Review Article

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Morphometric Study of the Pituitary Gland on MRI

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Abstract

Aims: 1. To study the shape and size of normal pituitary gland with respect to both the lobes in all age groups of both genders by studying MRI images of brain. 2. To determine and evaluate mean normal size and shape of normal pituitary gland with relation to age and gender. **Setting and Design:** For the study MR images all ages were used to characterize the effect of age and sex on pituitary size and shape. All the three dimensions of both the lobes of pituitary gland and stalk were measured using mid sagital and axial MR images. **Methods and Material:** Images of 160 living subjects (76 females and 84 males) of all ages were used. By using electronic caliper all above mentioned parameters were measured. **Statistical Analysis Used:** The data was grouped in age group 0-10, 11-20, 21-50, >51 years of both the genders, analyzed by One way ANOVA test, unpaired t-test. For shape of gland percentage and Chi-square test used. **Results:** The dimensions were steadily increased up to 21-50 years group later decreased. The changes were noted statistically significant. Also significant change in shape. More convex up to 50 yrs then become concave. **Conclusion:** This study demonstrated the database all age groups, which was its mean size and shape of both lobes of pituitary gland, can apply for clinical evaluation.

Keywords: Pituitary gland; MRI, anterior and posterior lobe; Shape.

Introduction

Previous studies describing the growth patterns of midline brain by MR Imaging with the measurement of four midline brain structure, one of that was a pituitary gland.[1] High-resolution computed tomography (CT) with intravenous contrast material is recognized as the method of choice for imaging the pituitary gland. However, there are limitations to the ability of CT to identify micro-adenomas, and magnetic resonance imaging (MRI) is increasingly being recognized as an excellent imaging method for the central nervous system with morphological details of normal pituitary gland.[2] MRI allows multiplanar scan without artifact of bone shadows. In addition, T1-weighted sequences permit evaluation of the hyper intense signal of the posterior pituitary (HSPP), although the origin of this signal remains controversial.[3,4] Various studies has been published about shape and size of pituitary gland of age group from new born child to adult individually or compiled of all age groups.[5,6,7,8,9] All these studies were retrospective and very few studies are available from Indian population. As we have not found a report with regards to separate dimensions specifically of the anterior and posterior lobes in Indians; hence we report this research for the purpose of:

1. To study the shape and size of normal pituitary gland with respect to the both lobes in all age groups of both genders by studying MRI images of brain.
2. To determine and evaluate mean normal size and shape of normal pituitary gland with relation to age and gender.

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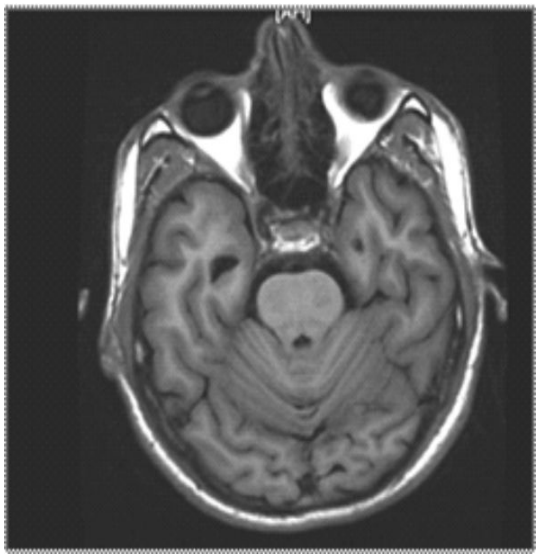
Fig 1: Methods: For Measurements by Using Electronic Caliper: Sagital View

Fig 2: Axial View: for Transverse Dimensions



Material and Methods

The sample size was 160 patients (84 male and 76 female), at age 1year to maximum of 83 years old. All were from Maharashtra from in-patient and outside-patient departments of general hospital of medical college. For the study, routine high field MR images at 1.5 T of brain since January 2013 were studied. Only those showing normal anatomy, with no pathology, with no history related to the pituitary gland or hormonal disorders, surgery or history of treatment by hormone therapy were included in this study. In case of unclear MRI images or those showed pathology of the pituitary and abnormality in sellar and parasellar region were excluded. The subjects were grouped gender wise into eight different groups of four age groups (1-10, 11-20, 21-50, >51 years).

In the sagital and axial views of MR scan, the measurements of the antero-posterior, vertical and transverse dimensions of both lobes of pituitary gland and stalk were taken by using the electronic caliper of the display. (Fig 1 & Fig 2) Also the shape of superior surface of pituitary gland was studied as shown in Fig 3. The T1-weighted sequences

Fig 3: Shape of Superior Surface

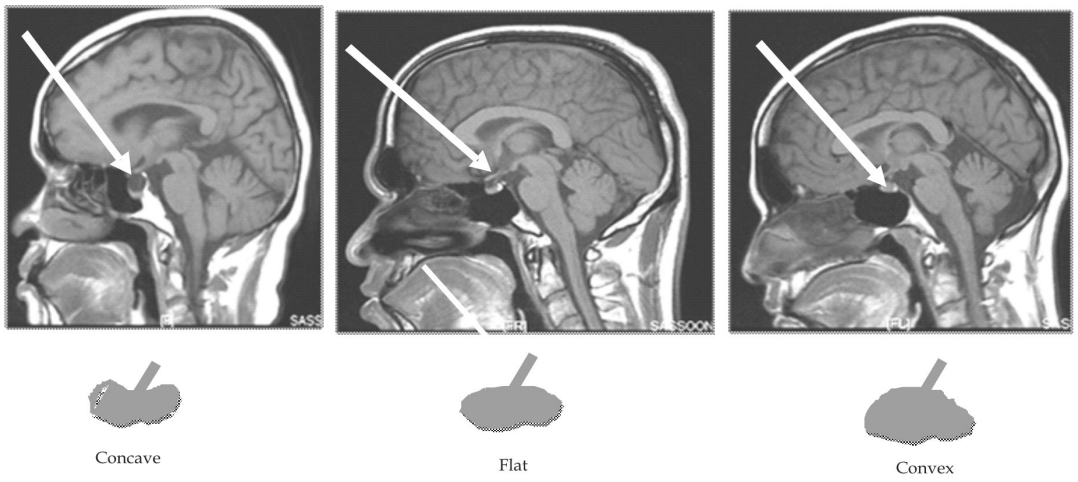
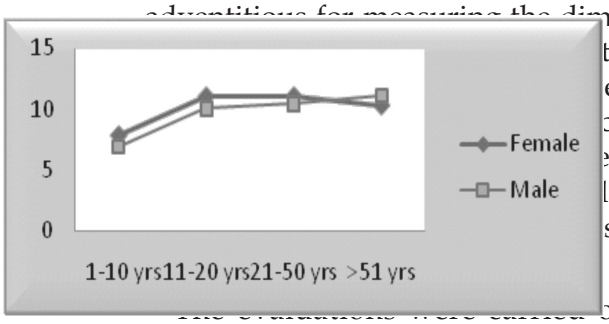


Table 1: Total Antero-Posterior Diameter of Whole Gland

Patient age groups (years)	Mean measurement: mm ±SD	
	Total Antero-posterior diameter of whole gland	
	Female	Male
1-10 n= 18	7.88± 1.06	6.97±0.67
11-20 n= 20	11.05 ± 1.55	10.04 ±1.60
21-50 n= 68	11.07 ±1.10	10.41 ± 2.30
>51 n= 54	10.33 ± 1.4	11.08 ± 3.05
p Value * ANOVA	0.0186	0.0190

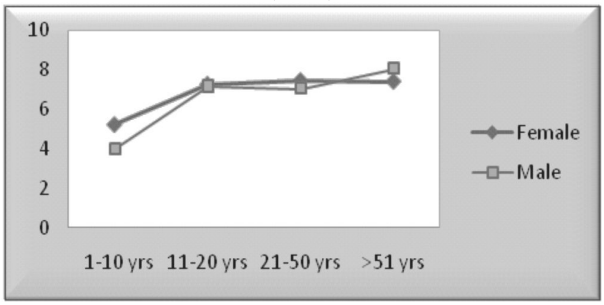
Graph 1: Total Antero-Posterior Diameter (mm) of Whole Gland



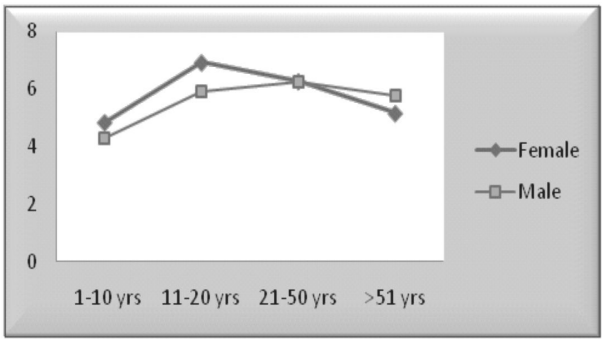
permits evaluation of the hyper intense signal of the posterior pituitary (HSPP) that was advantitious for measuring the dimensions of the stalk of educt and considered views, in land bright sions were

out by the authors independently, with subsequent discussion, as necessary, to agree on the hyper intense signal of the posterior pituitary to minimize observation variation. The measurements were analyzed in 8 different age groups of both genders separately for mean ± SD and One way ANOVA test. Further data

Graph 2.1: Anterior Lobe Mean Measurement: Antero-Posterior Diameter (mm)



Graph 2.2: Anterior Lobe Mean Measurement: Height (mm)



was subjected by unpaired t-test using open EPI software for analyzing the sexual dimorphism. The shape of gland evaluated to percentage and Chi-square test. P-value less than 0.05 considered as significant.

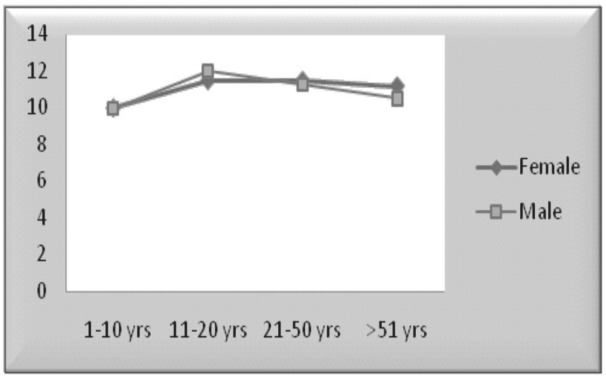
Results

A total of 200 cases were selected for study, out of that 40 were excluded according to the selection criteria. In this 76 were female and 84 were male. The data was arranged into eight groups on the basis of age and gender (1-10, 11-20, 21-50, >51 years).

Table 2: Anterior Lobe Mean Measurement

Patient's age groups (years)	Anterior lobe Mean measurement: mm ±SD					
	Antero-posterior diameter		Height		Transverse	
	Female	Male	Female	Male	Female	Male
1-10 n= 18	5.25±1.00	4.00±0.32	4.83±0.91	4.30±1.15	9.97±3.24	9.95±2.16
11-20 n= 20	7.30 ± 1.18	7.15±1.50	6.93±1.47	5.92±1.27	11.46±3.64	12.02±2.92
21-50 n= 68	7.49±1.17	7.07±1.66	6.27±1.37	6.24±1.26	11.46±0.78	11.26±2.58
>51 n= 54	7.45±1.45	8.05±2.13	5.15±0.62	5.78±1.24	11.17±1.98	10.49±2.96
p Value * ANOVA	0.0159	0.0140	0.0088	0.0117	0.0310	0.0228

Graph 2.3: Anterior Lobe Mean Measurement: Transverse Diameter (mm)



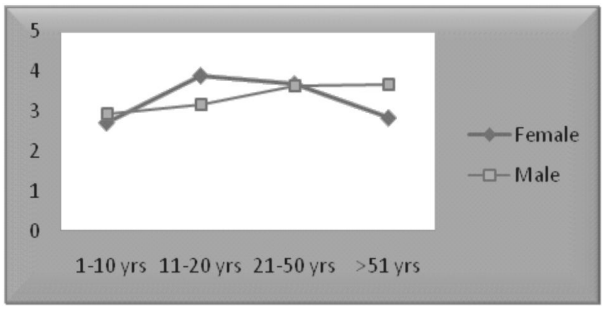
Size

As seen in Table 1 and corresponding graph 1, the mean value of total antero-posterior diameter of whole gland in female (1-10 yrs, n = 10) was 7.877mm ±1.06 (SD) and that of male (n = 8) was 6.973 mm ± 0.6683 (SD). Group 2, (11-20 yrs) was 11.05 ± 1.54mm in female (n=8) and 10.04 ±1.59 mm in males (n=12). In group 3 (21-51yrs) was 11.07 ±1.102 mm in females (n=33) and 10.41± 2.29 mm in males (n=35). While in group 4 (>51 yrs) that was 10.33 ± 1.396 mm in females (n=25) and 11.08 ± 3.051 mm in males (n=29). These were significantly different ($p< 0.01$) among the both male and female groups, as shown in Table 1.

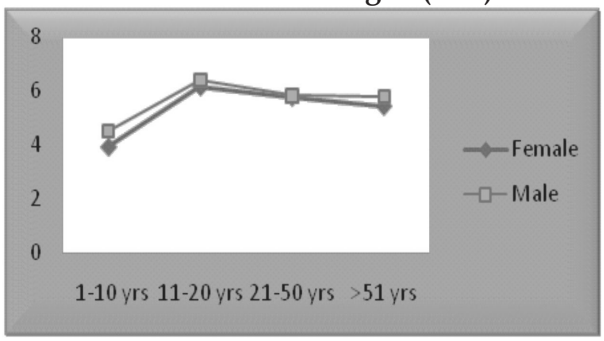
Similarly, the mean and standard deviation of different dimensions of anterior lobe, posterior lobe and that of stalk were given in Table 2, 3, 4 and their corresponding graphs, respectively. The means of different dimensions of both the genders among the all age groups were significantly related with each other as tested by One way ANOVA ($p<0.01$- $p <0.03$).

Further, the sexual dimorphism was analyzed among the all age groups by using unpaired t-test. In all age groups, majority of male mean dimensions were nearly similar with that of females except the few like antero-posterior diameter of anterior lobe, at age group I (1-10yrs), ($p=0.004$) antero-posterior diameter of posterior lobe, at age group IV (>51

Graph 3.1: Posterior Lobe Mean Measurement: Antero-Posterior Diameter (mm)



Graph 3.2: Posterior Lobe Mean Measurement: Height (mm)



Graph 3.3: Posterior Lobe Mean Measurement: Transverse Diameter (mm)

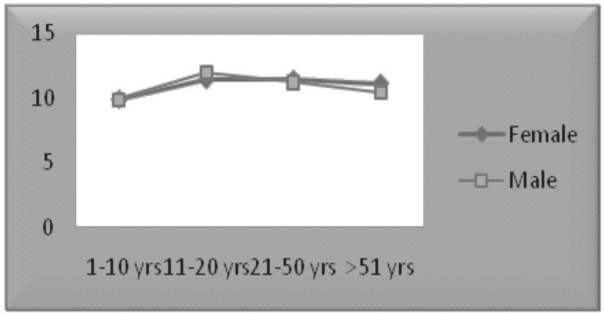


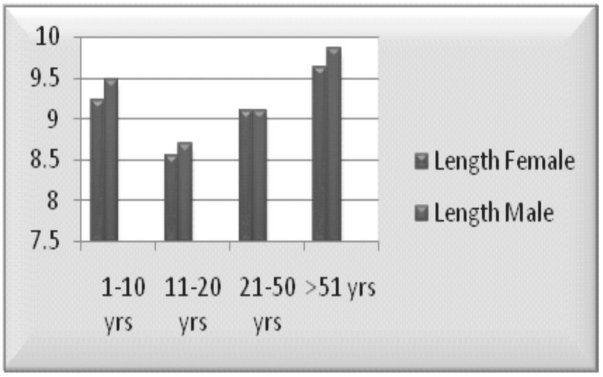
Table 3: Posterior Lobe: Mean Measurement

Patient age groups (years)	Posterior lobe Mean measurement: mm ±SD					
	Antero-posterior diameter		Height		Transverse	
	Female	Male	Female	Male	Female	Male
1-10 n= 18	2.72±0.46	2.94±0.54	3.96±1.15	4.55±1.17	6.39±1.07	6.81±1.86
11-20 n= 20	3.89±0.61	3.16±0.85	6.17±0.8	6.40±2.04	9.17±4.35	10.34±4.16
21-50 n= 68	3.68±0.93	3.63±1.01	5.79±1.43	5.84±1.52	9.60±4.42	9.58±4.14
>51 n= 54	2.84±0.39	3.67±0.84	5.46±1.98	5.79±1.79	7.89 ±1.78	9.58±4.25
p Value * ANOVA	0.0095	0.0084	0.0144	0.0129	0.029	0.0280

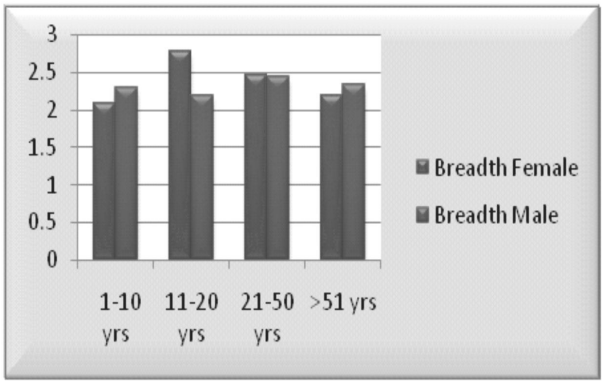
Table 4: Stalk Mean Measurement: Length and Breadth.

Patient age groups (years)	Stalk Mean measurement: mm ±SD			
	Length		Breadth	
	Female	Male	Female	Male
1-10 n= 18	9.227±2.07	9.49±1.55	2.08±3.95	2.29±0.50
11-20 n= 20	8.544±2.01	8.69±1.68	2.77±0.46	2.20±0.43
21-50 n= 68	9.10±1.92	9.10±1.51	2.47±0.51	2.44±1.06
>51 n= 54	9.63±2.03	9.86±1.82	2.19±0.25	2.33±0.46
p Value * ANOVA	0.0218	0.0165	0.0083	0.0071

Graph 4.1: Stalk Mean Measurement: Length (mm)



Graph 4.2: Stalk Mean Measurement: Breadth (mm)



yrs) (p=0.0033) and breadth of stalk, at age group II (11-20 yrs) (p=0.011), showed no statistically significant difference. By considering these results, there was no sexual dimorphism in different dimensions of the both lobes of Pituitary.

Shape

The shape of the superior surface of the gland (SS) was observed in all 160 patients. The total frequency of convexity seen for 70% females and 50% males, and it was found to be significant. (F, p=0.03; M, p=0.029) (Table 5). This convex upper border was more common in group III (21-50 yrs) of both males and females with frequency (28%) and (35%) respectively. In males, the frequency of flat upper surface was seen in 4% cases while only 3% female patients showed the flat surface, which was not significant in both (p> 0.5). And remaining all cases were having concave upper surface (27% in females and 46% in males). There was no significant gender difference in convex shape of the upper border (p=0.3) and hence no sexual dimorphism seen.

Discussion

Different textbooks of anatomy mentioned the measurements of Pituitary gland. According to Gartnermasurements were 10×6×5 mm in new borns; 15×10×6 mm at 20 years; 16×13×7 mm at 40 yrs, 17×12×6 mm at

Table 5: Shape of Superior Surface

Total Frequency of	Female	Male
Convex surface	70%	50%
Concave surface	27%	46%
Flat surface	3%	4%
P value by Chie- square test among convex and non convex frequency	0.03	0.029

70 yrs and 13×11×6 mm at 80 years; this showed a decrease in measurements as a whole after the age 40 yrs.[10] According to Harrisonthe diameters were; 14 mm-transverse, 9 mm-anteroposterior and 6 mm-vertical.[11] Williams *et al* reported the measurements of the gland as 12 mm transverse and 8mm anteroposteriorly.[12] Using MRI Gonzalez *et al* found the average measurements, in 20 normal Mexican living women to be 12.4 mm (transverse) 7.9 mm (anteroposterior) and 6 mm (vertical).[13] Also a useful guide to the gland's height in relation to age is "Elster's rule"of 6,8,10,12: 6 mm for infants and children, 8 mm in men and postmenopausal women, 10 mm in women of childbearing age and 12 mm for women in late pregnancy or postpartum women. Andthe pituitary stalk has a normal thickness of 2 mm, and it should not exceed a maximum of 4 mm or the width of the basilar artery.[14]

In our study also, the measurements were 9.97; 9.95 (F;M) – transverse, 7.88; 6.97 (F;M) – antero-posterior, 4.83; 4.30 (F;M) – height at 1-10 yrs, 11.46; 11.26 (F;M) – Transverse, 11.07; 10.41(F;M) – anteroposterior and 6.27; 6.24 (F;M) – vertical i.e height at 21-50 yrs, while at >51 yrs measurements were 11.17; 10.49 (F;M) – transverse, 10.33; 11.8 (F;M) – anteroposterior and 5.15; 5.78 (F; M) – height. This also showed a decrease in measurements as a whole after 50 years as like previous authors.[8,9]

Sexual Diamorphism

Lurie *et al* measured length, breadth and height of the pituitary gland in 35 (16 male and 19 females) adult volunteers between the age 26-79 yrs by MRI in sagittal and coronal sections of the head.[15] They observed that, statistically there was no sexual difference in the size of pituitary.

Similarly, in our study except for few parameters, remaining all suggested that there was no statistically significant sexual dimorphism in the size of pituitary gland. The parameters like antero-posterior diameter of anterior lobe, at 1-10 yrs and that of posterior lobe, at >51yrs and also the breadth of stalk, at 11-20 yrs showed statistically significant difference among the both sexes.

Along with these dynamic changes in size of pituitary, this study also showed the range of appearances i.e. the shape of superior surface of the normal whole Pituitary gland during different stages of life. Pronouncely, at age of 21-50 yrs, the superior surface showed convexity in 35% females & 28% of males out of total frequency of convex surface which was in 70% females and 50% males.

These dynamic changes occur in the size, shape Pituitary gland during life were similar with the previous authors.[5,8,9,10] It was suggested that, there was a complex hormonal environment of the pituitary gland reflect into the variability in size and shape of gland at different stages of life and they were most pronounced at times of hormonal flux such as menarche[16,17] and pregnancy.[18]

Observations of the pituitary gland during puberty have shown a definite but transient increase in size, attributed to the increased hormonal activity at this time.[16,17] The hormonal levels of pituitary at puberty, even though higher than adult levels, but are much lower in the neonatal period. This may account for the change in size of the gland.

It has been documented that the pituitary gland also enlarges and may increase in signal intensity during pregnancy.[18] The changes in appearance of the gland during different phases of the menstrual cycle have been also shown (R. Shankwiler, M. E. Mawad, C. Valdes,K. Elkind-Hirsch, "Biphasic Morphological Changes of the Normal Menstrual Cycle demonstrated on Gadolinium MRI," presented at the29th Annual Meeting of the American Society of Neuroradiology, Washington, DC, June 13,1991).[8] The children with precocious puberty showed changes in the gland paralleling to those seen in healthy adolescents irrespective of their chronologic age.[19] It therefore appears that, there is a strong link between the fluctuation in hormone levels and the changing appearances of the pituitary gland during life.

Hence we conclude that, the changes in shape and size of Pituitary gland observed in our study also reflect the same reason of hormonal level fluctuation.

The Age related changes in the shape of upper border have been documented.[20,21] The frequency of convex upper border of the pituitary gland is reported to be higher in young age group. It becomes very important to differentiate the normal convex upper border of the pituitary from an abnormal convex upper border due to microadenoma, lymphocytic adenohypophysitis and pituitary cyst etc.[8] For this reason, observations of chronological changes in the shape of the pituitary upper border in young age group, was done in this study which were similar to that of the previous authors.

The studies of Pituitary gland in childhood also have clinical application in the evaluation of children with possible pediatric endocrine abnormalities, who may demonstrate an abnormal appearance of the gland for their age. The demonstration of a small, low-signal-intensity gland in an infant younger than 6 weeks of age may raise the possibility of panhypopituitism. By contrast, in an older child with precocious puberty, an enlarged gland may be seen at a time when the gland should have a flat or concave appearance.[20]

Conclusion

This study demonstrates the database of Indian people in age groups from children to puberty to young adults to old age whose mean size and shape of pituitary gland from each age groups, was acquired by MR Imaging, can apply to clinical evaluation particularly of clinical symptoms of patients in pubertal period and young adults in which physiologic pituitary hyperplasia can mimic pituitary tumor.

Acknowledgement

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Key Message

The database of Indian people, with respect to morphometry of both lobes of pituitary gland.

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