < 6 months, patients using drugs that affect pituitary size and shape were excluded from the study. Patients with a history of craniofacial trauma, surgery or evidence of intracranial mass-occupying lesion also exclude from this study. Sampling duration was six months.

290 subjects fulfilling the inclusion criteria in the age range 10 - 70 years were recruited. They were examined on 1.5T MR scanner (AvantoMagnetom with Tim Dot Technology). T1-weighted spin echo sagittal images were acquired with time to repeat (TR) = 365-428 ms and time to echo (TE) = 9-15 ms. Coronal images were acquired using TR = 420-530 ms and TE = 13 ms. All images were taken at 2 or 3 mm slice thickness and constructed on a 512 × 256 matrix with a field of view of 23 cm.

Pituitary gland dimensions were taken as the maximum distance (in cm) between two surfaces (lateral and superoinferior surfaces) using the in-built electronic calipers provided by the software. The pituitary height and depth were measured from the sagittal plane, using a midline image at a section where the cerebral aqueduct was visible (Fig. 1), while the pituitary gland width was measured from the coronal plane, at a section where the pituitary stalk was visible. The pituitary volume (cm^3) was obtained by multiplying the height (H) by depth (D) by width (W) by 0.52. The factor 0.52 was derived from sphere volume equation coefficient and cubic volume calculation.[12]

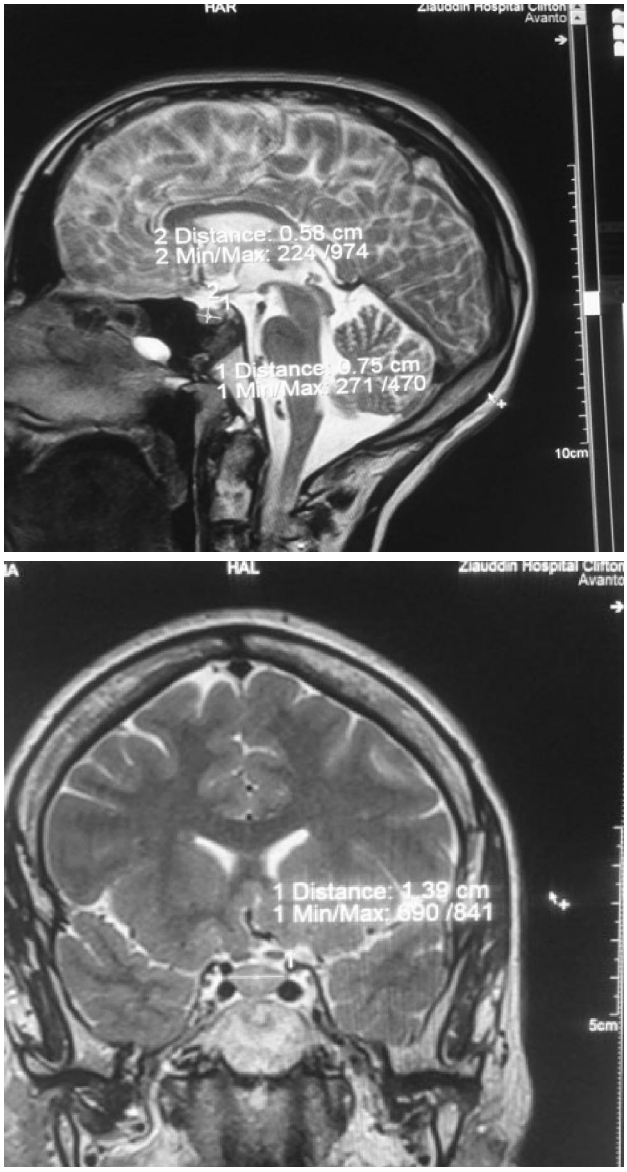

Figure 1

Statistical analysis

SPSS software version 20 was used. The patients were stratified on the bases of age and sex. Quantitative data was expressed as means and standard deviation and illustrated using tables and graphs. The relationship between pituitary gland dimensions with age quartiles and gender was evaluated using the Student's *t*-test. P-value less than 0.05 was considered to indicate statistically significant difference.

Results

In our study sample, out of the 290 subjects,152 were males and 138 were females. The youngest subject was 10 year and oldest was 70 year. They were stratified into age quartiles with an interval of 10 years. (Tab. 1)

Age Quartiles (Years)	Females N (%)	Males N (%)	Total N (%)
10-20	19 (13.77)	22 (14.47)	41 (14)
21-30	14 (10.14)	15 (9.87)	29 (10)
31-40	33 (23.91)	15 (9.87)	48 (16.55)
41-50	21 (15.22)	24 (15.79)	45 (15.52)
51-60	23 (16.66)	27 (17.76)	50 (17.24)
61-70	28 (20.29)	49 (32.23)	77 (26.55)
Total	**138**	**152**	**290**

Table 1: Age and sex distribution of patients

The mean height, width and depth of the pituitary gland were 0.57 cm, 1.31 cm and 1.24 cm respectively. Using these values, the calculated mean volume of the gland was 0.45 cm^3. (Tab. 2)

There was no significant difference between the height and depth of the pituitary gland between the two genders. However, females had a significantly (p=0.03) greater width and a significantly (p=0.001) greater volume of the gland compared to males. (Tab. 2).

Pituitary dimension	Total Mean±SD	Males Mean±SD	Females Mean±SD	P value
Height (cm)	0.57±0.072	0.56±0.074	0.58±0.067	0.72
Width (cm)	1.31±0.193	1.28±0.185	1.33±0.199	0.03*
Depth (cm)	1.24±0.228	1.21±0.226	1.25±0.221	0.15
Volume (cm^3)	0.45±0.115	0.43±0.102	0.47±0.123	0.001*

*Indicates significance p<0.05

Table 2: Pituitary height, width, depth and volume in different genders

The height of the gland increased from 0.53 cm in first decade of life to 0.60 cm in the second decade and progressively decreased to 0.55 cm in the sixth decade. The volume of the gland was least in the first decade of life (0.36 ± 0.11 cm^3) and maximum in the third decade (0.49 ± 0.111 cm^3). (Tab. 3)

Age Group	Pituitary height (cm)			Pituitary volume (cm^3)		
	Males	Females	Total	Males	Females	Total
10-20	0.53±0.085	0.53±0.081	0.53±0.082	0.34±0.123	0.37±0.099	0.36±0.11
21-30	0.58±0.081	0.62±0.026	0.60±0.064	0.428±0.11	0.50±0.082	0.46±0.103
31-40	0.57±0.68	0.59±0.57	0.58±0.06	0.45±0.90	0.50±0.11	0.49±0.111
41-50	0.58±0.071	0.57±0.084	0.57±0.077	0.45±0.125	0.45±0.143	0.44±0.133
51-60	0.59±0.60	0.58±.059	0.59±0.598	0.46±0.072	0.500±0.09	0.48±0.084
61-70	0.54±0.070	0.57±0.56	0.55±0.066	0.43±0.77	0.51±0.12	0.46±0.106

Table 3: Pituitary height and volume in age quartiles

Discussion

Despite its small size the pituitary gland plays a major rolein neuroendocrine regulation. Evaluation of pituitary height and volume is of great diagnostic and prognostic significance. We found that mean pituitary height in our population was 0.57 ± 0.072 cm (Tab. 2). Similar results have been reported by Denk et al (0.57 ± 0.02 cm)[9] and Naiket al (0.58 cm).[13] Lower height has been reported by Tsunoda et al (0.53 ± 0.12 cm)[14] whereas greater height has been reported by Ibinaiye et al (0.64cm)[15] and Ikram et al (0.63 ± 0.14 cm).[6]

The mean pituitary volume in our population was 0.45 ± 0.115 cm^3 (Tab. 2). Tsunoda et al (0.49 ± 0.10 cm^3)[14] have also reported pituitary volume in this range. Lower volumes have been reported by Ibinaiye et al (0.33cm^3)[15] whereas greater volumes have been reported by Naiket al, (0.54 cm^3),[13] Denk et al (0.56 ± 0.02 cm^3)[9] and Ikram et al (0.59 ± 0.1 cm^3).[6]

We found that the mean width and volume of pituitary gland was statistically greater in females than males, however the mean pituitary height and depth did not statistically differ between the genders.(Tab. 2). Furthermore, the difference is more stark in younger age groups. (Tab. 3). Lamichhane et al[16] and Naiket al[13] have also reported similar findings. This could be because of early puberty and adolescence in females as compared to males as suggested by Mc Master et al.[17]

The height of the gland increased from 0.53 cm in first decade of life to 0.60 cm in the second decade

and progressively decreased to 0.55 cm in the sixth decade. The volume of the gland was least in the first decade of life (0.36 ± 0.11cm^3) and maximum in the third decade (0.49 ± 0.111cm^3) with greater volumes in females. (Tab. 3). Ibinaiye et al[15] reported that the gland attained peak height and volume in the third decade, with higher values in males. Thereafter, the height and volume declined steadily and the lowest levels were recorded after the seventh decade. Lamichhane et al[16] reported that the largest volume among males was 0.49 cm^3 ± 0.23 cm^3 in the fifth decade quartile and in females the largest pituitary volume 0.52 ± 2.22 cm^3 was in the fourth decade quartile.

We have observed that among the four parameters that we studied in relation to the pituitary gland, pituitary height changed most remarkably with respect to age and sex. This is in partial agreement with the opinion that mid-sagittal height of the pituitary gland accurately indicates variations in structure of the pituitary gland.[18-20] Minor variations reported in literature regarding the height, width, depth and volume and their relationship with gender and age progression could be due to geographical variations in genetics, diet and hormonal factors.

Limitations

Our study is limited by selection bias due to the fact that the high cost of the examination did not permit us to study normal volunteers. Hence, patients with other conditions, but without clinical or imaging evidence of neuroendocrine or neuropsychiatric pathology were selected. The non-availability of 3D software in our center might have affected the accuracy of our measurements. As suggested by Lurie SN et al,[21] we also recommend using 3D volumetry for measuring pituitary sizes in future studies with a greater sample size.

Conclusion

Our study points to gender and age related variation in pituitary dimensions. We have reported reference values for the normal pituitary gland dimensions in our population which will aid in assessment and diagnosis of patients with structural and functional abnormalities of the pituitary gland.

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