



Morphological Characterization of Pituitary Gland: A Retrospective Study Using Magnetic Resonance Imaging

Mr. Shubham Gupta^{1*}, Dr. Rajul Rastogi²

^{1*}Research Scholar, Department of Radio- Imaging Techniques, College of Paramedical Sciences, Teerthanker Mahaveer University, Moradabad-244001, Uttar Pradesh, India

²Professor, Department of Radio-Diagnosis, Teerthanker Mahaveer Medical College and Research Centre, Teerthanker Mahaveer University, Moradabad

***Corresponding Author:** - Mr. Shubham Gupta,
Department of Radio- Imaging Techniques, College of Paramedical Sciences, Teerthanker Mahaveer University, Moradabad-244001, Uttar Pradesh, India.

(Received: 02 June 2025

Revised: 29 June 2025

Accepted: 11 July 2025)

KEYWORDS

Magnetic Resonance Image, T1 Weighted image, T2 Weighted image, Pituitary gland

ABSTRACT:

Background: The pituitary gland plays a crucial role in endocrine function, and its morphology can vary with age and gender. Understanding the normative values of pituitary size, volume, and shape is essential for identifying pathological deviations. Magnetic Resonance Imaging (MRI) provides a reliable modality for assessing these parameters non-invasively.

Objective: To examine the normative values of pituitary gland size, volume, and shape across different age groups and genders using brain MRI, and to assess the relationship between these measurements and demographic variables such as age and gender.

Result: A total of 200 patients (146 men and 54 women), aged 10 to 60 years, who underwent brain MRI were included in this retrospective analysis. The average pituitary height was 5.78 mm in men and 5.52 mm in women, with no statistically significant difference. Pituitary length measured 9.34 mm in men and 9.67 mm in women. The pituitary volume was 388.31 mm³ in men and 396.39 mm³ in women, while the pituitary surface volume was 345.75 mm³ in males and 333.65 mm³ in females, with none of these differences reaching statistical significance. Significant associations were observed between pituitary measurements (height, length, and surface area) and age.

Conclusion: The study found no significant differences in pituitary gland dimensions between males and females. However, pituitary height, length, and surface area were significantly associated with age. Further research is warranted to explore the factors influencing these age-related changes in pituitary morphology.

1. Introduction

The pituitary gland displays variations in its dimensions, configuration, and signal strength, which mirror the intricate hormonal functions of the gland. Situations like borderline pituitary irregularities, including natural gland enlargement, minor microadenomas, enlarged

uneven borders, inflammatory diseases, and empty sella, are frequently encountered. To diagnose such conditions, establishing measurements for the typical pituitary gland across various age brackets proves beneficial. Magnetic Resonance Imaging (MRI) stands as an effective diagnostic method for assessing the pituitary gland. The absence of previous



measurements for pituitary height and volume across a wide spectrum of age ranges and both genders within a specific Indian population underscores the necessity of the study. Sanjay SC et al., 2014[3]

Investigation of Size and Shape Variations in the Pituitary Gland of Adult Women: A Radiological Analysis. As per the research findings, the prevalent shape observed in pituitary glands is flat, and their height experiences a decrease as individuals age, except for those aged between 40 and 49. This particular study solely focused on female patients and didn't consider glandular volume. To establish the average normal volume of the pituitary gland with respect to age and gender, the present research was conducted to assess the dimensions and configuration of the typical pituitary gland across diverse age groups and both sexes using MRI. Yadav P, Singhal et al., 2017 [2]

Indeed, the most common abnormality encountered in the sellar region is pituitary adenomas. When it comes to the structural assessment of active endocrine pituitary adenomas, magnetic resonance imaging (MRI) typically suffices as the sole necessary technique. The treatment approach for acromegaly and Cushing's syndrome is directly guided by the findings from MRI. Should there be instances of skeletal distortions, anatomical deviations, or calcification, a computed tomography (CT) scan should only be conducted with a secondary purpose and should be reserved for exceptional situations to complement the information provided by MRI images. Our comprehensive analysis of the MR characteristics of pituitary adenomas encompasses details regarding their dimensions, gender prevalence, age distribution, endocrine functionality, and certain specific disorders. Bonneville JF et al., 2005.[10]

2. Material and Methods

Study Area:

The study was carried out at the Department of Radiology of a 750-bedded tertiary medical facility located in Gujarat.

Study Design and data collection: -

We evaluated the clinical data of all patients who had an MRI Brain examination from June 2022 to May 2023. Clinical data were retrieved from the Department of Radiology's MR Console room. This database was authorized by the Hospital Ethical Committee and was also double recorded into the MRI record book and Microsoft spreadsheets. The study was approved by the Institute Ethical Committee of Human Research (PU-IECHR) with approval number PUIECHR/PIMSR/00/081734/5305.

Patient Selection: -

The patients were chosen by identifying all instances of Brain at Parul Sevashram Hospital between June 2022 to May 2023. We thoroughly checked the data of all individuals who had an MRI Brain. Case files from patients were utilized to validate data from another source of data. The 200 patients examined ranged in age from 10 to 60 and came with a variety of brain pain issues, with 146 males and 56 female patients.

Inclusion criteria: -(i) Patients with regular brain scans, encompassing individuals aged between 10 and 60 years, were incorporated into the study.

Exclusion criteria: - (i) Patients with endocrine disorders, head injuries, those who are pregnant or breastfeeding during the examination, as well as individuals with empty sella and cases where the sella was filled with cerebrospinal fluid (CSF), along with a pituitary gland height measuring less than



2mm, were categorized as having an empty sella. (ii) Patient with a history of Degenerative & any Pathological conditions of the brain. (iii) Patients above the age of 60 years, patients with a history of claustrophobia, are contraindicated and were excluded.

Material & Instrumentation: - The brain examination was done on GE Signa DXT 1.5

T MRI Scanner the brain coil is used for the examination with immobilization devices. MRI Work stations-OsiriX DICOM.

Data Analysis: - Statistical analysis was performed using SPSS (Statistical Package for the Social Science Software) version 26.0, Microsoft Excel 2021 MSO (Version 2304 Build 16.0.16327.20200) 64-bit and 3D slicer version 5.2.1.

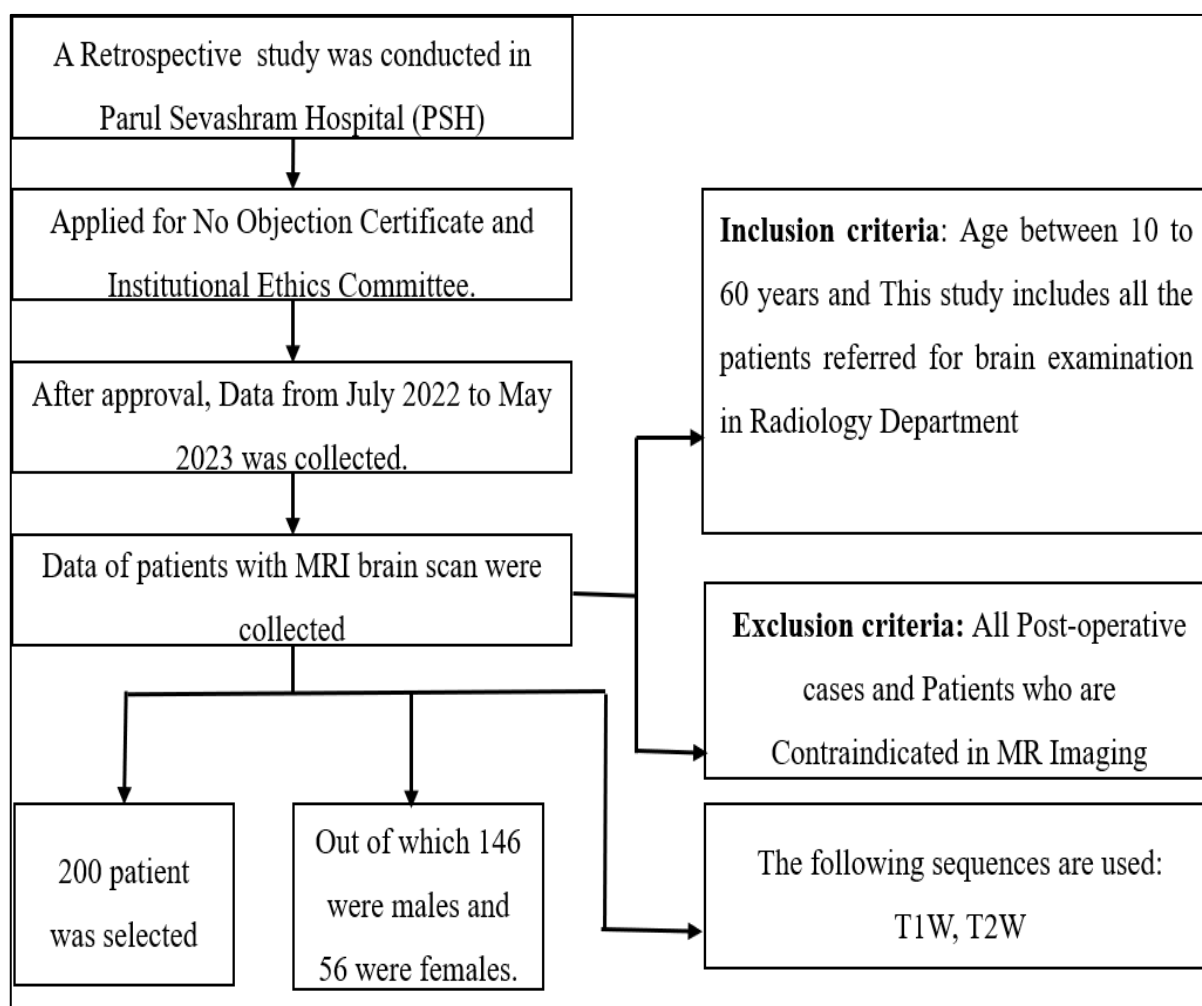


Fig: - 1: The Study's Procedure Flowchart

3. Result

In present study includes 200 patients, of whom 146 are male & 54 are female. The

patients are divided into 5 individual groups according to age their mean value of pituitary height, length, volume, and surface area as shown in Table 5.1



Frequency and percentage of Population

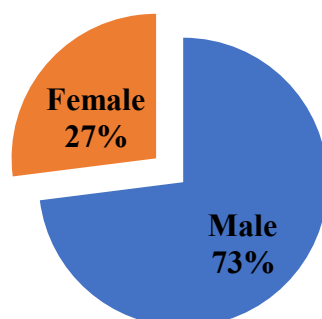


Figure 2- Shows frequency and percentage of Population

Table 1: - Mean & S.D. of Pituitary Height, length, Volume and Surface Area among different age groups

Age Group	Mean \pm S.D. Height		Mean \pm S.D. length		Mean \pm S.D. volume		Mean \pm S.D. surface area	
	Male	Female	Male	Female	Male	Female	Male	Female
10-20	5.89 \pm 1.31	-	7.97 \pm 1.11	-	355.88 \pm 77.68	-	336.76 \pm 84.28	-
21-30	5.57 \pm 0.87	5.41 \pm 0.84	9.69 \pm 1.40	9.67 \pm 1.44	379.89 \pm 91.54	377.47 \pm 75.97	326.67 \pm 80.48	307.41 \pm 69.10
31-40	5.81 \pm 1.00	5.73 \pm 0.87	9.57 \pm 1.38	9.80 \pm 1.32	405.00 \pm 80.05	404.56 \pm 76.68	368.70 \pm 89.83	362.84 \pm 88.92
41-50	6.35 \pm 0.50	5.39 \pm 0.81	9.29 \pm 1.96	8.16 \pm 1.73	400.05 \pm 75.26	330.10 \pm 25.25	351.32 \pm 72.83	370.81 \pm 142.87
51-60	5.96 \pm 0.60	5.14 \pm 0	9.14 \pm 1.56	9.77 \pm 0	404.84 \pm 52.53	425.13 \pm 0	364.22 \pm 54.66	433.99 \pm 0

Above table 1 shows about mean and standard deviation of height, length, volume and area of pituitary gland between different age groups.

Table 2: - of Pituitary Height, length, Volume and Surface among gender according to Z Test

Gender	Frequency	Mean \pm S.D. Height	Mean \pm S.D. length	Mean \pm S.D. volume	Mean \pm S.D. surface area
Male	146	5.78 \pm 0.91	9.34 \pm 1.52	345.75 \pm 80.23	388.31 \pm 81.37
Female	54	5.52 \pm 0.88	9.67 \pm 1.39	333.65 \pm 83.36	396.39 \pm 109.81

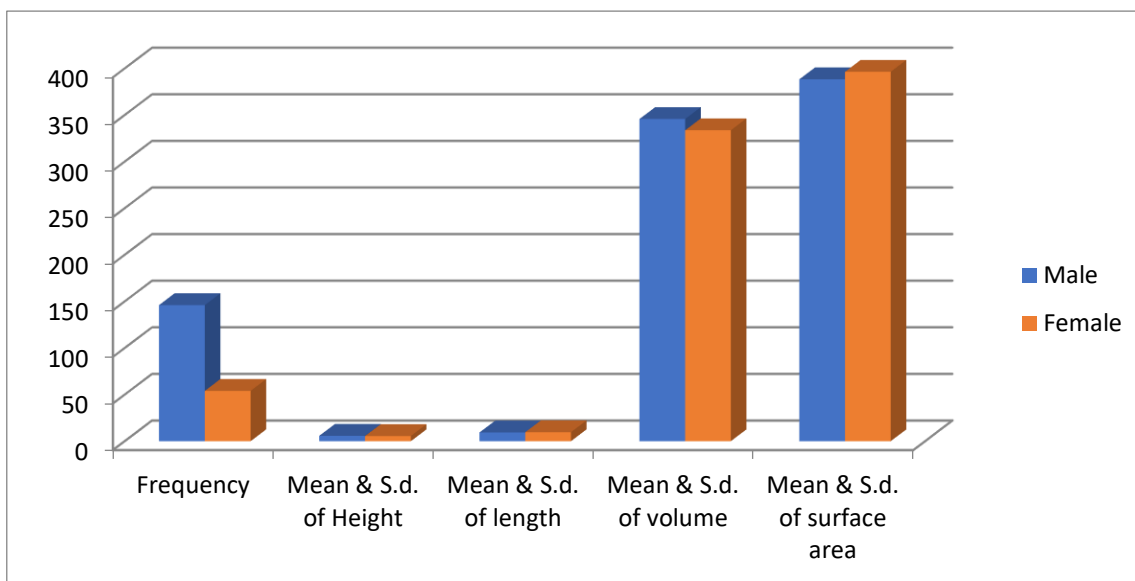


Figure:3- Mean & S.d. of Pituitary Height, length, Volume and Surface among gender according to Z Test

The above table 5.2 shows that the mean pituitary height is 5.78 ± 0.91 mm in males and 5.52 ± 0.88 mm in females, with ($p > 0.07$), indicating that the difference between males and females was not significant (z value = 1.80). The length of the pituitary is 9.34 ± 1.52 mm in males and 9.67 ± 1.39 mm in females, with ($p > 0.15$), suggesting that the difference between males and females was not significant (z value = 1.41). The volume of the

pituitary is 388.31 ± 6.73 mm in males and 396.39 ± 14.94 mm in females, with ($p > 0.62$), indicating that the difference between males and females was not significant (z value = 0.49). The surface volume of the pituitary is 345.75 ± 6.64 mm in males and 333.65 ± 11.34 mm in females, with ($p > 0.35$), showing that the difference between males and females was not significant (z value = 0.92).

Table 5.3 :- Anova Test Descriptive Value According to Age Group

Parameter	Age Group	Frequency	Mean & S.D.
Height (mm)	10-20	17	5.88 ± 1.30
	21-30	91	5.51 ± 0.86
	31-40	53	5.77 ± 0.94
	41-50	15	6.15 ± 0.63
	51-60	24	5.92 ± 0.60
	Total	200	5.71 ± 0.90
Length (mm)	10-20	17	7.96 ± 1.11
	21-30	91	9.68 ± 1.40
	31-40	53	9.66 ± 1.35
	41-50	15	9.22 ± 1.87
	51-60	24	9.16 ± 1.53
	Total	200	9.43 ± 1.49
Volume (mm ³)	10-20	17	355.88 ± 77.68



	21-30	91	376.14 ± 83.10
	31-40	53	401.12 ± 74.25
	41-50	15	389.95 ± 70.27
	51-60	24	405.68 ± 51.54
	Total	200	385.62 ± 77.03
Surface area (sq.mm)	10-20	17	336.76 ± 84.28
	21-30	91	320.32 ± 77.06
	31-40	53	366.37 ± 88.65
	41-50	15	359.65 ± 78.32
	51-60	24	367.12 ± 55.31
	Total	200	342.48 ± 81.06

In above table 5.3 shows the mean pituitary gland height in age group 10-20 years came out to be 5.8 ± 1.3 mm. in the age group 21-30 years mean pituitary height was 5.5 ± 0.8 mm. in the age group 31-40 years 5.5 ± 0.9 mm, 41-50 years age group 6.1 ± 0.6 mm, in 51-60 years age group 5.9 ± 0.6 mm. A p-value for relation of pituitary height with age came out to be 0.03 (<.05) in both group of male and female group which was statistically are significant,

The mean pituitary gland length in age group 10-20 years came out to be 7.96 ± 1.11 mm. in the age group 21-30 years mean pituitary length was 9.68 ± 1.40 mm. in the age group 31-40 years 9.66 ± 1.35 mm. 41-50 years age group 9.22 ± 1.87 mm. 51-60 years age group 9.16 ± 1.53 mm. A p value for a relation of pituitary gland length with age came out to be 0.00 (<.05) in the both group of male and female group which was statistically are highly significant,

The mean pituitary gland surface area in age group 10-20 years 336.76 ± 84.28 mm. in age group 21-30 years 320.32 ± 77.06 mm. 31-40 years age group 366.37 ± 88.65 mm. 41-50 years age group 359.65 ± 78.32 mm. 51-60 years age group 367.12 ± 55.13 mm. A p value for relation of pituitary gland with age came out to be 0.005 (<.05) in the both group of male and female group which was statistically are significant,

The pituitary gland volume in age group 10-20 years 344.88 ± 77.68 mm. in age group 21-30 years 376.14 ± 83.10 mm. 31-40 years age group 401.12 ± 74.25 mm. 41-50 years age group 389.95 ± 70.27 mm. 51-60 years age group 405.68 ± 51.54 mm. A p-value for relation of pituitary gland with age came out to be 0.100 (>0.05) in the both group of male and female group which was statistically are not significant.

Table 4: - Anova Test in different age groups

Parameters	Difference group	Sum of square	Df. value	Mean square	F Value	Significant
Height (mm)	Between group	8.21	4	2.05	2.59	0.038*
	Within groups	154.41	195	0.79		
	Total	162.63	199			
Length (mm)	Between group	47.29	4	11.82	5.82	0.000*



	Within groups	395.81	195	2.03		
	Total	443.10	199			
Volume (mm³)	Within groups	1135007.00	195	2.03	1.97	0.100
	Total	1180903.88	199			
Surface area (sq.mm)	Between group	94501.64	4	23625.41	3.79	0.005*
	Within groups	1213152.42	195	6221.29		
	Total	1307654.06	199			

*(significant)

4. Discussion

According to the z-test results, there were no statistically significant gender differences in pituitary height, length, volume, or surface volume. All of the p-values were larger than the frequently accepted threshold of 0.05, suggesting that there was insufficient statistical evidence to indicate a significant difference between males and females. Although the disparities were not statistically significant, there were numerical differences in the averages between males and females. These variances, however, might be ascribed to natural fluctuations or other variables not taken into account in this study. The mean pituitary height was found to be 5.78 ± 0.91 mm in males and 5.52 ± 0.88 mm in females. The calculated p-value was 0.07, indicating that the difference between male and female pituitary height was not statistically significant. The z-value of 1.80 suggests that the observed difference is 1.80 standard deviations away from the mean difference.

Lurie SM. et.al, Future studies could reasonably use pituitary height alone, with findings on mid-sagittal T1-weighted images serving as the single measure of pituitary size, as suggested by the changes in pituitary size are primarily due to changes in pituitary gland

height, as there are no age-related effects on gland length or width.[8]

The purpose of this discussion is to interpret the results of the z-tests conducted to examine gender differences in pituitary height, length, volume, and surface volume. The z-test is a statistical test used to compare the means of two independent groups. In this study, the mean measurements of male and female individuals were compared, and the p-values and z-values were calculated to determine the significance of the observed differences.

Sanjay SC. et.al, determined that the average height of the pituitary gland was 6.27 ± 0.56 , the average length was 9.10 ± 0.78 , and the average width was 11.22 ± 0.82 . They also discovered that height decreases with age, however there was a little rise in height in the 40-49 age bracket.[3].

For pituitary length, the mean was 9.34 ± 1.52 mm in males and 9.67 ± 1.39 mm in females. The p-value obtained was 0.15, suggesting that there is no statistically significant difference in pituitary length between males and females. The z-value of 1.41 indicates that the observed difference is 1.41 standard deviations away from the mean difference. In terms of pituitary volume, the mean was 388.31 ± 6.73 mm in males and 396.39 ± 14.94 mm in females. The calculated p-value was 0.62, indicating that there is no



statistically significant difference in pituitary volume between males and females. The z-value of 0.49 suggests that the observed difference is 0.49 standard deviations away from the mean difference. Pituitary The mean pituitary surface volume was $345.75 \pm 6.64\text{mm}$ in males and $333.65 \pm 11.34\text{mm}$ in females. The p-value obtained was 0.35, indicating that there is no statistically significant difference in pituitary surface volume between males and females. The z-value of 0.92 suggests that the observed difference is 0.92 standard deviations away from the mean difference.

The present study aimed to investigate the relationship between pituitary gland measurements (height, length, surface area, and volume) and age across different age groups. The mean values and standard deviations for each age group were calculated, and an analysis of variance (ANOVA) test was conducted to determine the significance of the relationship between pituitary gland measurements and age. The many results compounded during this study the most striking result was that the height of the pituitary gland in both sex increases again in the 41-50 years old age group the first increases in pituitary height during puberty in 10-20 years old age group, the decreases in the middle age group in 21-30 to 31-40 years old age group. height is measuring observed minimum and maximum increase according to age group 10 to 60 years old age group minimum height 3mm, maximum 7 mm observed

Yadav P. et.al, study provided to offer data on normal pituitary height and volume in the Indian population at various ages. Age and gender have an effect on normal pituitary gland dimensions. Pituitary height peaked between the ages of 21 and 30. Pituitary height more than 9mm in the 21–30-year age group and greater than 8mm in the other age groups was judged abnormal. Perimenopausal women

had an increase in pituitary height, which might be owing to the lack of gonadal steroid feedback. This discovery in pituitary size and shape change is useful in evaluating pituitary morphology in neuroendocrine diseases.[2].

In summary, the results of the ANOVA tests indicate that there is a significant relationship between pituitary gland height, length, and surface area with age, as demonstrated by the p-values of 0.03, 0.00, and 0.005, respectively (all $p < .05$). However, there was no significant relationship found between pituitary gland volume and age, as indicated by the p-value of 0.100 ($p > .05$). These findings suggest that pituitary gland measurements, except for volume, may change significantly with age, highlighting the importance of considering age as a factor when interpreting pituitary gland measurements

5. Conclusion

In relation to the correlation between measurements of the pituitary gland and age, the study's outcomes revealed noteworthy connections. Pituitary height displayed a substantial correlation with age ($p = 0.03$) for both males and females, showcasing diverse averages across distinct age groups. Similarly, pituitary length exhibited a highly significant association with age ($p = 0.00$), with mean lengths differing across various age categories. Additionally, a significant relationship was observed between pituitary surface area and age ($p = 0.005$), demonstrating variations in mean surface areas across age groups. However, no significant correlation emerged between pituitary volume and age ($p > 0.100$). These findings suggest that as individuals age, alterations occur in pituitary height, length, and surface area, while pituitary volume remains unchanged.



In conclusion, this study found no significant differences in pituitary measurements between males and females. However, there were significant associations between pituitary height, length, and surface area with age. These results provide insights into the relationship between pituitary gland characteristics and age, which may have implications for further research and clinical considerations.

Limitations:

1. Our study might lack a fundamental comparative baseline with healthy subjects, potentially curbing the extent to which our findings can be generalized to a wider population.
2. Another significant drawback in our study is Enlisting a larger group of subjects would offer a more comprehensive portrayal of the population, facilitating more precise deductions concerning the relationships under scrutiny.
3. The implementation of measures to curtail measurement discrepancies and the implementation of meticulous calibration protocols could alleviate this limitation in forthcoming studies.

Reference

1. Varrassi M. et.al, High-resolution magnetic resonance imaging at 3T of pituitary gland: advantages and pitfalls. *Gland Surgery*. 2019 Sep;8(Suppl 3):S208.
2. Yadav P. et.al, MRI evaluation of size and shape of normal pituitary gland: age and sex related changes. *J Clin Diagn Res*. 2017 Dec 1;11(12):1-4.3
3. Sanjay SC. et.al, Variation in size and shape of a normal adult female pituitary gland: A radiological study. *Journal of Evolution of Medical and Dental Sciences*. 2014 May 5;3(18):4934-40.
4. Chaudhary V. et.al, Imaging of the pituitary: Recent advances. *Indian journal of endocrinology and metabolism*. 2011 Sep;15 (Suppl3):S216.
5. Garel C. et.al, Contribution of magnetic resonance imaging in non-tumoral hypopituitarism in children. *Hormone Research in Paediatrics*. 2007;67(4):194-202
6. Bonneville JF. Magnetic resonance imaging of pituitary tumors. *Imaging in Endocrine Disorders*. 2016;45:97-120.
7. MacMaster F. P. et.al, MRI study of the pituitary gland in adolescent depression. *Journal of Psychiatric Research*. 2004 May 1;38(3):231-6.
8. Uozumi T. et.al, MRI of pituitary adenomas: the position of the normal pituitary gland. *Neuroradiology*. 1994 May;36(4):295-7.2
9. Lurie SN. et.al, In vivo assessment of pituitary gland volume with magnetic resonance imaging: the effect of age. *The Journal of Clinical Endocrinology & Metabolism*. 1990 Aug 1;71(2):505-8.
10. Wolansky LJ. et.al, MRI of pituitary abscess: two cases and review of the literature. *Neuroradiology*. 1997 Jul;39(7):499-503.
11. Bonneville JF. et.al, Magnetic resonance imaging of pituitary adenomas. *European radiology*. 2005 Mar;15(3):543-8.
12. Tabarin A. et.al, Comparative evaluation of conventional and dynamic magnetic resonance imaging of the pituitary gland for the diagnosis of Cushing's disease. *Clinical endocrinology*. 1998 Sep;49(3):293-300.
13. Piotin M. et.al, The various MRI patterns of pituitary apoplexy. *European radiology*. 1999 May;9(5):918-23.
14. Kato K. et.al, Morphological changes on MR imaging of the normal pituitary



- gland related to age and sex: main emphasis on pubescent females. *Journal of clinical neuroscience*. 2002 Jan 1;9(1):53-6.
15. Sumida M. et.al, Displacement of the normal pituitary gland by sellar and juxtaseilar tumors: surgical-MRI correlation and use in differential diagnosis. *Neuroradiology*. 1994 Jul;36(5):372-5.
 16. Vieira Jr Jo. et.al, Evaluation of magnetic resonance imaging criteria for cavernous sinus invasion in patients with pituitary adenomas: logistic regression analysis and correlation with surgical findings. *Surgical neurology*. 2006 Feb 1;65(2):130-5.
 17. Nomura M. et.al, Contrast-enhanced MRI of intrasellar arachnoid cysts: relationship between the pituitary gland and cyst. *Neuroradiology*. 1996 Aug;38(6):566-8..
 18. Bladowska J. et.al, Comparison of post-surgical MRI presentation of the pituitary gland and its hormonal function. *Polish Journal of Radiology*. 2010 Jan;75(1):29.
 19. Kollias S.S. et.al, Review of the embryologic development of the pituitary gland and report of a case of hypophyseal duplication detected by MRI. *Neuroradiology*. 1995 Jan;37(1):3-12.