

## Original Research Article

# Size and morphology of sella and volumetric evaluation of pituitary gland: a radiological survey

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## ABSTRACT

**Background:** Sella turcica is an important anatomical structure in the middle cranial fossa. It's size follows the size of pituitary gland. The present study aimed to evaluate the size and morphology of sella and pituitary gland in the same patients without known hormonal or pituitary pathology.

**Methods:** In this cross-sectional observational study three hundred patients underwent lateral x-ray of skull for sella turcica measurements and MRI brain for pituitary gland measurements.

**Results:** We observed normal shape of sella (round or oval) in 66.7% of the study participants. Maximum mean anterior-posterior (AP) dimension was seen in the age group of 41 to 50 years ( $1.24 \pm 0.19$  cm), while maximum length ( $0.87 \pm 0.12$  cm), depth ( $0.87 \pm 0.21$  cm) and volume ( $0.49 \pm 0.21$  cu cm) was observed in the age group of 51 to 60 years. Similarly, CC dimension was observed to be maximum in the age group 41 to 50 years ( $5.9 \pm 0.51$  mm). Study participants of age group more than 60 years had the maximum mean transverse dimension ( $12.73 \pm 0.29$  mm) and the pituitary volume on MRI was observed to be maximum for the age group 51 to 60 years ( $398.45 \pm 61.24$  cu mm).

**Conclusions:** In our sample of 300 patients, sella turcica was normally shaped in 66.7%. Various dimensions of sella turcica and pituitary gland increased significantly till 50 to 60 years of age, after which they decreased.

**Keywords:** Sella turcica, Pituitary gland, Dimensions

## INTRODUCTION

The sella turcica is located in a depression lying on the intracranial surface of the body of the sphenoid bone. It has a unique relationship with the pituitary gland, as previous studies have shown that larger sella turcica is present in a hyperfunctioning pituitary gland and a smaller sella turcica in a hypofunctioning pituitary gland.<sup>1</sup> Increased growth of the sella turcica must follow increased growth of the pituitary gland as pituitary can serve as a functional matrix for the sella turcica. The complex hormonal physiology can bring changes in the size and shape of pituitary gland. Sometimes clinically asymptomatic or borderline pituitary abnormalities such

as physiological hypertrophy of gland or subtle microadenoma can bring changes in the dimensions of the sella or pituitary gland.<sup>2</sup> Measuring these dimensions can help diagnose such cases.

A thin white curve on lateral skull x-rays can be used for tracing the sella turcica for morphometric analysis. As a result, it becomes an important identification of pathologies related to the pituitary gland. While pituitary gland can be assessed accurately using MRI.<sup>3</sup> The present study aimed to evaluate the size and morphology of sella using x-ray skull lateral view and volumetric evaluation of pituitary gland using MRI brain in same patients without known hormonal or pituitary pathology.



Figure 1: Pituitary MRI- normal study.

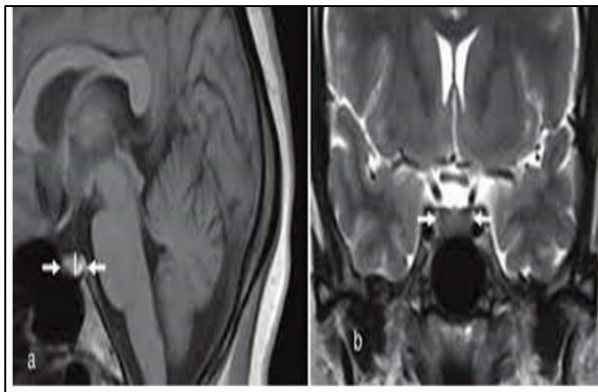


Figure 2: (a) Mid sagittal T1W MRI, white arrows indicate the length (AP) and central line indicates the height (CC) of pituitary gland; and (b) coronal T2W MRI, white arrows indicate the width (T) of pituitary gland.<sup>4</sup>

## METHODS

### Study design and sampling

The present cross-sectional observational study was conducted on patients who were referred to the Department of Radiodiagnosis, Bharati Vidyapeeth Medical College, Sangli, Maharashtra for undergoing MRI brain. These patients were also taken for skull x-ray lateral. We included subjects presenting to our department for MRI brain imaging with apparently normal pituitary gland anatomy and function. We excluded patients with past or present pituitary diseases, on hormonal therapy, history of intracranial surgery or radiation, pregnant or 2 weeks post-partum, structural abnormality in the pituitary hypothalamic region on MRI or past history of bone disorders. Empty sella and patients having sella which was completely filled with cerebrospinal fluid with pituitary gland having height of less than 2 mm were regarded as empty sella and were

not included in the final analysis. Yadav et al reported that above the age of 50 years, mean pituitary volume among males is  $410 \pm 168$  cu mm, while among females it is  $420 \pm 174$  cu mm.<sup>4</sup> Using this data, we calculated the sample size using the formula  $n = (Z\alpha/2 + Z\beta)^2 * (SD * 2) / d^2$ , where  $Z\alpha/2$  is Z value at 5%,  $Z\beta$  is Z value for 80% power of study, SD is average standard deviation  $[(SD1+SD2)/2]$  and d is the clinically relevant effect, taken as 10 mm. We obtained the sample size of 270, which was round off to 300 patients. Consecutive sampling was employed. The study participants were explained the purpose of the study and an informed written consent was obtained from them. The study was approved by the Institutional Ethics Committee.

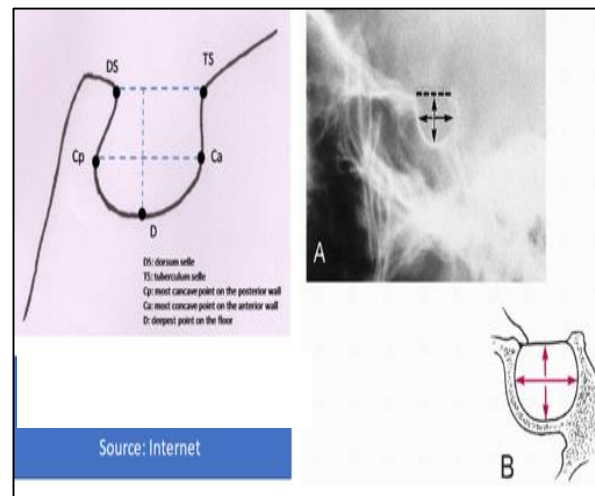


Figure 3: Measuring the length, width and height of sella on lateral X-ray.

### MRI and X-ray protocol

MRI examinations were performed for pituitary gland dimensions. 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 using standard protocols. The mid-sagittal image T1 weighted image was used to measure pituitary gland height (cranio-caudal) and Anterior-Posterior (AP) dimensions. Pituitary gland width (transverse) was measured on a coronal T2 weighted slice through the pituitary stalk. Pituitary gland volume was estimated by the formula = Anterior-posterior dimension\*Craniocaudal dimension\*Transverse dimension\*0.52.

For sella turcica measurements radiographs were used. The contour of the sella turcica was traced between points tuberculum sella (TS) and posterior clinoid (Pclin), and nine additional equally spaced points along this contour were located by the computer software, which also helped to know the shape of pituitary gland. In addition, we calculated the most posterior point, the most anterior point and the deepest point of the sella (sella floor), using the Frankfurt plane (FH) as the horizontal reference direction. Sella length was distance

from TS to PClin, sella AP dimension was measured parallel to the FH plane, from anterior to posterior, sella height median was the vertical distance, as measured perpendicular to the FH plane, from the sella floor to a point midway between PClin and TS. Sella turcica volume was obtained from the same formula as that for pituitary gland.

### Data collection and data analysis

Using a pre-designed semi-structured questionnaire, patient related information like age and gender were noted. All measurements for sella turcica and pituitary gland were noted in the study proforma. The data were compiled in a Microsoft Excel sheet and analysed in Statistical package for social sciences (SPSS) version 23 (IBM, NY). Gender and shape of the sella were presented as frequency distribution, while age and various dimensions of sella and pituitary were described as means and standard deviation with minimum and maximum values. We then compared the dimensions of sella turcica and pituitary gland between difference age groups using one-way Analysis Of Variance (ANOVA) test, using Tukey's post-hoc test, considering p value of less than 0.05 to be statistically significant.

## RESULTS

Mean age of the participants included the present study was 43.7 years. The most common age group was 41 to 50 years (27.7%) (Table 1).

**Table 1: Baseline characteristics of the patients included in the study.**

Baseline characteristics	Frequency	Percent
<b>Age groups (in years)</b>		
Up to 20	28	9.3
>20 to 30	41	13.7
>30 to 40	38	12.7
>40 to 50	83	27.7
>50 to 60	61	20.3
More than 60	49	16.3
<b>Gender</b>		
Female	150	50
Male	150	50
<b>Shape of sella turcica</b>		
Normal (round or oval)	200	66.7
Oblique anterior wall	50	16.7
Irregular dorsum sella	20	6.7
Double contour of floor	10	3.3
Pyramidal shape	10	3.3
Sella turcica bridge	10	3.3
Total	300	100

There was an equal distribution of males and females in the study. We observed normal shape of sella (round or oval) in 66.7% of the study participants. Other pituitary

shapes observed were oblique anterior wall (16.7%), irregular dorsum sella (6.7%), double contour of floor (3.3%), pyramidal shape (3.3%) and sella turcica bridge (3.3%). Table 2 describes how the measurements of sella on x-ray were associated with the age of the study participants. We observed that with increasing age, anterior-posterior dimension, length, depth and volume increases till 60 years of age, after which it decreases (Table 2). Maximum mean AP dimension was seen in the age group of 41 to 50 years ( $1.24 \pm 0.19$  cm), while maximum length ( $0.87 \pm 0.12$  cm), depth ( $0.87 \pm 0.21$  cm) and volume ( $0.49 \pm 0.21$  cu cm) was observed in the age group of 51 to 60 years. Similarly, table 3 describes the measurements of pituitary gland on MRI. We observed that the maximum mean AP dimension was observed in the age group of 51 to 60 years ( $11.24 \pm 1.19$  mm), and it decreased in those with age of more than 60 years (mean AP dimension =  $10.52 \pm 1.01$  mm). Similarly, CC dimension was observed to be maximum in the age group 41 to 50 years ( $5.9 \pm 0.51$  mm). Study participants of age group more than 60 years had the maximum mean transverse dimension ( $12.73 \pm 0.29$  mm) and the pituitary volume on MRI was observed to be maximum for the age group 51 to 60 years ( $398.45 \pm 61.24$  cu mm).

## DISCUSSION

The sella turcica is an important component of the middle cranial fossa and knowledge about its normal dimensions can help in early identification of related pathologies. The shape of the sella turcica was first classified by Gordon and Bell into circular, oval, and flattened or saucer shaped.<sup>5,6</sup> According to their observation, a circular or oval-shaped sella turcica was the most common shape found in their sample. However, in our sample, round or oval shape sell was observed in two-thirds of all patients. Aberrations in shape of the sella turcica was found in nearly 34% of the study participants. These findings are also consistent with that of Gargi from Meerut, India who also found shape aberrations in 31% of their sample.<sup>7</sup> Similar results were also reported by Kiran et al who found that 70% of the patients from Andhra Pradesh and Shah et al who found 66% of subjects from Islamabad had a normal-shaped sella turcica.<sup>2,8</sup>

In contrast, Nagaraj et al found normal shaped sella turcica in 46.5% of the study population.<sup>9</sup> Likewise Chauhan et al also reported a normal shaped sella in 28% of the subjects.<sup>10</sup> Thus it can be safely concluded that variations in the shape of sella turcica can be misleading since it may be present in normal subjects or may indicate a clinical condition like spina bifida, Fragile X syndrome and Down syndrome.<sup>11,12</sup>

In the present study we observed that the dimensions of pituitary gland increased till the age of 60 years, after which the dimensions were found to decrease. Studies done previously suggest that changes in the hormone levels could be the cause of such changes in the pituitary morphology.

**Table 2: Association of various dimensions of sella turcica on lateral skull X-ray with age.**

Measurements of sella	Age groups	N	Mean	Std. Deviation	Minimum	Maximum	P value
<b>Anterior-Posterior dimension (cm)</b>	Up to 20	28	1.01	0.16	1.10	1.50	<0.05
	>20 to 30	41	1.14	0.18	0.90	1.50	
	>30 to 40	38	1.19	0.20	0.90	1.50	
	>40 to 50	83	1.24	0.19	1.00	1.70	
	>50 to 60	61	1.21	0.15	1.00	1.50	
	More than 60	49	1.19	0.08	1.10	1.30	
	Total	300	1.21	0.17	0.90	1.70	
<b>Length (cm)</b>	Up to 20	28	0.77	0.05	0.80	0.90	<0.001
	>20 to 30	41	0.92	0.05	0.80	1.00	
	>30 to 40	38	0.81	0.07	0.70	0.90	
	>40 to 50	83	0.83	0.12	0.70	1.10	
	>50 to 60	61	0.87	0.12	0.70	1.10	
	More than 60	49	0.78	0.08	0.68	0.90	
	Total	300	0.84	0.11	0.68	1.10	
<b>Depth (cm)</b>	Up to 20	28	0.67	0.22	0.50	1.00	<0.001
	>20 to 30	41	0.75	0.07	0.50	1.00	
	>30 to 40	38	0.85	0.17	0.70	1.10	
	>40 to 50	83	0.82	0.14	0.70	1.20	
	>50 to 60	61	0.87	0.21	0.60	1.20	
	More than 60	49	0.74	0.11	0.60	0.87	
	Total	300	0.81	0.16	0.50	1.20	
<b>Volume (cu cm)</b>	Up to 20	28	0.39	0.20	0.23	0.70	<0.001
	>20 to 30	41	0.41	0.10	0.23	0.70	
	>30 to 40	38	0.42	0.12	0.32	0.60	
	>40 to 50	83	0.45	0.17	0.33	0.89	
	>50 to 60	61	0.49	0.21	0.26	0.89	
	More than 60	49	0.35	0.07	0.27	0.45	
	Total	300	0.44	0.16	0.23	0.89	

**Table 3: Association of various measurements of pituitary gland on MRI brain with age.**

Measurements of pituitary	Age groups	N	Mean	Std. Deviation	Minimum	Maximum	P value
<b>Anterior-Posterior dimension (mm)</b>	Up to 20	28	10.80	0.88	9.70	11.80	<0.001
	>20 to 30	41	10.33	1.11	9.70	13.10	
	>30 to 40	38	10.73	0.86	9.60	13.10	
	>40 to 50	83	10.72	0.95	9.60	13.80	
	>50 to 60	61	11.24	1.19	10.10	13.80	
	More than 60	49	10.52	1.01	9.00	12.10	
	Total	300	10.88	1.05	9.00	13.80	
<b>Cranio-caudal dimension</b>	Up to 20	28	4.94	0.31	4.50	5.20	<0.001
	>20 to 30	41	5.54	0.58	4.50	6.20	

Continued.

Measurements of pituitary (mm)	Age groups	N	Mean	Std. Deviation	Minimum	Maximum	P value
	>30 to 40	38	5.58	0.40	4.70	6.00	
	>40 to 50	83	5.90	0.51	5.30	6.80	
	>50 to 60	61	5.38	0.32	4.80	5.70	
	More than 60	49	4.78	0.57	4.10	5.60	
	Total	300	5.43	0.61	4.10	6.80	
Transverse dimension (mm)	Up to 20	28	11.12	0.62	10.60	12.00	<0.001
	>20 to 30	41	11.92	0.63	10.60	13.80	
	>30 to 40	38	12.57	0.20	12.30	12.90	
	>40 to 50	83	13.47	0.40	12.30	13.80	
	>50 to 60	61	12.62	0.54	11.70	13.80	
	More than 60	49	12.73	0.29	12.30	13.20	
	Total	300	12.77	0.78	10.60	13.80	
Volume (cu mm)	Up to 20	28	307.75	27.50	272.38	337.97	<0.001
	>20 to 30	41	365.11	41.49	272.38	461.64	
	>30 to 40	38	389.69	28.85	365.85	456.41	
	>40 to 50	83	441.11	36.21	371.56	503.11	
	>50 to 60	61	398.45	61.24	294.95	503.11	
	More than 60	49	333.80	56.77	280.59	404.32	
	Total	300	392.94	63.48	272.38	503.11	

The increased production of Luteinizing Hormone (LH) during the time of growth of puberty can be related to the above-mentioned increase in pituitary height during puberty. Also, relatively greater pituitary height in young patients, both the males and females, may be because of the physiological differences in the neuro- endocrinal hormones between younger and older subjects. The basal serum concentrations of gonadotropic hormones such as LH, Follicle Stimulating Hormone (FSH) are found to decrease after puberty up to the fifth decade of life.<sup>13</sup> Naik et al have done pituitary gland volume assessment in the normal Indian adolescent population and they concluded that there was only moderate correlation between all pituitary measurements and age; however, they have done the study only in adolescent age group.<sup>14</sup>

Furthermore, we observed that with increasing age, AP dimension, length, depth and volume of sella turcica increases till the age of 60 years, after which it decreased. Chauhan et al reported that mean sella height consistently decreased with age where as median sella height first found to increase with age and after 40 years was found to be stationary.<sup>15</sup> Nagaraj et al reported that the depth and AP diameter gradually increased with age, and the length showed no significant increase with age.<sup>16</sup> The average length, depth, and AP diameter ranged as 10±5 mm, 8±3 mm, 12±4 mm, respectively. The authors concluded that the growth of the individual can be assessed based on the size of the sella turcica at different age periods. In a similar study by Choi et al concluded that the linear dimensions of sella turcica had a positive

linear tendency until 25 years of age. After 26 years of age, no significant increase could be found in sella turcica size.<sup>17</sup> Kumar et al reported that age and sella depth and diameter were found to be statistically significant ( $p < 0.001$ ).<sup>18</sup> Similar observations were made by Chilton et al who reported that volume of the sella turcica increases with age. Age related increase of sella turcica size is expected because of its contents, i.e., the hypophysis, have been shown to increase in size with age.<sup>19</sup>

### Limitations

There were few limitations of our study; most important was selection bias as expensive MRI test prohibited the normal volunteers for the study. Secondly, we could not recruit sufficient number of subjects in the age group of less than 5 years as most of them were excluded because of their illnesses. And thirdly, participants included in our analyses were all presumably without any presently known pituitary disease. However, endocrinological evaluation of subjects was not performed, thus subjects included with potential neuroendocrine disorders affecting the pituitary could not be ruled out.

### CONCLUSION

The normal anatomy and its morphometric variations of sella turcica on a lateral cephalometric radiograph and of pituitary gland on MRI should be understood well by clinicians, so that various pathological situations can be

identified early. In our sample of 300 patients, sella turcica was normally shaped in 66.7%. Various dimensions of sella turcica and pituitary gland increased significantly till 50 to 60 years of age, after which they decreased.

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