

Morphological Study on Magnetic Resonance Imaging of the Normal Pituitary Gland in Nepalese Population: Age and Sex-Related Changes

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ABSTRACT

Introduction: The pituitary gland is the master endocrine gland that secretes important hormones and controls other glands. Its size, shape and volume vary with age and sex and also in various pathological conditions. This study was conducted to identify the size, shape and volume of the normal pituitary gland in different age groups of both genders using Magnetic Resonance Imaging (MRI).

Methods: A retrospective study of the brain MRI Images of 203 patients was done in the Radiology and Imaging department of Pokhara Academy of Health Sciences, Nepal. Anterior-posterior dimension, transverse dimension, height and shape of the pituitary gland were noted and volume was calculated. Descriptive analysis and relationship of pituitary parameters with age and sex were assessed using ANOVA and Chi-square tests.

Results: The pituitary height and volume was maximum in the 11-20years age group. Similarly, the mean height and volume of the pituitary gland in female patients of each age group were greater than that of male patients in the same age group. The inferential analysis revealed significant differences for mean pituitary height and volume with age but not with gender. The upper surface convexity was maximum in the age group 11-20years.

Conclusion: The study has shown a clear trend with regards to the morphology of the pituitary gland with the age and sex of the individual highlighting the size, shape and volume of the pituitary gland should be taken into consideration while evaluating the glands for any neuroendocrine disorders.

Keywords: *Humans; Magnetic Resonance; Nepal; Pituitary Gland; Retrospective Studies*

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INTRODUCTION

The pituitary gland is the master endocrine gland of the body which controls other endocrine glands and secretes various important hormones. Variation in size, shape and volume of the pituitary gland reflects the changes in hormonal physiology of the gland which depends on the age and sex of the individuals.^{1,2} The gland tends to be globular in shape at a younger age and becomes more flattened with increasing age.^{3,4} Furthermore, previous studies have found that female in the 20-40 age group had larger pituitaries than males of similar age.^{2,5} Changes in the hormone levels during puberty causes an increase in the height and volume of the pituitary gland.^{2,4,5} Young females more often have a convex upper pituitary margin than males of any age or older females.⁵ Pituitary height and cross-sectional area decline with increment in age and is more significant in women than in men.^{1,4,5,6}

Measurements of the normal pituitary gland for various age ranges and sex are helpful to diagnose cases with borderline pituitary abnormalities like physiological hypertrophy of the gland, subtle microadenoma, convex or lobulated margins and inflammatory diseases accurately.⁴ The diagnosis of pituitary adenomas especially the microadenoma mainly depends on the size and configuration of the gland.¹ The morphological knowledge of the pituitary gland is essential to study the pituitary growth, to diagnose and treat various diseases related to this gland. MRI has proved to be an accurate diagnostic modality for the assessment of the pituitary gland.⁶ MRI provides multi-planar images of better contrast and resolution without bony artifacts.⁴ Only a few similar types of research had been conducted in lower magnetic field strength MRI among the Nepalese population. Therefore this study was conducted to identify the age and sex-related morphological changes in the normal pituitary gland using higher magnetic field strength MRI which yields more accurate measurements.

METHODS

A retrospective observational study was done in the MRI Unit of Radiology and Imaging department at Pokhara Academy of Health Sciences, Nepal. This site was chosen because it is a tertiary level hospital with high patient flow and a 1.5 Tesla MRI machine. The study was conducted after getting ethical approval from the Institutional Review Board. The study period extended from March 2019 to February 2020. A total of 203 patients of 10 to 90years of age with apparently normal endocrine status undergoing routine brain MRI for indications other than those related to pituitary gland disorder were included in the study. The age of the patient ranged from 11 to 88years and was categorized into six different groups: 11-20years, 21-30years, 31-40years, 41-50years, 51-60years and above 60years. All the subjects were free from significant current neuroendocrine, neurologic and psychiatric disorders as determined by history and physical examination. Those with a history related to the pituitary gland or hormonal disorders, pituitary surgeries, gross pathology of the pituitary gland or treated by exogenous hormonal/steroid/drugs were excluded from the study.

MRI examinations were performed using Philips 1.5 Tesla Multiva scanner. The coronal and sagittal views were displayed using the midline plane of both T1-weighted sagittal spin-echo and T2-weighted coronal spin-echo images. MRI protocol for the sagittal scan was: matrix: 240x240, FOV: 240mm and 1mm isometric voxel. MRI protocol for the coronal scan was: matrix: 324x324, FOV:233mm and 5mm slice thickness. The mid-sagittal image T1-weighted image was used to obtain pituitary gland height (craniocaudal) and anterior-posterior (AP) dimensions. Pituitary gland width (transverse dimension) was measured on a coronal T2-weighted slice through the level of the pituitary stalk. Mathematically, the configuration of the pituitary gland was treated as a scalene ellipsoid (or triaxial ellipsoid). The volume of the ellipsoid was

given by $V = 1/6 \square a h t$, where a, h and t are the anterior-posterior dimension, height and transverse dimensions of the pituitary gland respectively. The shape of the superior surface of the pituitary was recorded as flat, concave, and convex. (Figures 1 & 2)

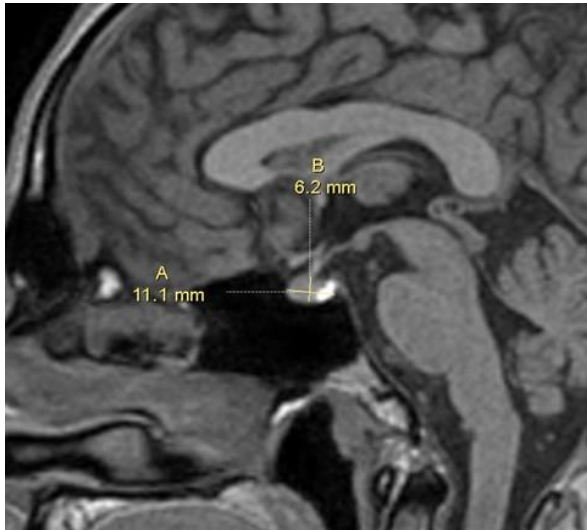


Figure 1: Mid Sagittal weighted image: A indicates the anterior-posterior dimension of the pituitary gland
B indicates Craniocaudal dimension (Height) of the pituitary gland

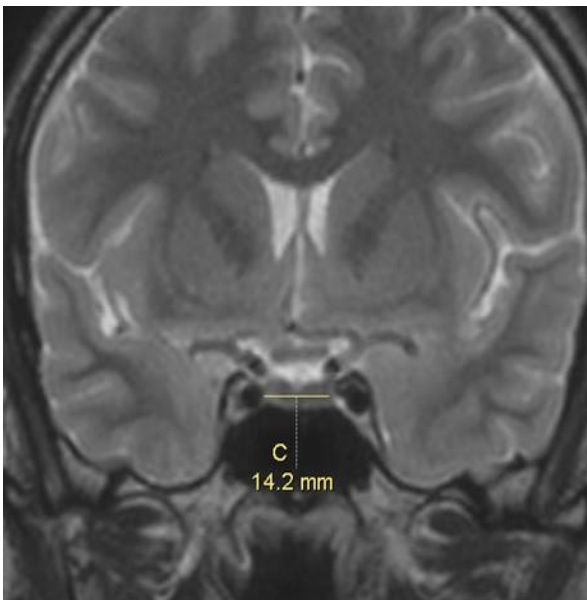


Figure 2: Coronal T2 weighted image: C indicates the transverse dimension of the pituitary gland

Data were entered and analyzed through

SPSS version 20. The shape, anterior-posterior dimension, vertical height, transverse dimension of the pituitary gland were measured in mm and the volume of the pituitary gland was calculated on the scale of millimeter³ (mm³). Mean and Standard deviations of each scale were calculated. Furthermore, the association of mean height and volume with age and sex was identified by using an ANOVA test. Chi-square test was used to assess the association of shape of the pituitary gland with age and sex. p-value <0.05 was considered as significant.

RESULTS

During one year of study, 203 patients met the inclusion criteria and their brain MR images were evaluated. Among them 95 were male and 108 were female. The age of the patient ranged from 11 to 88years.

We found the mean pituitary anterior-posterior dimension 9.99 ± 10.00 mm, transverse dimension 12.988 ± 13.00 mm, height 5.11 ± 1.54 mm and pituitary volume 344.49 ± 124.4 mm³. The most common shape of the upper surface of the pituitary gland was flat (43.3%) followed by convex (28.6%) and concave (28.1%).

The maximum mean value of the anterior-posterior dimension was observed in the age group 21-30years and least in 11-20years. However, for the transverse dimension maximum mean value was found in the 11-20years age group and least in 41-50years. Also, pituitary height and volume were maximum in 11-20years and minimum in 51-60years. The difference with age was statistically significant for transverse dimension, height and volume but not for the anterior-posterior dimension (Table 1). Regarding sex differences, the mean pituitary transverse dimension, height and volume were higher in female than male but the value of the anterior-posterior dimension was greater in male. However, for all four scales, the difference was not statistically significant (Table 2).

Table 1: Mean Anterior-posterior dimension, Transverse dimension, Height and Volume of Pituitary Gland according to Age

Age (in years)	n	Anterior-posterior	Transverse	Height	Volume
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
11-20	28	9.50±0.86	13.68±1.33	6.15±1.69	418.67±132.17
21-30	30	10.14±1.12	13.17±1.93	5.55±1.49	389.01±145.35
31-40	47	9.89±1.11	13.30±1.73	4.85±1.57	341.77±117.95
41-50	39	9.77±1.41	12.25±1.55	4.99±1.61	312.35±107.94
51-60	23	10.03±1.08	12.70±1.61	4.58±1.03	295.56±86.06
>60	36	9.99±1.37	12.82±1.43	4.73±1.22	319.32±112.87
F, p value	203	1.582, 0.167	3.261, 0.007	4.686, 0.000	4.712, 0.000

The mean height of the pituitary gland was 4.89 ± 1.45 mm in male and 5.30 ± 1.61 mm in female (Table 2). The maximum mean height in male and female were 5.71 ± 1.66 mm and 6.74 ± 1.62 mm respectively which were seen in the age group of 11-20years. The height steadily decreased with increasing age and minimum height for male was observed in the 51-60years age group (4.211 ± 1.09) and for female in the above 60years age group (4.70 ± 1.28). However, there was a slight increase in height at 51-60years in the female. (Table 3) Moreover, the study found that compared to male, the female had a maximum mean pituitary volume except in the 31-40 and 41-50years age group. Similar to the pituitary height, the maximum mean volume for male and female was seen in the 11-20years age group which were 370.90 ± 112.31 mm³ and 482.35 ± 133.93 mm³ respectively. The value progressively decreased thereafter and minimum volume was noted in the age group 51-60years in male and 41-50years in the female. There was a decreased trend up to 50years in female and 60years in male and again the value increased thereafter (Table 3). Also, the inferential analysis revealed significant differences for mean pituitary volume with age (p-value < 0.001) but not with gender (p-value > 0.05). Separate analysis among male revealed that though

the mean pituitary height and volume were different among age groups the difference was not statistically significant (p-value > 0.05) whereas for the female statistically significant difference was found (p-value 0.002).

Table 2: Mean Anterior-posterior dimension, Transverse dimension, Height and Volume of Pituitary Gland according to Sex

Sex	n	Anterior-posterior	Transverse	Height	Volume
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
Male	95	10.07±1.20	12.78±1.63	4.89±1.45	327.66±110.01
Female	108	9.92±1.50	13.15±1.68	5.30±1.61	359.29±133.94
F, p value		0.675, 0.412	2.474, 0.117	3.53, 0.061	3.323, 0.070

Table 3: Mean value of pituitary volume and pituitary height in the different age group

Age group	Sex	Mean volume in mm ³	Mean height in mm
11-20	M	370.90±112.31	5.71 ±1.66
	F	482.35±133.93	6.74±1.62
21-30	M	353.19±93.11	5.16±0.92
	F	406.91±164.70	5.75±1.69
31-40	M	345.73±114.12	4.57±1.31
	F	338.29±123.46	5.10±1.75
41-50	M	321.72±119.82	4.55±1.71
	F	298.87±90.17	5.02±1.51
51-60	M	269.90±86.04	4.21±1.09
	F	335.46±73.45	5.15±0.62
Above 60	M	287.73±92.96	4.82±1.09
	F	331.47±119.04	4.70±1.28

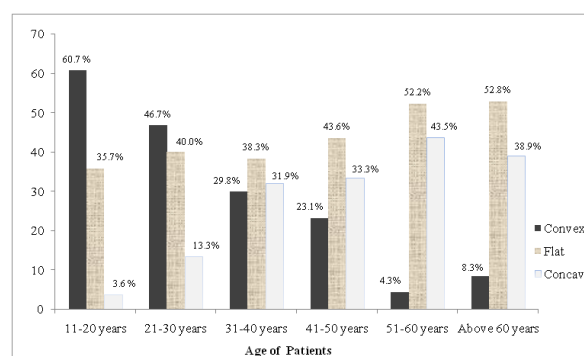


Figure 3: Shape of the upper surface of pituitary gland according to age

The upper surface convexity was maximum in the age group of 11-20years (60.7%) and 21-30years (46.7%), after that its incidence gradually decreased. However, the incidence of the flat surface and concave surface gradually increased in higher age groups. The highest incidence of the flat and concave surface was seen in the above 60years and 51-60years respectively (Figure 3). For male flat surface was common (51.6%) followed by concave (28.4%) and convex (20%). While in the female both convex and flat surface was common (36.1% each) followed by concave (27.8%) (Figure 4).

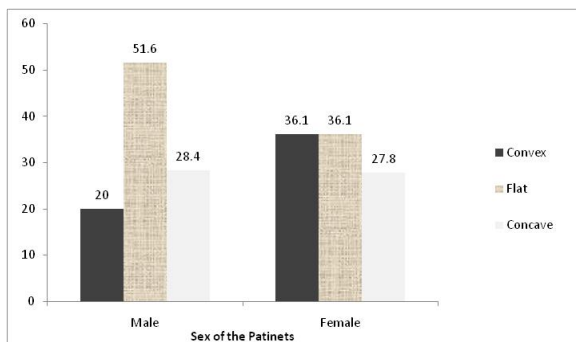


Figure 4: Shape of the upper surface of pituitary gland according to sex

DISCUSSION

The majority of pituitary gland measurements are focused on height, as a change in the size are due to a change in pituitary gland height.^{7,8} However in this study all the parameters were measured and evaluated since the size and shape of a normal pituitary gland vary considerably according to age, gender and the hormonal environment.^{1,5,7,8,9} The development of the human body is closely related to the different pituitary hormones and ultimately is accompanied by changes to the pituitary gland morphology. The size and shape of the pituitary gland reflect the level of hormones related to it and is important in the diagnosis of pituitary diseases.^{2,7}

Our study showed that pituitary height and volume increase during puberty in the second decade of life then gradually decreases and again increases after 50years of age in female

and after 60years in male. Maximum mean transverse dimension, height and volume of the pituitary gland were observed in the 11-20years age group and the difference in these parameters with age was statistically significant. Regarding sex, higher pituitary transverse dimension, height and volume were found in female compared to male but the difference was not statistically significant. Previous studies also showed a similar trend with regards to the morphology of the pituitary gland with the age and sex of the subjects.^{1,10,11,12}

The mean pituitary gland height and volume in our study was 5.11 ± 1.54 mm and 344.49 ± 124.4 m³ respectively. A study from Nepal by Lamichhane et al. reported a mean pituitary height of 5.9 ± 0.3 which was almost similar to our finding (5.1 ± 1.5). However, their pituitary volume (463 ± 25.9) was greater than our study result (344 ± 124.4). Other findings¹ like pituitary volume maximum for female in most of the age group, the largest difference in pituitary volume between males and females at the age of 11-20years, decreasing trend of pituitary volume up to 50years and sudden increase thereafter were consistent with our study findings. These results indicated that the growth of the pituitary gland is more prominent in adolescents, particularly in females which have been supported by previous studies.^{1,8,13} Besides, the previous study was done among 71 adults also found an inverse relationship between pituitary height and age.⁵ Other studies also found the maximum height of the pituitary gland during the second and/or third decade of life and gradual decline thereafter.^{7,8,10,11,12} Again increase in height was noted at the fifth or/and sixth decade of life.^{2,5,7,12}

The increase in pituitary height during puberty might be related to the increased production of Follicle-stimulating hormone (FSH) and Luteinizing Hormone (LH) at this time of growth and decrease in the pituitary height in the older age group might be due to changes

in the endocrine status with ageing and also physiological atrophy of the pituitary gland.^{2,5} However, in females the concentrations of these hormones start to rise in their fifth and sixth decades, because of an age-related decrease in circulating gonadal steroids hormones and an increase in gonadotropin-releasing hormones resulting increase in height of the pituitary gland.^{2,7,14}

Regarding the shape of the upper surface of the pituitary gland, the most common shape was flat (43.3%) which was similar to the recent study conducted in India (46.0%).² However, findings with sex were different when compared with the same study.² The other similar types of the study found concave surface the most frequently observed shape among the Indian population.¹² Furthermore, in our study younger female had a greater prevalence of a convex upper pituitary margin than males of all ages and older females which is consistent with the previous studies.^{5,12,14} As the age advanced majority of female had flat surface whereas for males of all the age group common shape was flat. In line with our study finding, previous studies also reported convex/ globular pituitary gland in a younger age but as the age advanced the superior surface became more concave and flat.^{3,4} In general, the upper surface of the pituitary gland for various age groups and sex in this study was in agreement with the previously published study from Nepal.¹

CONCLUSION

The size, shape and volume of a normal pituitary gland undergo substantial changes during the lifespan and are affected by age and gender. The pituitary height and volume reflect physiological neuroendocrine differences between younger and older; male and female subjects. These findings suggest the need for consideration of the normal physiological variation of pituitary gland size and morphology while evaluating the pathological condition of the pituitary gland.

CONFLICT OF INTEREST

None

SOURCES OF FUNDING

None

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