

Volumetric MRI Evaluation of Pituitary Gland in North Indian Subjects with Non-diseased Pituitary: Setting the Standards for Normative Data

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Abstract

Introduction

The pituitary gland, also called the master gland, was first described by a Belgian scientist Andreas Vesalius in 1543. Pituitary gland is the engine of normal human physiology and its size and volume changes normally during various physiological stages as well as in various pathological processes, so it becomes imperative to have a normal reference value for a particular population to differentiate the normal and pathological pituitary gland. It is a tiny endocrine gland and is found in sella turcica (meaning Turkish Saddle) of sphenoid.

Our study was designed to obtain standardized reference values for the volumes of pituitary gland among North Indian population to analyze the potential diagnostic values of pituitary gland volumetric variation with respect to age and gender. The volume of the pituitary gland was measured using a thin-section three-dimensional (3D) magnetic resonance imaging (MRI) with a section thickness of 1 mm.

Methods

The study was conducted between 2018-21 on patients with non-diseased pituitary by performing T1-multiplanar sequence and calculating pituitary volume by using Di chiro & Nelson formula. MRI was performed on a Siemens 3 Tesla MRI scanner unit. High resolution Multiplanar-T1 Weighted images were obtained with following parameters: Slice thickness: 1 mm, Acquisition plane: Sagittal & Coronal TR 1180 MS, TE 4.4 MS, Flip angle: 15 degrees, Matrix size: 256 × 256, FOV: 24 × 24 cm.

$$\text{Volume} = 0.52 \times \text{Depth in Sagittal Plane} \times \text{Height in Sagittal Plane} \times \text{Width in Coronal Plane}$$

Results

There were 152 patients included in the study. The mean age of participants was 43.50 years. Age group of 20-30 years comprised the maximum number of patient's. The overall mean pituitary volume was

277.96 mm³ and in males the mean pituitary was 267.74 mm³ while in females the mean volume was 288.74 mm³. The largest pituitary gland volumes were 401.94 mm³ and 369.86 mm³ in females and males respectively in 10–20-year group while 319.18 mm³ and 360.49 mm³ in females and males respectively in 20-30 years age group. Beyond 70 years and children age group less than 10 years showed the smallest pituitary. Mean pituitary depth was 9.40 mm. Mean pituitary width was 8.81 mm.

Keywords: Pituitary Volume, Magnetic Resonance Imaging, Growth Hormone Deficiency, Idiopathic Short Stature

Introduction

The pituitary gland also called master gland was first described by a Belgian scientist Andreas Vesalius in 1543. Pituitary gland is the engine of normal human physiology and its size and volume changes normally during various physiological stages as well as in various pathological processes, so it becomes imperative to have a normal reference value for a particular population to differentiate the normal and pathological pituitary gland. It is a tiny endocrine gland and is found in sella turcica (meaning Turkish Saddle) of sphenoid bone. The adult hypophysis measures approximately 10 mm in length, 10-15 mm in width, and about 5 mm in height. The volume of the pituitary gland decreases with aging. The pituitary gland is divided into two main lobes coming from separate embryological origins. The anterior lobe (adenohypophysis) arising from Rathke's pouch which originates rostral to the oropharyngeal membrane consists of the pars tuberalis, pars intermedia and pars distalis, pars distalis and neurohypophysis arising from the posterior wall of Rathke's pouch and may give rise to Rathke's Cleft Cysts (also known as pars intermedia cysts). Normal variation of the pituitary gland can occur. This is usually dependent upon the age and gender of the patient.

- A normal adult pituitary usually measures 8 mm or less
- A pediatric pituitary usually measures 6 mm or less in greatest height

During adolescence (puberty), postpartum or pregnancy, the pituitary can measure up to 10 mm and 12 mm respectively.

Preliminary evaluation of the Sella is almost always performed using magnetic resonance imaging (MRI). Although an MRI examination takes considerably longer than computed tomography (CT) (at least 20 minutes for MRI and perhaps up to 35–40 minutes depending on the sequences obtained, compared with 5 minutes for CT), MRI offers markedly better parenchymal definition than CT, uses no ionizing radiation, and may be acquired in any orthogonal or oblique plane. MRI is not prone to the beam hardening artifact from the surrounding sphenoid bone that is present on CT, but other artifacts can influence image quality, particularly metallic artifacts in dental braces or prostheses. Sequences obtained for MRI vary significantly by institution, and choice of sequences depend on the specific scanner hardware available, field strength, and radiologist preference. In general, scans are obtained to survey the gland and surrounding tissue adequately, with coverage in at least 2 planes. Thus, examinations might include sagittal and coronal T1-weighted and T2-weighted sequences, and gadolinium-enhanced sagittal and coronal T1-weighted sequences. Because sellar structures are so fine it is imperative to obtain thin-section images to limit the effects of partial volume averaging, a condition in

which two adjacent structures cannot be clearly resolved because they lie within the same slice. Traditional imaging at 1.5 T employed 2 or 3 mm scan thickness with little or no gap (10% or less) between sections. With advances in scanner technology, and with the growing popularity and prevalence of 3 T scanners, many centers now obtain 1 or 1.5 mm sections or even volumetric scans to assess the Sella.

Aim

The aim of the present study was to obtain standard reference values for the pituitary gland volumes of apparently normal subjects. The study was designed to obtain standardized reference values for the volumes of pituitary gland among North Indian population to analyze the potential diagnostic values of pituitary gland volumetry variation with respect to age and gender.

Material and Methods

The study was conducted between 2018-21 on patients with non-diseased pituitary by performing T1-multiplanar sequence and calculating pituitary volume by using Di Chiro & Nelson formula. MRI was performed on a Siemens 3 Tesla MRI scanner unit. High resolution Multiplanar-T1 Weighted images were obtained with following parameters: Slice thickness: 1 mm, Acquisition plane: Sagittal & Coronal TR 1180 ms , TE 4.4 ms , Flip angle: 15 degrees, Matrix size: 256 × 256, FOV 24 × 24 cm.

Volume = 0.52 × Depth in Sagittal Plane × Height in Sagittal Plane × Width in Coronal Plane. The volume of the pituitary gland was measured using a thin-section three-dimensional (3D) magnetic resonance imaging (MRI) with a section thickness of 1 mm.

A group of 152 patients aged between 5 and 92 years were recruited to obtain normal volumetry values of the pituitary gland. These individuals demonstrated no evidence of abnormalities to the central nervous or endocrine systems prior to the study. The student's t-test was used to evaluate the repetition test, while Pearson's correlation coefficient and regression analyses were performed to examine the correlations between the volume and height of the pituitary glands.

Indications for Performing MRI Brain

Indication	Number of Patients	Percentage
Headache	25	16.5%
Sudden Loss of Consciousness	22	14.4%
Vertigo	20	7.80%
Ischemic Stroke	20	13.1%
Migraine	12	7.80%
Vertigo	12	7.80%
Seizures	11	7.20%
Dementia	9	5.92%
Visual Deficit	7	4.60%
Suspicion of Metastasis	6	3.94%

Multiple Sclerosis	5	3.20%
Brain AVM	5	3.20%
CNS TB	5	3.20%
Meningoencephalitis	3	1.97%
Sudden Onset Facial Palsy	3	1.90%
Acoustic Neuroma	3	1.90%
Hearing Loss	2	1.31%
Transverse Myelitis	2	1.31%

Statistical Analysis

Statistical analysis was performed using SPSS software version 17.0 (SPSS, Inc., Chicago, IL, USA). $P < 0.05$ was considered to indicate a statistically significant difference. The normal range of the pituitary gland volumes was expressed as the mean \pm standard deviation. The student's t-test was used to evaluate the repetition test, while Pearson's correlation coefficient and regression analyses were performed to evaluate the correlations between the volume and height of the pituitary glands.

Results

There were 152 patients included in the study. The mean age of participants was 43.50 years. The youngest of them was a 5 years old female child and the oldest a 92 years old male. Age group of 20-30 years comprised the maximum number of patients and included 16 females and 10 males. The overall mean pituitary volume was 277.96 mm^3 and in males the mean pituitary was 267.74 mm^3 while in females the mean volume was 288.74 mm^3 . The largest pituitary gland volumes were observed between 10-20 and 20-30 years age groups with a mean of 401.94 mm^3 , and 369.86 mm^3 in females and males respectively in 10–20 years age group, while 319.18 mm^3 and 360.49 mm^3 in females and males respectively in 20-30 years age group. The elderly patients beyond 70 years and children age group less than 10 years showed the smallest pituitary glands in both genders with a mean of 164.94 mm^3 in the 70–80 years age group, and a mean volume of 158.45 mm^3 in the less than 10 years age group. Mean pituitary depth was 9.40 mm with a mean depth of 9.49 mm in females and 9.31 in males. Largest values for pituitary depth were observed in 20-30 and 30-40 years age groups for males while 10-20 and 20-30 years age groups for females. Mean pituitary width was 8.81 mm with a mean depth of 8.92 mm for females and 8.71 mm for males. Highest values for pituitary width were observed in 10-20 and 20-30 years age groups for females while 20–30 years age group for males.

Discussion

Variations in pituitary gland volumes with age and gender in North Indian population were studied in view of no significant data available. In the present study, the pituitary gland was traced by obtaining T1-multiplanar images and calculating the pituitary height and depth in sagittal planes while pituitary width was calculated in coronal plane.

The overall mean pituitary volume was 277.96 mm^3 and in males the mean pituitary was 267.74 mm^3 while in females the mean volume was 288.74 mm^3 . Mean pituitary gland volumes and standard deviations obtained in different age groups are depicted in Table 2. The largest pituitary gland volumes

were observed between 10-20 and 20-30 years age groups with a mean of 401.94 mm³ and 369.86 mm³ in females and males respectively in 10–20 years group while 319.18 mm³ and 360.49 mm³ in females and males respectively in 20-30 years age group. Not much of significant differences in pituitary volumes was observed between the two genders at the other age groups.

The elderly patients beyond 70 years and children age group less than 10 years showed the smallest pituitary glands in both genders with a mean of 164.94 mm³ in the 70–80 years age group and a mean volume of 158.45 mm³ in the less than 10 years age group.

Mean pituitary depth was 9.40 mm with a mean depth of 9.49 mm in females and 9.31 in males. Largest values for pituitary depth were observed in 20-30 and 30-40 years age groups for males while 10-20 and 20-30 years age groups for females.

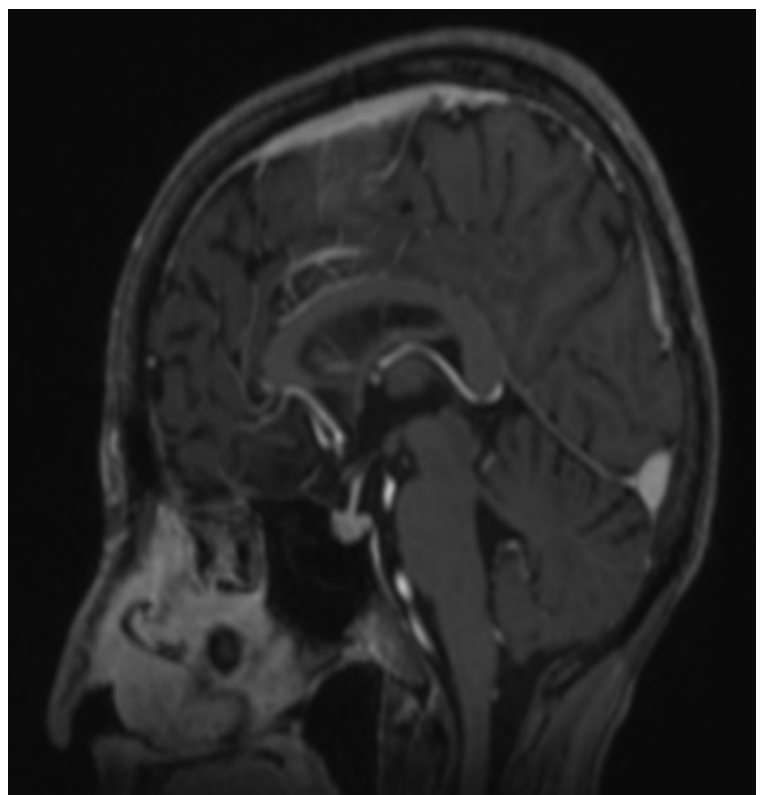
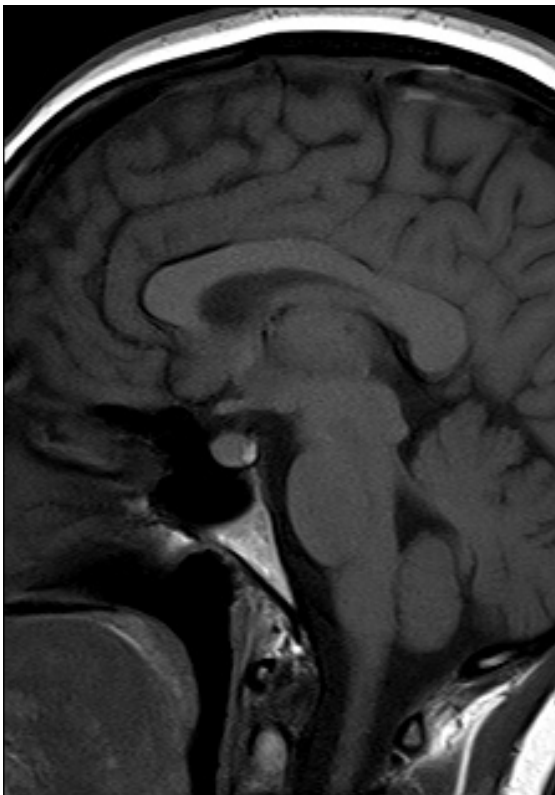
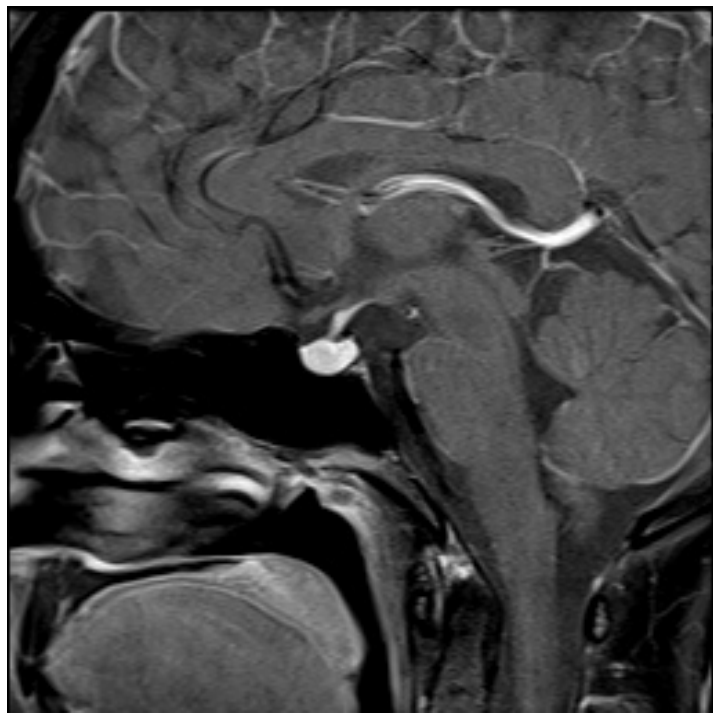
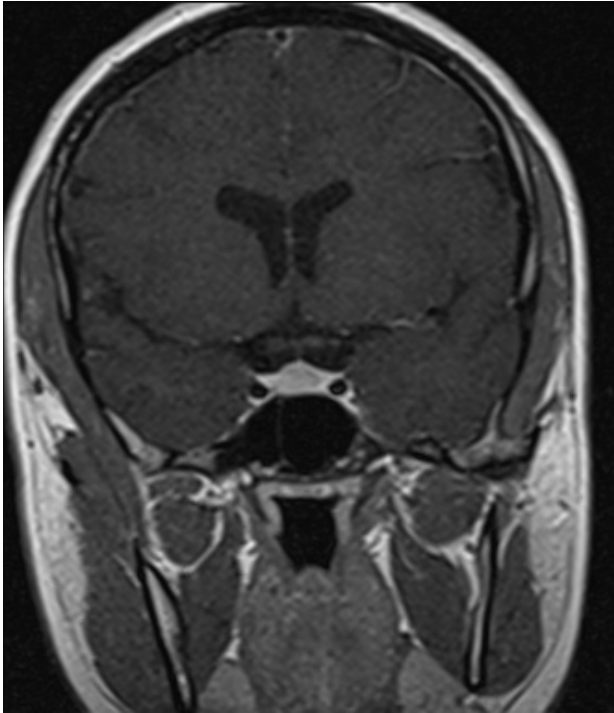
Mean pituitary width was 8.81 mm with a mean depth of 8.92 mm for females and 8.71 mm for males. Highest values for pituitary width were observed in 10-20 and 20-30 years age groups for females while 20–30 years age group for males. Regarding the height of pituitary among the studied population, mean pituitary height was 6.30 mm with a mean height of 6.31 mm for females and 6.29 mm for males. Highest values for pituitary height were observed in 10-20 and 20-30 years age groups while 10-40 years age group for males.

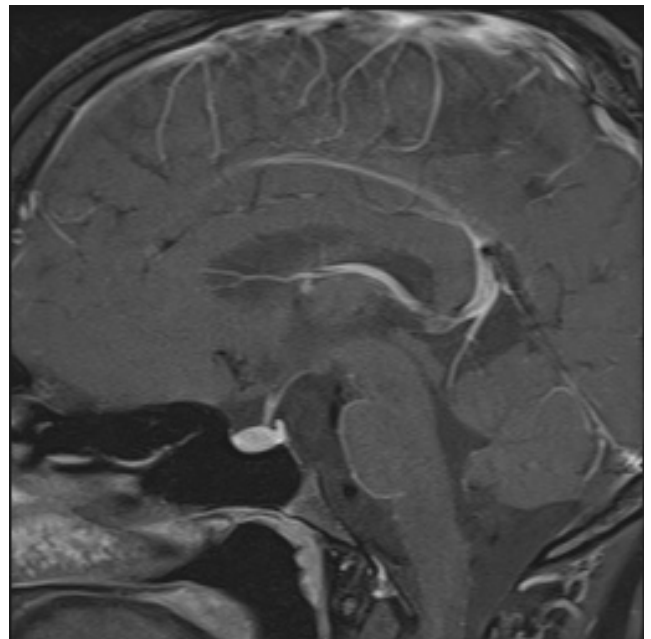
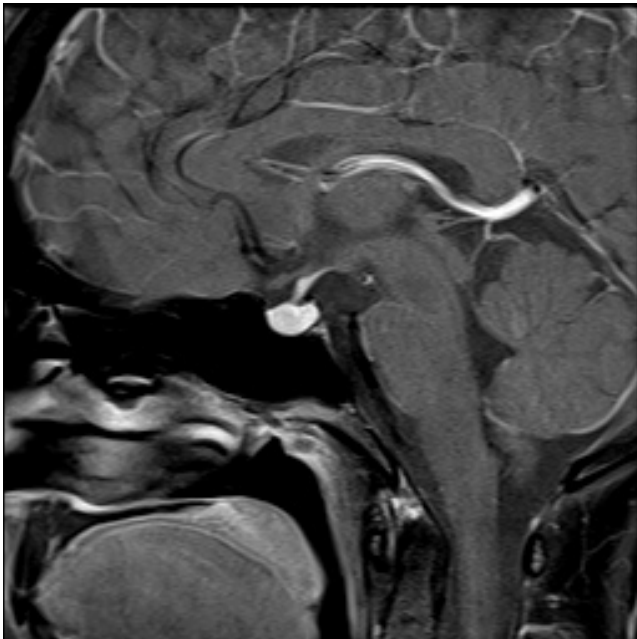
In our study, the depth of pituitary gland did not show a consistent relationship with the highest values in the 10-20 and 21–30 years age groups for females, while as 31-40 and 41-50 years age groups for males.

The height was minimum in the first decade of life, maximum in second and third decade and progressively decrease thereafter till late age. Volume of the gland was minimum in the first decade and maximum in the second decade and declined thereafter. These results are consistent with the observations made by Sanobar Bughio et al. in their study.

Conclusion

We conclude that mean volume of pituitary gland in our population is 277.96 mm³ with males having a mean volume of 267.74 mm³ and females having a mean volume of 288.74 mm³. Maximum voluminous glands are noted in pubertal and adolescent age groups while as minimum volume glands are noted in the old age groups. Glands with convex upper borders are noted in pubertal and adolescent age groups.





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