Original article:

Quantitative Determination of Normal Anterior Pituitary Gland Dimensions in North Indian Population by Magnetic Resonance Imaging (MRI)

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Abstract

Objectives: To determine the dimensions heights and volumes of normal anterior pituitary gland using Magnetic resonance images (MRI) and to assess their variation with age and sex.

Material and methods: This prospective study was done in a tertiary care teaching hospital in North India consisting of 100 subjects with no clinical evidence of Hypothalamic-pituitary related disease and whose MRI examination was normal. Subjects with confounding factors such as pregnancy, breastfeeding, or on exogenous hormone therapy that might affect the pituitary volumes were excluded from the study.

Results: The mean pituitary volume of all the subjects was 231.9 mm^3 and in males and females it was 219.3 mm^3 and 244.5 mm^3 respectively, whereas the mean anterior pituitary height mean anterior pituitary height for all subjects was 7.7±2.60 mm while it was 7.73± 2.70 mm and 7.70 ± 2.56 mm in males and females respectively, however no statistically significant difference was seen between the two sexes ($p>0.05$).

Conclusion: Normal pituitary gland dimensions may be used for research purposes and as a reference standard to evaluate Pituitary pathologies in Indian population.

Keywords: MRI, Pituitary, volume, height, anterior, normal

Introduction

Magnetic Resonance Imaging (MRI) is the modality of choice for imaging of pituitary gland because of its multiplanar ability and outstanding soft tissue resolution. It permits comprehensive visualization of the anterior and posterior lobes, pituitary infundibulum, optic chiasma, and other parasellar structures. The pituitary gland, or hypophysis, is a tiny endocrine gland and is found in the sella turcica of sphenoid bone [1]. The pituitary gland is comprised of two anatomically and functionally different lobes: the anterior lobe (adenohypophysis) and the posterior lobe (neurohypophysis). The anterior

lobe of pituitary is isointense to cerebral cortex on both T1-weighted and T2-weighted images [2]. The posterior lobe appears as a hyperintense spot on T1-weighted images [3]. High signal intensity of the posterior pituitary lobe is due to neurosecretory vesicles [4]. In animals, configuration of anterior and posterior pituitary is altered with the posterior pituitary being an extension of hypothalamus [5]. MRI of the pituitary is encouraged as part of the standard investigations to be done on patients with endocrinopathy. Nevertheless its common clinical use, detection of deviations in pituitary size can be hard, and radiological reports of pituitary gland size are commonly based upon subjective opinion. The size and shape of the normal pituitary gland vary substantially and are also influenced by age, sex, and hormonal environment. The dissimilarity in shape of the pituitary between persons means that any evaluation of its size will be bound by a high grade of inaccuracy unless a true volume is measured. In routine MRI reporting, radiologists commonly visually evaluate the shape and size of the pituitary gland which may occasionally be deceptive due to variations of pituitary gland dimensions established on the hormonal status, age, sex, and even race of the individual [6]. Therefore, there is a requirement for quantitative evaluation of the pituitary gland dimensions. There are limited studies on the normal range of pituitary gland volumes amongst Indian population in general [7]. The aim of our study was to ascertain a normal reference range for pituitary volumes based on volumetric MRI measurements in north Indian population.

Materials and Methods

This prospective study was carried out in a tertiary care teaching hospital in North India from February 2016 to February 2017 involving 100 subjects with no evidence of Hypothalamic-pituitary related disease clinically and whose MRI Brain examination was done for other reasons such as Headache, vertigo, migraine, seizures etc. Pregnant or breastfeeding women, patients with prior brain surgery, and those with clinically suspected abnormality of hypothalamic-pituitary axis and those on exogenous hormone therapy were omitted from our study. Meticulous history eliciting and general physical examination was carried out to exclude any of above-mentioned conditions. Informed consent was taken from the individuals for cranial MRI that was performed on a Magnetom Avanto 9 Channel 1.5 Tesla MR Machine (Siemens). High resolution Multiplanar T1 weighted MRI images were acquired with following parameters: Slice Thickness: 0.9 mm, Acquisition plane: Sagittal, coronal and axial, TR: 1180 milliseconds, TE: 4.4 milliseconds Flip Angle: 15 degrees, Matrix Size: 256x256 and FOV: 24x24 cm. Maximal anterior pituitary height (mm) was estimated from midline coronal images by calculating the maximum distance between the superior and inferior borders of the gland. Width (mm) and antero-posterior dimensions (mm) were likewise estimated by the greatest dimensions on the coronal and sagittal images respectively (Figure 1). Assessments of pituitary volume (PV, mm3) were derived from these measures using the ellipsoid [0.52xlength x width x height)] formulas. Means and two standard deviations of the pituitary heights and

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volume measurements were also estimated.

Results

A total of 100 patients (50 males and 50 females) were included in this study. The mean age of participants was 35.2 years with youngest of 12 years old male and oldest a 65 years old female. The data was divided into five age groups. Age group of 31-40 years comprised the maximum number of individuals (25) and included 9 males and 16 females (Table 1).

Table 1: Table showing age-groups of subjects

Age Groups (years)	Males (n)	Females (n)	Total subjects
11-20	**9**	**11**	**20**
21-30	**13**	**10**	**23**
31-40	**9**	**16**	**25**
41-50	**11**	**7**	**18**
51-60	**8**	**6**	**14**

The mean pituitary volume of all the subjects was 231.9 mm^3 and in males and females it was 219.3 mm^3 and 244.5 mm^3 respectively. Mean anterior pituitary gland volumes obtained in different age groups and sexes are depicted in figures 2, 3 and 4. The height of pituitary gland in different age groups and genders is depicted in figure 5.

The largest pituitary gland volumes were seen in age group of 40-50 years in males with a mean of 229.5 mm^3. However, in females, the largest pituitary glands were seen in 30-40 years age group with a mean of 286.3 cm^3. The elderly individuals aged more than 50 years showed the smallest pituitary glands in males with a mean of 193.6 mm^3 . In females smallest pituitary gland volumes was seen in females with volume of 213.3 mm^3 in 40-50 years age group. The mean anterior pituitary height for all subjects was 7.7±1.30 mm and in males and females it was 7.73± 1.35 mm and 7.70 ± 1.28 mm in males and females, respectively. Based on paired-'t'test values of significance, there was not enough evidence to conclude that the mean anterior pituitary heights and volumes of males and females (all age categories combined) differ at 0.05 level of significance ($p>0.05$).

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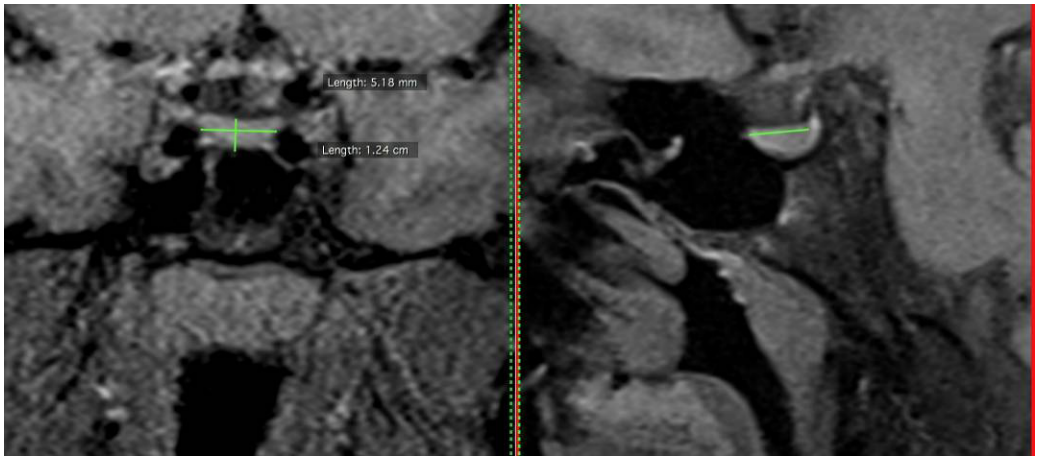

Figure 1 showing measurement of dimensions of anterior pituitary in coronal and sagittal planes on T1-weighted images.

Figure2

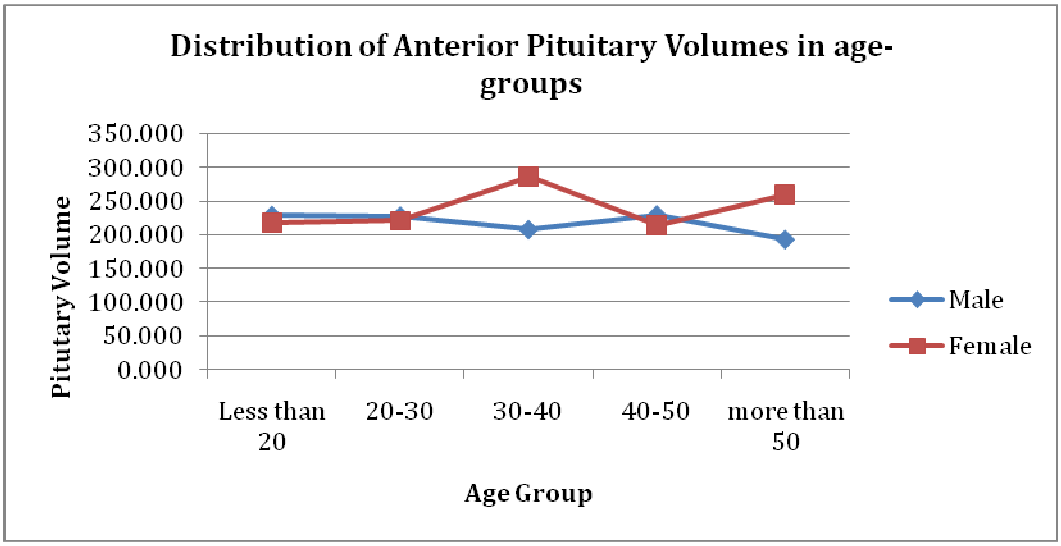

Figure 3

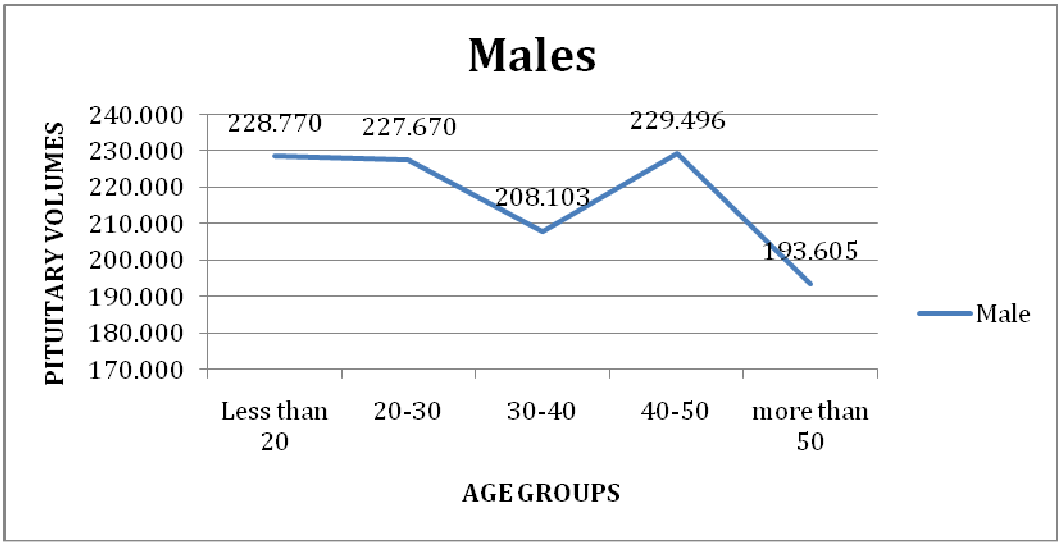

Figure 3 showing distribution of normal Pituitary volumes in male subjects.

Figure 4

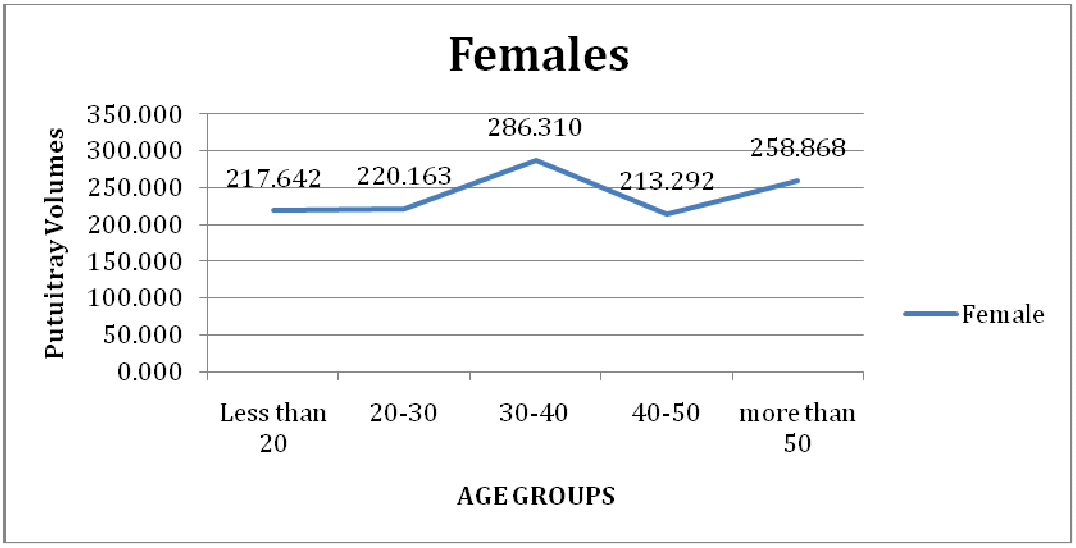

Figure 4 showing distribution of normal Pituitary volumes in female subjects.

Figure 5

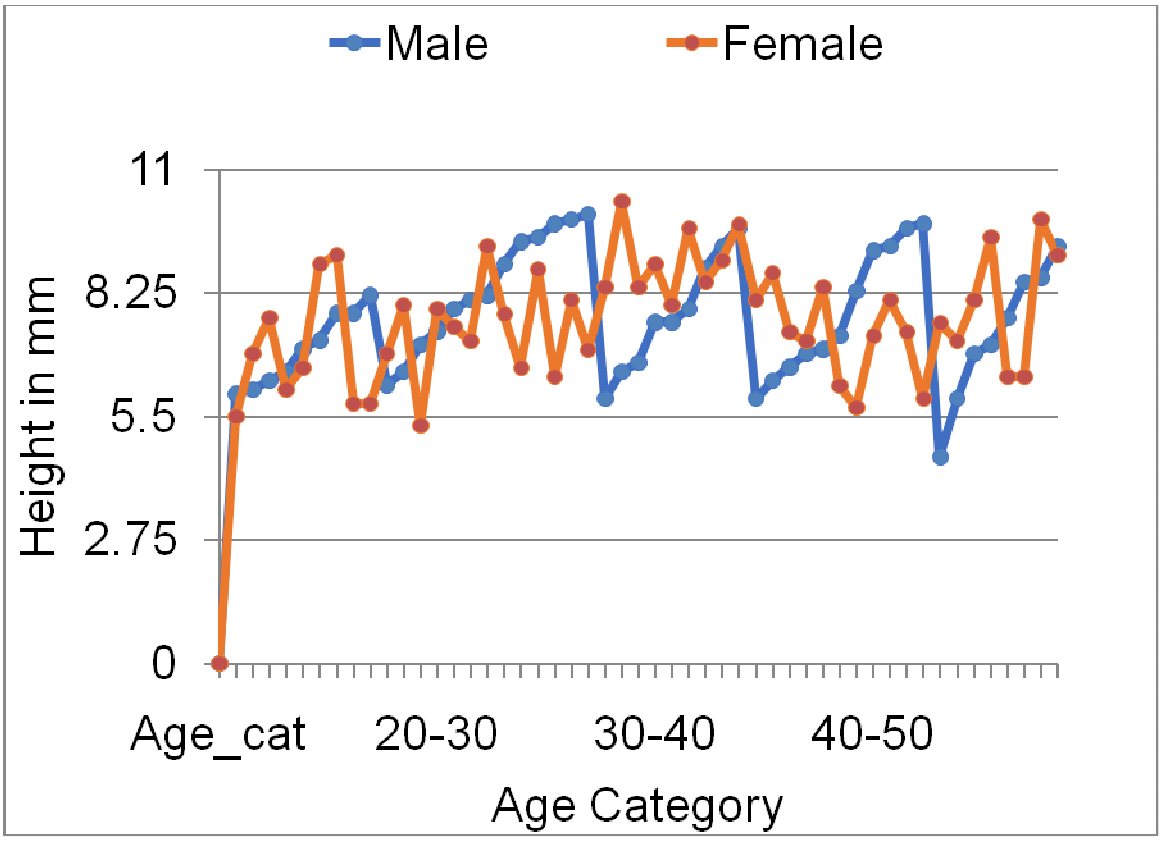

Figure 5 showing distribution of normal Pituitary heights in all subjects.

Discussion

In the current analysis, the anterior pituitary gland was outlined on sagittal and coronal images acquired by T1 weighted images employing thin slices. The volume of anterior pituitary gland was estimated by almost similar formula also used by Ibinaive PO et al [8] except coronal images were chosen for height measurements instead of Sagittal Images. The formula used in present study is as follows: Pituitary Gland Volume = 0.52xHeight (in Coronal Plane) x antero-posterior (in Sagittal Plane) x Width (in Coronal Plane).

In the present study, the mean anterior pituitary height for the subjects was 7.7mm±1.30 mm and the volume was 231.9 mm^3. The values for pituitary height in our study (7.73± 1.35 mm and 7.70 ± 1.28 mm in males and females, respectively) were however comparable to Ibinave et al (7.62 ± 2.0 mm and 7.81 ± 1.60 mm in males and females, respectively) but higher than those calculated in the studies by Faisal et al[11] (6.3 ± 1.4 mm and 5.9 ± 1 mm, respectively), Denk et al[12] (5.7 ± 0.2 mm and 5.6 ± 0.2 mm, respectively), Elster et al[13] and Tsunoda et al[14] (5.33 ± 1.2 mm and 4.93 ± 1.0 mm, respectively). These variations might be possibly due to the differences in the sample sizes and populations studied.

The pituitary volume in our present study appears to be less than the previous studies [7,8,11,12] as we have not included the posterior

pituitary bright spot in our calculations, which has been included in previous studies. It has been well-known that size of the pituitary gland alters with age. Some authors have documented sex differences in pituitary volumes with females having slightly larger glands [9,10]. We did not find a statistically significant difference in pituitary volumes between males and females in our study. Estimation of pituitary volumes in majority of the studies depend on indirect measurements of volume parameters, but few studies have performed volume measurements using three-dimensional MR volumetry which appears to be more accurate probably due to variations in shape of pituitary gland.[15] Our study is limited by small sample size and selection bias due to high cost of the examination, which did not permit us to study normal volunteers. Further, the non-availability of 3D software at our center might have affected the accuracy of our measurements.

Conclusion

This study provides reference values for the normal anterior pituitary gland dimensions that may be taken as reference standard for Indian subjects.

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