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Morphometric analysis of pituitary gland using magnetic resonance imaging in Indian subjects

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ABSTRACT

Background: Before the advent of magnetic resonance imaging (MRI), the radiological assessment of the hypothalamic-pituitary region relied on plain radiographs and computed tomography scans. However, contemporary medical practice now widely recognizes MRI as the preferred imaging modality for this purpose. The objective is to investigate variations in size and morphology of the pituitary gland associated with age and gender. **Aims and Objectives:** (a) The aims of this study were as follows: To establish normative measurements of pituitary gland in South Indian population. (b) To evaluate the relationship between gender, weight, height, and body mass index in different patients using conventional MRI sequences. **Materials and Methods:** This cross-sectional study, approved by the Institutional Review Board, included the enrolment of 140 normal individuals. The dimensions of the pituitary gland were assessed in 140 individuals exhibiting apparently normal pituitary gland function. The height and length of the pituitary gland were measured utilizing mid-sagittal T1-weighted images (T1-WI) obtained through MRI. The width of the pituitary gland was determined using coronal T1-WI, and the pituitary gland volume was subsequently calculated. **Results:** This study comprised 98 females and 102 males. The anteroposterior dimension, height, and volume of the pituitary gland showed statistically significant correlations with age ($P<0.05$), while the transverse dimension did not show a significant correlation with age ($P>0.05$). The shape of the pituitary gland was found to have statistically significant correlations with age and gender. Conversely, the transverse diameter, height, and volume of the pituitary gland showed no significant correlations. **Conclusion:** The findings underscore the importance of considering pituitary size, shape, and volume in the evaluation of neuroendocrine disorders.

Key words: Pituitary Gland, MRI, Morphometric Analysis, Indian Subjects, Age-Related Changes, Gender Differences

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INTRODUCTION

Before the development of magnetic resonance imaging (MRI), the hypothalamic-pituitary area was radiologically imaged using computed tomography scans of the skull and conventional radiography.[1] However, due to its many advantages over other modalities, MRI is now widely used in medicine as the preferred imaging method for observing intracranial structures, including the pituitary gland. The most important characteristics for determining the disease of the pituitary gland are its size and structure.[2]

While looking at cerebral structures on MRI in various age groups, dynamic changes in the pituitary's size, shape, and signal intensity were recorded. Depending on an individual's age and gender, the pituitary gland's size, shape, and volume indicate changes in the gland's hormone functioning.[3]

The need for the study arises from the lack of measurement of pituitary dimensions and volume in various age groups and among both genders in the Indian population. Owing to the paucity of available data, a study was carried out to evaluate the use of MRI in assessing changes in the pituitary

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gland's dimensions that are related to age and gender in the Indian population.[4]

Aims and objectives

- To establish normative measurements of pituitary gland in South Indian population.
- To evaluate the relationship between gender, weight, height, body mass index in different patients using conventional MRI sequences.

MATERIALS AND METHODS

Design of study

This was a hospital-based prospective study.

Method of collection

MRI brain will be performed on 1.5 T 18 channel MR Scanner (Siemens®MagnetomAvanto®) in patients who meet the inclusion criteria. Patient will be informed and consent will be taken.

Following imaging sequences will be included

- T1-weighted image (T1-WI) (coronal and sagittal)
- T2-WI (sagittal and coronal)
- Magnetization prepared rapid gradient echo (MPRAGE) (sagittal and coronal)

The height, transverse diameter, and anteroposterior diameter of the pituitary will be obtained from mid-sagittal and coronal planes, while the volume will be calculated from these measured parameters (Figure 1). Mid-sagittal T1-WI and MPRAGE imaging on MRI will be used to measure anteroposterior diameter and height of pituitary gland. Pituitary gland transverse diameter will be measured using coronal T1-WI and MPRAGE (Figure 2). The data obtained will be stratified based on age and sex for analysis. Statistical tests applied included student's t-test and Pearson correlation. A minimum level of statistical significance was set at $P<0.05$ (Figure 3).

Inclusion criteria

Patients undergoing an MRI brain for various reasons are not included in the exclusion criteria.

Exclusion criteria

a. Patients with a history of any pituitary diseases in the past or present
b. Patients with any structural abnormality in the pituitary hypothalamic region on MRI (pituitary cyst, adenoma, partial empty sella, tumors invading sella)
c. Patients who received in the past or receiving at present, hormonal therapy, including thyroxin, gonadal steroids, and adrenal steroids (except use of corticosteroid for <7 days before current MRI and not prescribed for adrenal insufficiency)
d. Patients with a history of any psychiatric disorder or receiving antipsychotic drug.

Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) software, version 23 (SPSS Inc., Chicago, IL, USA). Continuous variables are described in terms of mean±standard deviation or median with interquartile range. Categorical variables are described in the form of frequency and proportion. Intergroup differences were analyzed using student's t-test, Mann–Whitney U-test, and Chi-square test as appropriate. A $P<0.05$ was considered to be statistically significant.

RESULTS

The MRI images of 200 patients were examined, of which 102 (51%) were males and 98 (49%) were females, with the ages of the patients varying from 11 to 80 years. The mean anteroposterior dimension of the pituitary in the study group was 9.55±1.37 mm, with the mean transverse size, mean pituitary height, and volume being 11.97±1.84 mm, 5.40±1.19 mm, and 321.05±105.96 mm^3, respectively. On observing the MRI images, the most common shape of the pituitary was found to be flat (40%), followed by convex (29%), and then concave (31%). The maximum mean value of the anteroposterior dimension was found in the age group of 21–30 years and the least was in the age group of 41–50 years (Table 1).

Mean anteroposterior dimensions, mean transverse dimensions, and pituitary gland volumes were less in females than males. Nevertheless, it was discovered that women had a greater mean height than men. Independent t-tests showed significant differences between the anteroposterior dimension in males and females. In contrast, the pituitary gland's transverse size, height, and volume showed no significance (Table 2).

Maximum pituitary height and volume were seen in the age group of 11–20 years for both males and females. The lowest pituitary volume was observed in male patients aged 41–50 whereas those older than 60 had the lowest pituitary height. The lowest pituitary height and volume were observed in female patients older than 60 (Table 3).

In males, flat surfaces were most common (51.97%), followed by concave (27.45%), and then convex (20.58%). In females, the most common shape was convex (41.83%), followed by flat (34.69%), and then concave

Table 1: Mean anteroposterior dimension, transverse, height, and volume of the pituitary gland according to age

Age	Number	Anteroposterior diameter	Transverse diameter	Height (in mm)	Volume (in mm³)
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
11–20	22	9.17±0.58	12.10±2.10	6.52±1.23	378.75±108.27
21–30	39	10.6±1.62	12.07±1.84	5.28±0.99	357.99±104.25
31–40	52	9.29±1.39	12.20±2.05	5.27±1.11	318.76±112.13
41–50	39	8.91±0.98	11.27±1.81	5.30±1.27	280.79±94.50
51–60	24	9.89±1.30	12.08±0.97	5.24±0.99	327.20±87.92
>60	24	9.21±1.31	11.65±1.22	4.91±1.27	277.11±76.15
F-value	200	8.953	1.632	5.865	4.821
P-value	200	0.000	0.153	0.000	0.000

SD: Standard deviation

Table 2: Mean anteroposterior dimension, transverse, height, and volume of the pituitary gland according to gender

Gender	Number	Anteroposterior (in mm)	Transverse (in mm)	Height (in mm)	Volume (in mm³)
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
Male	102	9.79±1.42	12.31±1.88	6.11±1.12	331.61±106.67
Female	98	9.15±1.19	11.79±1.69	6.32±1.20	309.61±102.13
t-value		3.131	0.868	−0.423	1.44
P-value		0.001	0.381	0.661	0.129

SD: Standard deviation

Table 3: Mean pituitary volume and pituitary height in male and female gender across different age groups

Age distribution	Gender	Mean volume (in mm³)	Mean height (in mm)
11–20 years	Male	374.40±85.61	6.48±1.25
	Female	363.54±121.02	6.58±1.33
21–30 years	Male	343.50±119.52	5.06±0.97
	Female	361.28±112.21	5.45±0.96
31–40 years	Male	331.32±136.80	5.34±0.97
	Female	284.92±79.66	5.25±1.32
41–50 years	Male	271.06±95.95	5.18±1.07
	Female	270.50±110.46	5.47±1.48
51–60 years	Male	367.30±111.61	5.57±1.26
	Female	287.11±71.79	4.98±0.59
Above 60 years	Male	295.33±89.71	4.95±1.48
	Female	235.01±66.07	4.94±1.08

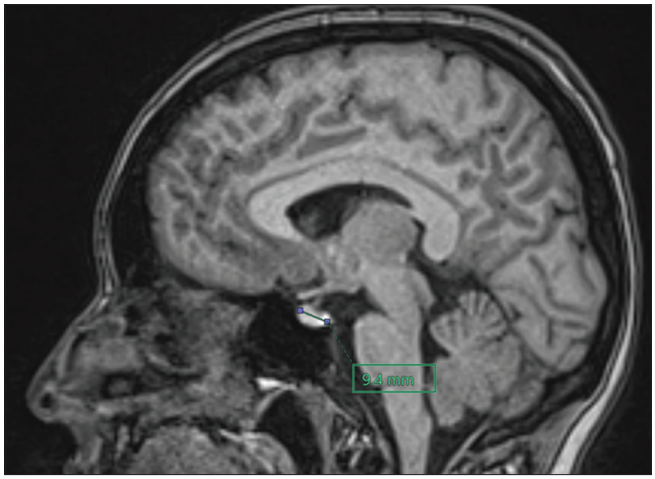

Figure 1: Mid-sagittal magnetic resonance imaging of the brain showing measurement of anteroposterior diameter of the pituitary gland

(23.46%). The shape of the pituitary gland was found to be statistically significant with age and gender (P<0.05) (Figures 4 and 5).

DISCUSSION

The study was carried out in the Department of Radiology at Sri Devaraj Urs Medical College, Tamka, Kolar. In this study, 102 (51%) were males compared to 98 (49%) females, similar to the survey done by Ahangar et al., which had 112 males (55.17%) and 91 females (44.83%).[5] The majority of patients whose MRI scans were analyzed fell into the 31–40 age group, which is consistent with the findings of Khanal et al.[6] While many studies focus on pituitary height, such as the one by Tsunoda et al.,[7] our analysis covers all parameters, including anteroposterior dimension, height, and the transverse dimension of the pituitary. This is important because the size and shape of a normal pituitary gland can vary based on the patient's age, gender, and hormonal environment. Pituitary height reaches its peak in the 11–20 age groups, with females showing higher values than males. After that, there is a gradual decrease in height with increasing age. This aligns with the findings of Yadav et al.[8] During puberty, height increases due to higher luteinizing hormone production and differences in the physiology of neuroendocrine hormones in younger

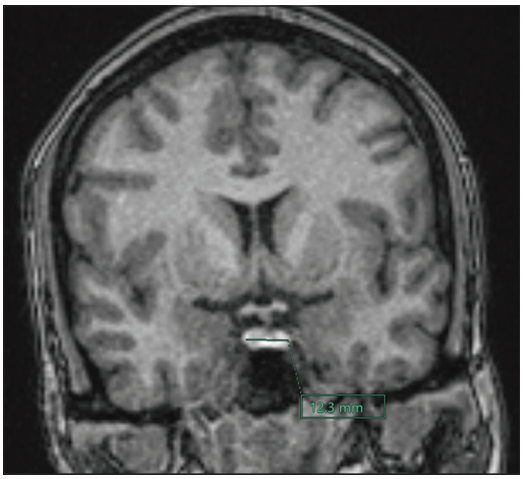

Figure 2: Coronal magnetization prepared rapid gradient echo image of brain showing measurement of transverse diameter of the pituitary gland

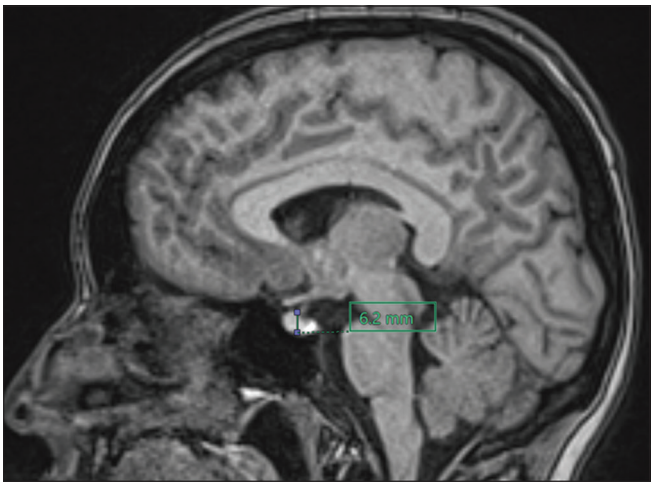

Figure 3: Mid-sagittal magnetic resonance imaging of the brain showing measurement of height of pituitary gland

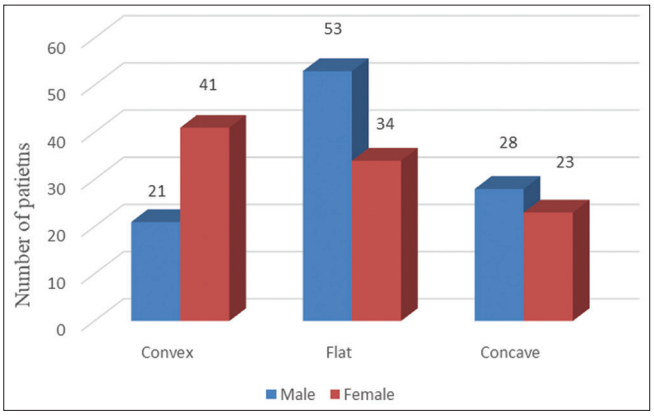

Figure 4: Shape of pituitary gland among males and females

and older patients. The decline in pituitary height with age is attributed to changes in endocrine status and the natural atrophy of the gland, which corroborates the research conducted by Maskey et al.[9] Our study also revealed a

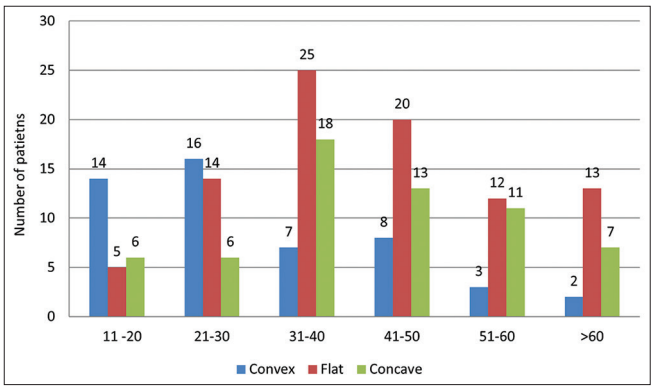

Figure 5: Shape of pituitary gland among different age groups

gradual linear increase in pituitary volume over the first 30 years of life, which is consistent with the findings of Mangieri et al.[10]

The study found that pituitary volume varies significantly among different age groups, which is consistent with the findings of a study by Kumar.[11] The maximum anteroposterior dimension was observed in the 20–29 age groups, aligning with the results of a survey conducted by Sanjay et al.[12] While pituitary height, volume, and transverse dimension did not show statistically significant differences between sexes, pituitary volume was found to be larger in males than in females, similar to the findings of a study by Ibinaiye et al.[13]

The anteroposterior dimension showed statistical significance with sex, as reported in the study by Maskey et al.[9] On examining the MRI images, it was found that flat shapes were the most prevalent (4%), followed by convex (30%) and concave (28%). This corresponds with the findings of the study by Yadav et al.,[8] which also reported that flat shapes were the most common (46.8%), followed by convex (31.03%) and concave (20.7%).

The research found that the upper surface of the pituitary gland was most often convex in individuals aged 11–20 years (60%) and 21–30 years (50%), with this incidence decreasing as age increased. However, as participants aged, there was a rise in the occurrence of flat and concave shapes of the pituitary. In males, the most common shape was flat (50.96%), followed by concave (26.92%) and convex (22.12%). On the other hand, in females, the most common shape was convex (38.54%), followed by flat (32.29%) and concave (29.17%). These results align with a study conducted in Nepal.[4] It is essential to note that the primary limitations of our study were its single-center design, which restricted the generalizability of the findings to other ethnic groups and the retrospective nature of the study.

Limitations of the study

- Sample Size: May not fully represent the Indian population.
- Age Distribution: Uneven across subjects.
- Technology: MRI model and quality variations.
- Data Collection: Potential inconsistencies and missing clinical details.
- Gender Factors: Hormonal influences not considered.
- Design: Cross-sectional, lacking longitudinal data.

CONCLUSION

This study uses MRI scans to collect data about the standard dimensions and shape of the pituitary gland in different age groups and genders. The research helps us understand the significant changes in the pituitary gland throughout a person's life, depending on their age and gender. The height and volume of the pituitary gland can reveal differences in hormone levels that occur in people of all ages and genders, including younger and older males and females. Detecting any abnormal variations in the dimensions and size of the pituitary gland can help identify any potential health issues and aid in early diagnosis. Therefore, MRI can be a valuable tool for accurately assessing pituitary size, correlating the findings with age and gender, and identifying any potential health problems.

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Authors' Contribution:
KGK- Definition of intellectual content, literature survey, prepared the first draft of manuscript, implementation of the study protocol, data collection, data analysis, manuscript preparation and submission of article; **HB-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **AKS-** Design of study, statistical analysis, and interpretation; **LJ-** Literature survey and preparation of figures.

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