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# PITUITARY GLAND VOLUME ON MAGNETIC RESONANCE IMAGING: NORMATIVE OBSERVATIONS

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## ABSTRACT

**Objective:** The purpose of this study was to determine the normal range of pituitary gland volume in Pakistani individuals aged 30 or younger. **Methods:** A total of 220 subjects aged 30 years with normal pituitary morphology were evaluated by using T2 weighted Magnetic Resonance (MR) Imaging. Pituitary height (PH), width (PW), and length (PL) were observed. Pituitary volume (PV) was calculated using the formula for volume of an ellipsoid. Data were classified by gender and stratified into three age groups. **Results:** PV increased gradually to a peak in the second decade of life in females ( $316 \pm 126$  mm<sup>3</sup>, n = 43) and in the third decade of life in males ( $309 \pm 117$  mm<sup>3</sup>, n = 41). Significant difference was observed in PV within the different age groups in both genders. **Conclusion:** This study determines the measurements of normal pituitary volume in a selected population of Pakistan. These values are comparable with those obtained in other countries.

With recent advancements, Magnetic Resonance (MR) imaging has become the modality of choice for visualizing intracranial structures such as the sellar and parasellar regions.<sup>1,2</sup> While visualizing intracranial structures on MR in different age groups, dynamic changes have been reported in the size, shape and signal intensity of the pituitary gland, which reflects changes in the complex hormonal environment of this gland. These changes are more significant in females.<sup>3-8</sup> Measurements of pituitary gland for various age ranges with different thickness of imaging slice have been published. The majority of these reports have focused on pituitary height. A few authors have presented data on pituitary volume, and these studies have shown a considerable variation in the mean pituitary volume.<sup>5,9-12</sup>

The Growth Hormone Research Society in their summary statement in 2000 highlighted the importance of pituitary height and volume in the diagnosis of growth hormone deficiency. The statement also identified the requirement of more normative data for improving the quality of diagnosis.<sup>2</sup> The purpose of our study was to analyze age- and sex-related changes in pituitary morphology in a selected sample drawn from Karachi, Pakistan's largest city. To the best of our knowledge, normative data for pituitary gland size is not available for the South Asian population. We determined measurements of pituitary

volume in individuals aged 30 years who had no history to suggest pituitary dysfunction.

## METHODS

This cross-sectional study was conducted at the department of radiology in Ziauddin University Hospital (North Nazimabad campus), Karachi. All 30 year old patients who were referred for full cranial MR study during July 14, 2004 to July 13, 2005 and consented for the study were included in this study. The following patients were excluded: all suspected or diagnosed cases of hormonal imbalance, epilepsy, and hydrocephalus; females who were pregnant or had delivered within the last 6 months; patients using hormonal preparations or drugs that could possibly affect pituitary morphology. Patients with a past history of intracranial surgery or currently having any intracranial space-occupying lesion were also excluded from the study.<sup>7,13</sup>

All patients were examined on a 1.0 T scanner of Siemens Harmony Magnetom. MR console was loaded with Syngo MR 2002A software. T2 weighted sagittal spin echo sequences with (3850-5240 / 95-116) (repetition time / echo time) were applied to obtain images. T2 weighted coronal images were also taken using the same protocol.

All images were taken on 4 mm thick slices that were then constructed on a 512 x 256 matrix.

Sagittal sections with visible cerebral aqueduct were taken for the measurement of pituitary height (PH) and pituitary length (PL). Coronal images with visible pituitary stalk were taken for measurement of pituitary width (PW). All measurements were taken as the maximum distance between two surfaces by using calipers provided with the installed software. Values were recorded in millimeters (mm). PV was calculated by using the formula for volume calculation of an ellipsoid:<sup>10</sup>

$$PV = PH \times PW \times PL \times \frac{4}{3}$$

Data analysis was done on the computer package SPSS (Statistical Package for Social Sciences) version 10.0. All variables are reported as mean  $\pm$  standard deviation. Student t-test and ANOVA were used to compare the means between different groups. A p-value of  $< 0.05$  was considered to be statistically significant.

## RESULTS

A total of 264 cases were recruited for this study, of which 44 were excluded based on the specified criteria. In the 220 included cases, 129 (57%) were male and 91 (43%) were female. As shown in Table 1, the data were stratified into three age groups for both males and females.

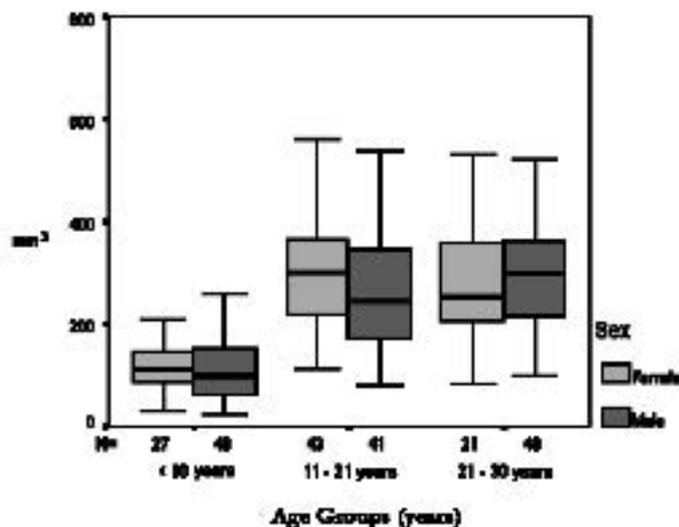


Figure 1: Box plot showing mean pituitary volume in different age groups by gender

Figure 1 shows the distribution of pituitary volume in the three age groups by gender. Mean PV in the first decade of life for females was  $128 \pm 73$  mm<sup>3</sup>, compared with  $116 \pm 62$  mm<sup>3</sup> in the first decade of life for males ( $p = 0.491$ ). In the second decade of life, mean PV was  $316 \pm 126$  mm<sup>3</sup> in females and  $268 \pm 118$  mm<sup>3</sup> in males ( $p = 0.079$ ). In the third decade of life, mean PV in females was  $298 \pm 117$  mm<sup>3</sup>, compared with  $309 \pm 117$  mm<sup>3</sup> in males ( $p = 0.731$ ).

TABLE 1

### Mean Pituitary Volume in different age groups

|   | Male<br>n=129       | Female<br>n=91      | p value*<br>(within age group between genders) |
|---|---------------------|---------------------|--|
| 10 years<br>n=75                                | 116 $\pm$ 62<br>48  | 128 $\pm$ 73<br>27  | 0.491  |
| 11-20 years<br>n=83                             | 268 $\pm$ 118<br>40 | 316 $\pm$ 126<br>43 | 0.079  |
| 21-30 years<br>n=62                             | 309 $\pm$ 117<br>41 | 298 $\pm$ 117<br>21 | 0.731  |
| p value**<br>(within gender between age groups) | <0.001              | 0.001               |  |

All values are in mm<sup>3</sup>

\* Student's test

\*\* ANOVA

When mean PV in different age groups were compared by using ANOVA, a significant difference across age strata was observed both in males ( $p < 0.001$ ) and in females ( $p < 0.001$ ). The highest volume of the gland in females was observed in the second decade ( $316 \pm 126 \text{ mm}^3$ ), while it was achieved in males in the third decade ( $309 \pm 117 \text{ mm}^3$ ). When the data was further stratified into groups of 5 years, PV was found to be highest in the 16 - 20 year old age group of females ( $358 \pm 102$ ,  $n = 21$ ) and in the 21 - 25 year old age group in males ( $337 \pm 103$ ,  $n = 20$ ).

## DISCUSSION

The Growth Hormone Research Society has identified the need for more normative data on pituitary size.<sup>2</sup> In this study we have reported the range of normal pituitary volume in the 30 year old population.

We found that pituitary volume (PV) followed the same morphological growth pattern that is reported for pituitary height (PH) except during the first two months of life. When the means of PV in the different age groups were compared, no significant gender difference was observed. This finding is in agreement with published data.<sup>11,12</sup> We found that the maximum volume of the gland was achieved in the second decade of life for females and third decade for males. When the data were stratified further into groups of five years each, we found that in females, the maximum volume was achieved in the 16 - 20 year group and in males in the 21 - 25 year old age group.

Increased secretion of lutenizing hormone (LH) and follicle stimulating hormone (FSH) is the main cause of increased volume of the pituitary gland at puberty.<sup>14</sup> Levels of both hormones are reported to be higher in this age group. Peak height velocity (PHV), which is an important determinant of pubertal development, is achieved five years earlier in females as compared with males. This fact may more precisely explain the early achievement of the maximum volume of the gland in the female as compared to males. Other reasons for early achievement of peak pituitary volume in females are speculative, and more data are required before a conclusion can be reached.

No significant gender difference was observed in the first and the third decade. However, in the second decade of life, females were found to have higher values of PV, which was marginally significant ( $p = 0.079$ ). A significant difference between different age groups was observed in males ( $p < 0.001$ ) and females ( $p = 0.001$ ).

While comparing these findings with the limited published data, significant differences have been observed. Values of PV reported by Fink et al<sup>11</sup> and Takano et al<sup>12</sup> are significantly higher than our values for PV. Both studies used direct 3D volumetric measuring. Values reported by Terano et al<sup>5</sup> are still higher than our values for PV, but the difference is not large. Values reported by Sharafuddin et al<sup>10</sup>, while using the same formula that we have used, are in close agreement with our values, but the sample size in that study ( $n = 15$ ) is smaller.

## CONCLUSION

This study determines the normal volume of the pituitary gland in males and females aged 30 years or less. This information can serve as an important diagnostic parameter for the evaluation of pituitary pathologies. Values provided by this Pakistani study are in agreement with the published literature, but certain differences are also evident.

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