بسم الله الرحمن الرحيم

كلية الدراسات العليا

Sudan University for Sciences and Technology

College of Graduate Studies

Characterization of Pituitary Gland and Sellar Region Using Magnetic Resonance Image

توصيف الغدة النخامية ومنطقة السرج التركى بإستخدام التصوير بالرنين المغناطيسي

A Thesis Submitted for Fulfillment of Ph.D. Degree Requirement in Diagnostic Radiologic Imaging

By:

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قال تعالى:

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ

الْإِنسَانَ مَا لَمْ يَعْلَمْ (5) ﴾

صدق الله العظيم

سورة العلق1-5

Dedication

To my parent who gives me love and cares forever

To my brothers and my sister who support me always

To my husband for his care and his cooperation with me

To my beautiful little angel, my son.

Acknowledgment

Thanks to God always and forever, so my gratitude and appreciation to my supervisor, Professor Caroline for her kindness, generosity, hospitality, guidance, and constant support until this study came to light.

Also, many thanks to Dr. Khaled Abdel Moneim, colleagues Mr. Nasreldeen Ali, and Mr. Tariq Yaqoub, and all the unique necklaces at Ysatabshiroon Medical Center, Al Amal Hospital and Modern Medical Center, and special thanks to Dr. Marwa Hussein, Dr. Alaa Ibrahim, Dr. Gadaa Al Fadil.

And last but not least, all the love for my friend Amal Mohamed Othman. And to all those who helped and supported me.

Abstract

The objective of the study to characterize the pituitary gland and sellar region using Magnetic Resonance Image (MRI). The current study included 301 participants within gender (123 males, 178 females) age between 20-60 years old who underwent brain MRI examination and diagnosed as a normal MRI brain, a study done in different MRI centers in Khartoum, in the period extended from 2015 to 2020.

The results of the current study showed that, the convex shape of the gland appeared as a common shape, concave, flat, partially empty, and empty respectively. The sphenoid sinus shape appeared was sellar, post-sellar, pre-sella, and conchal shape respectively, and the range of sphenoid sinus width was between (5.49mm to 49.70mm). The height measurement of the gland was higher in females than males (5.73mm for males, 5.78 mm for females) $P>0.05$, and with age the relationship appeared to be as U-shape the highest value among the adolescence in the third decade, followed by a decrease in pituitary height values, until they start to rise again relatively at the age group of 50-60 years. Also, the length, width, and volume of the gland mean were (11.12mm, 12.00mm, 383.39mm^3) respectively. The relationship of length with age was positive and inverse with width $P<0.05$. Males and females values were almost equal in gland area (0.565cm^2 for males, 0.561cm^2 for females) while males were a higher value for the ratio of the gland to sellar area (76.23% for males, 75.64% for females) $P<0.05$, while females were bigger values of the sellar area (0.748cm^2 for males, 0.756cm^{2}for females) $P<0.05$ and the opening distance (9.71mm for males, 9.98mm for females). The results of the gland area and opening distance and pituitary sellar percentage were statistically significant $P<0.05$ to the age. Males have longer measurements for the short axis of the bright region (2.82mm for males, 2.53mm for females) $P<0.05$, long axis measurement (4.4mm for males, 4.2mm for females) and the area of the bright region (0.1083cm^2 for males,

$0.1087 cm^2$ for females). The stalk lengths (3.57mm for males, 3.64mm for females) the stalk depth was longer in females than males (2.88mm for males, 3.05mm for females) $P<0.05$ in length with age. The angle of the stalk was in the range (40^o-58.90^o) which is a normal range of the angle. The distance between the columella nasal implant opening and the hypophysis was (89.09mm for males, 83.5mm for females). The distance between the hypophysis and the sphenoid nasal sinus (78.63mm for males, 73.43mm for females) the difference was statistically significant with gender as the values increased with age in general. The optic chiasm width was wider in males than in females (11.98mm for males, 11.36mm for females) $P<0.05$. The carotid artery distance in the saddle area (18.36mm for males, 16.83mm for females). The study concluded it's important to assess the dimensions of the pituitary gland and surround anatomical structure according to age and gender.

ملخص الدراسه

الهدف من هذه الدراسة هو توصيف الغده النخاميه ومنطقة السرج التركى بإستخدام التصوير بالرنين المغناطيسي اشتملت الدراسه الحاليه على 301 مشارك من الجنسين (123 من الذكور و 178 من الإناث) تتراوح أعمارهم بين 20-60 عامًا خضعوا لفحص التصوير بالرنين المغناطيسي للدماغ وتم تشخيص صورالرنين للدماغ بانها طبيعيه ,تمت الدراسه في مراكزمختلفه للرنين المغناطيسي في الخرطوم فى الفترة الزمنيه الممتده من 2015 إلى 2020.

نتائج الدراسة الحاليه اظهرت التالى ,الشكل المحدب للغدة ظهركالشكل الاكثر شيوعا يليه مقعر،مسطح ،فارغ جزئياً وفارغ على التوالي وكان ظهورأشكال الجيوب الوتدية على التوالى ,الشكل السرجى, ما بعد السرجى ,ما قبل السرجى والشكل الجنينى وكان مدى عرض الجيب الانفى الوتدى بين (5.49mm و49.70mm) . كان قياس ارتفاع الغدة أعلى عند الإناث منها عند الذكور (5.73mm للذكور ،5.78mm للإناث)P< 0.05 ، ومع تقدم العمر بدت العلاقة على شكل حرف U ,أعلى قيمة ظهرت فى الشباب في العقد الثالث من العمريليها هبوط في قيم ارتفاع الغده، ثم ارتفعت القيم مرة أخرى نسبيًا في الفئة العمرية من 50-60 عامًا. كما بلغ متوسط طول وعرض وحجم الغدة (11.12mm ، 12.00mm ،383.39mm^3) على التوالي, كانت علاقة العمربالطول علاقة طرديه وعكسيه مع العرضP<0.05. كانت قيم الذكور والإناث متساوية تقريبًا في مساحة الغدة (0.565cm^2 للذكور ،0.561 cm^2 للإناث) بينما كان الذكور أعلى قيمه فى نسبه مساحة الغدة إلى مساحه السرج (76.23٪ للذكور ، 75.64٪ للإناث) P <0.05 وكانت الإناث اكبرفى مساحه منطقة السرج (0.748cm^2 للذكور 0.756 cm^2 للإناث) ومسافة فتحه السرج (9.71mm للذكور و 9.98mm للإناث) اظهرت النتائج ان هناك دلاله احصائيه بين مساحه الغدة ومسافة فتحه السرج ونسبه مساحه الغده لمساحه السرج مع العمرP<0.05. الذكور لديهم قياسات اطول للمحور القصير للمنطقة المضيئة (2.82mm للذكور ، 2.53mm للإناث) P<0.05 ، كان قياس المحور الطويل (4.4mm للذكور ، 4.2mm للإناث) ومساحة المنطقه المضيئه (0.1083 cm^2 للذكور، 0.1087cm^2 للإناث). كان طول السويقه (3.57mm للذكور ، 3.64mm للإناث) وكان عمق السويقه اطول عند الاناث منه عند الذكور (2.88mm للذكور ، 3.05mm للإناث) P <0.05 لطول السويقه مع العمر. كانت زاوية الساق في المدى (40º-58.90º) وهو مدى طبيعي للزاوية. كانت المسافة بين الفتحه الخارجيه للانف والسرج التركي (89.09mm للذكور و 83.5mm للإناث). المسافة بين السرج التركي والجيوب الأنفية الوتدية (78.63mm للذكور ، 73.43mm للإناث) وكان الفرق ذو دلالة إحصائية مع النوع كما زادت القيم مع تقدم العمر بشكل عام. كان العصب البصري أعرض قياسا عند الذكور منه عند الإناث (11.98mm للذكور ، 11.36mm للإناث) P<0.05.كانت مسافة الشريان السباتي في منطقة السرج (18.36mm للذكور ، 16.83mm للإناث). خلصت الدراسة إلى أهمية تقييم أبعاد الغدة النخامية والأجزاء التشريحيه حولها حسب العمر والنوع.

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List of Abbreviation

ACTH	**Adrenocorticotropic Hormone / CRH Corticotropin-Relrasing Hormone**
ADH	**Antidiuretic Hormone**
AICP	**Acute Increased Intracranial Pressure**
AV	**Vasopressin**
aCP	**Adamantinomatous Cranio-Pharyngiomas**
CNS	**Central Nervous System**
CSF	**Cerebro-Spinal Fluid**
CT	**Computed Tomography**
E	**Empty Sella**
FEG	**Frequency Encoding Gradient**
FOV	**Field of View**
FSH	**Follicle Stimulating Hormone**
GE	**General Electric Health Care**
GE	**Growth Hormone**
ICD	**Inter Carotid Distance**
IIH	**Idiopathic Intracranial Hypertension**
LH	**Luteinizing Hormone**
MEN	**Multiple Endocrine Neoplasia**

MRI	**Magnetic Resonance Imaging**
OCW	**Optic Chiasm Width, OC/Optic Chiasm, WCHI /Width of the Optic Chiasm**
PBS	**Posterior Bright Spot /Posterior Pituitary Brightness**
PE	**Partial Empty Sella**
Pcp	**Papillary Cranio-Pharyngiomas**
PG /PI	**Pituitary Gland, PI/ Pituitary insertion**
PRL	**Prolactin**
PH	**Pituitary Height**
PS	**Pituitary Stalk**
RT / LT	**Right / Left**
SDP	**A small distance from pituitary to the point of intersection of the two imaginary lines. Small distance to pituitary.**
SS	**Superior Surface of the Gland**
SW	**Sinus width**
T1	**T1 Weighted Image (T1WI or the "spin-lattice" relaxation time)**
T2	**T2 Weighted Image(spin-spin" relaxation time)**
TE / TR	**Echo Time / Repetition Time**
TRH	**Thyrotropin-Releasing Hormone**
WL / WW	**Window Level / Window Width**

Chapter One

1.1 Introduction

The pituitary gland or hypophysis cerebri, derived from Greek terminology for its location as an attachment beneath the brain, was named by Andreas Vesalius in accordance with Aristotle's belief that the pituitary is the organ through which phlegm, The pituitary is an endocrine gland (called master glands), situate in the bony sella turcica, it divides functionally and anatomically to regions consist of the anterior lobe (adenohypophysis) and the posterior lobe (neurohypophysis) between these lobes lies a small region called the intermediate lobe. Gland secretion is regulated by the hypothalamus and connects to it by a pituitary stalk which transfers hormones and nervous orders to the gland and this gland was surrounded by important accurate structures, between them a specific distance.[Amar, A.P et al 2003, Ganapathy, M.K. et al 2019]

The average weight of the pituitary gland at birth is about 100 mg. Rapid growth occurs in childhood, followed by slower growth until the adult weight (approximately 500–600 mg) is attained in the latter part of the second decade. The height of the gland ranges between 3 to 11 mm. Any defect in the size and measurement of the gland or its vicinity may indicate a physiological or pathological change e.g. micro or macroadenoma, Pituitary Apoplexy, Stalk Compression Syndrome, Empty Sella Syndrome, Diabetes insipidus…etc. Physiologically there is a difference between the weight of the gland in females and males. In females, during pregnancy, the size of the gland may even double. The weight of the gland increases by 12% to 100% during pregnancy because of the enlargement of the pars distalis. The volume of the pituitary gland decreases with aging. On average, the female gland is almost heavier than the male gland primarily because of relative differences in the size of the pars distalis. The gland may be flattened laterally due to the pressure of the carotid arteries. If the gland is not filled the hypophyseal fossa, the subarachnoid cisterns will encroach upon the fossa, lead to a deferential pituitary shape. [Amar, A.P et al 2003, Ganapathy, M.K. et al 2019]

The study of the pituitary gland alone is not sufficient to evaluate the region, so the parts associated with it (sellar and para sellar region) must be studies anatomically, such as Pituitary Stalk, Optic Chiasm (OCW), Inter Carotid Distance (ICD), Sellar Aria, Columella Nasal to Hypophysis Distance, Sphenoid sinuses, and the posterior pituitary brightness phenomena (PBS) and to study the factors that affect its measurements and shapes, especially age and gender factors. Therefore, the knowledge of this region's normal anatomy, variations, or morphometry may be essential to determine the growth and may help neurologists and neurosurgeons in preventing damage during surgery.

Pituitary imaging is important not only in confirming the diagnosis of pituitary lesions but also in determining the differential diagnosis of other sellar lesions. Plain skull radiographs are poor at delineating soft tissues and are infrequently requested these days for diagnosing sellar and parasellar pathologies. The radiographic size of sella is not a sensitive indicator of pituitary gland abnormality, as the empty sella may itself lead to enlargement of size. Thus the plain radiographs have been replaced by cross-sectional imaging techniques such as MRI and CT scanning (CT scans are valuable, particularly when MRI is contraindicated). Currently, MRI is the examination of choice for sellar and parasellar pathologies due to its superior soft-tissue contrast, multiplanar capability, and lack of ionizing radiation. In addition, MRI also provides useful information about the relationship of the gland with adjacent anatomical structures and helps to plan medical or surgical strategy. MRI techniques in diagnosing pituitary lesions have witnessed a rapid evolution, ranging from non-contrast MRI in the late 1980s to contrast-enhanced MRI in the mid-1990s. The introduction of dynamic contrast-enhanced MRI has further refined this technique in diagnosing pituitary microadenoma. Recently, a variety of advanced MR techniques have been evolved which are particularly helpful in evaluating specific cases. These include 3D volumetric analysis of pituitary volume, high-resolution MR imaging at 3 Tesla (T) for evaluating pituitary stalk, diffusion-weighted imaging, MR spectroscopy, magnetization transfer ratio, and intraoperative MRI. [Chaudhary, V. 2011]

Therefore current study conducted descriptive and evaluate the gland and the compositions adjacent to it (sellar and para sellar) clearly for patients whose brain image shows normal, and assessed the differences between age groups from 20 to 60 years old and between gender and also assessed the relationships between the measured values.

1.2 Problem of the study

The anatomy of the sellar and parasellar regions is complex they are a small area rich in anatomical detail related and affected each other's, their measurements impacts by age and gender, this area includes the pituitary gland (the master gland in the body) which undergoing rapid growth and development in size in life period, any small change in it is size can effect this adjacent parts. A better understanding and good evaluation of these complex structures are essential in the clinical diagnosis and treatment of disease. There are a limited number of studies evaluating this area as a single block in meantime.

1.3 Objectives

1.3.1 General objective

To characterize the pituitary gland and sellar region using magnetic resonance image (MRI)

1.3.2 Specific objectives

- To study the normal anatomy, morphology of the pituitary gland.
- To determine the pituitary dimension.
- To correlate the impact of age and gender on the dimension, and morphological change of pituitary gland, sellar, and para sellar area.
- To measure the dimensions of sellar and para sellar region.
- To correlate between variables and their relationship with each other, and to determine the importance of evaluation.

1.4 Overview of the study

This is described through the chapters of the study in a sequential manner

Chapter one a summarized introduction, study problem, objectives (general and specific objectives), and an overview of chapters.

Chapter two included an overview of the literature including anatomy, physiology, and Pathology of pituitary, sellar, and para sellar area, MRI imaging, cross-section anatomy as well as previous studies.

Chapter three dealt with the material used in the practical study of MRI machines, Also the methodology of the practical setup was discussed in detail.

Chapter four dealt with the results of the study.

Chapter five includes the discussion, conclusions, of the study performed as well as future work and recommendations.

References include papers and scientific research from which the information was taken with the names of the book and editions.

The Appendixes includes some images for the cases measurements, the worksheet, the data sheet, and the two published scientific papers.

Chapter Two

Theoretical background and literature review

2.1 Theoretical background

2.1.1 Anatomy and physiology

2.1.1.1The brain

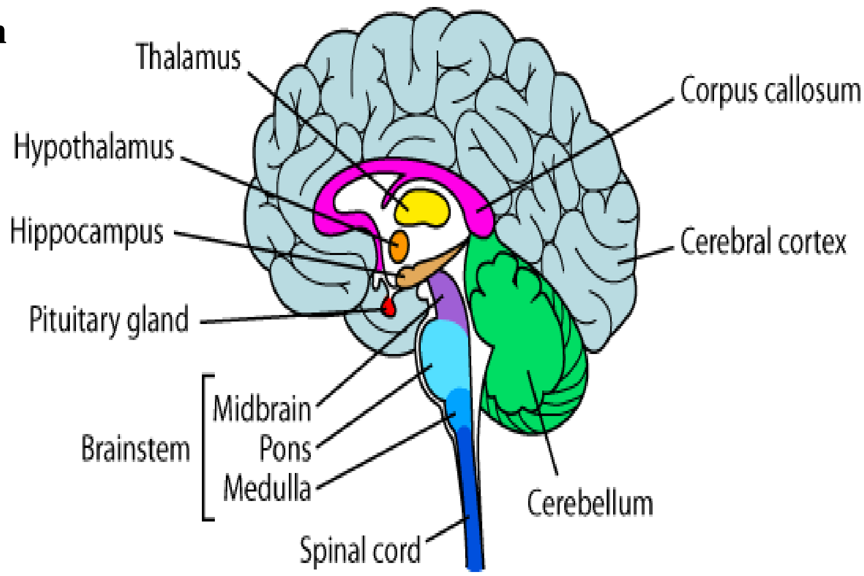


Fig (2.1) Parts of the brain (www.pinterest.com)

The brain is the big part of the central nervous system (CNS) that lies inside the skull. The human brain is a real miracle, complex composition and the engine of life in the human body embodies intelligence, emotion, memory, biological and physiological processes and others, and collects messages from inside and outside the body and enables us to interact with it, so the brain was the main engine of human life with its compositions and important parts that control the functions of the rest of the body and from these important compositions, a very small part dangling from the base of the brain it functions are secreting the body's basic hormones and controlling the rest of the hormones this formulation is called the master of the endocrine orchestra (pituitary gland).

2.1.1.1.1 Parts of the brain

The brain is composed of the cerebrum, cerebellum, and brainstem

Cerebrum is the largest part of the brain and is composed of right and left hemispheres. It performs higher functions like interpreting touch, vision, and hearing, as well as speech, reasoning, emotions, learning, and fine control of movement.

Cerebellum is located under the cerebrum. Its function is to coordinate muscle movements, maintain posture, and balance.

Brain stem acts as a relay center connecting the cerebrum and cerebellum to the spinal cord. It performs many automatic functions such as breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing fig (2.1) [Tonya Hines et al 2018].

2.1.1.1.2 Deep structures

Pathways called white matter tracts to connect areas of the cortex to each other. Messages can travel from one gyrus to another, from one lobe to another, from one side of the brain to the other, and to structures deep in the brain.

Hypothalamus Is located on the floor of the third ventricle and is the master control of the autonomic system. It plays a role in controlling behaviors such as hunger, thirst, sleep, and sexual response. It also regulates body temperature, blood pressure, emotions, and secretion of hormones.

Thalamus Serves as a relay station for almost all information that comes and goes to the cortex. It plays a role in pain sensation, attention, alertness, and memory.

Basal ganglia Include the caudate, putamen, and globus pallidus. These nuclei work with the cerebellum to coordinate fine motions, such as fingertip movements.

Limbic system is the center of our emotions, learning, and memory. Included in this system are the cingulate gyri, hypothalamus, amygdala (emotional reactions), and hippocampus (memory).

Pineal gland is located behind the third ventricle. It helps regulate the body's internal clock and circadian rhythms by secreting melatonin. It has some role in sexual development.

Pituitary gland lies in a small pocket of bone at the skull base called the sella turcica it controls other endocrine glands in the body [Tonya Hines et al 2018].

2.1.1.2 Endocrine system

In the embryo, the primitive cells lining the body surfaces are called epithelial cells. A part from being protective, their most important function is to absorb substances from the surrounding medium which are then modified and secreted in another form. As the embryo grows, certain epithelial cells develop this function to a specialized degree and are formed onto structures called glands. They may remain connected to the epithelial surface, thereby localizing its site of action, or they may lose their connection with the surface and secrete their product into the blood stream, thus making them accessible to all the body cells. Glands that have a duct and secrete externally are called an exocrine gland, e.g. the intestinal gland, the pancreas, sweat gland, lacrimal and mammary glands. Those without a duct have an internal secretion and are called endocrine or ductless glands e.g. pituitary gland, thyroid gland (Fig 2.2) [Eroschenko, V.P., 2008.]

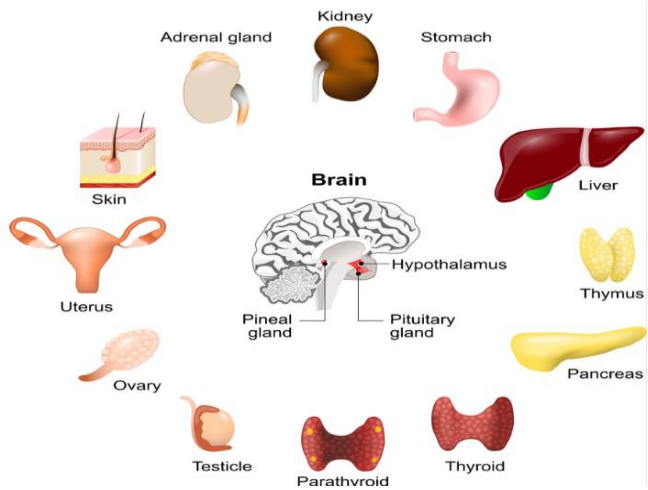


Fig (2.2) The endocrine system (www.vectorstock.com)

2.1.1.3 The Pituitary gland (PG)

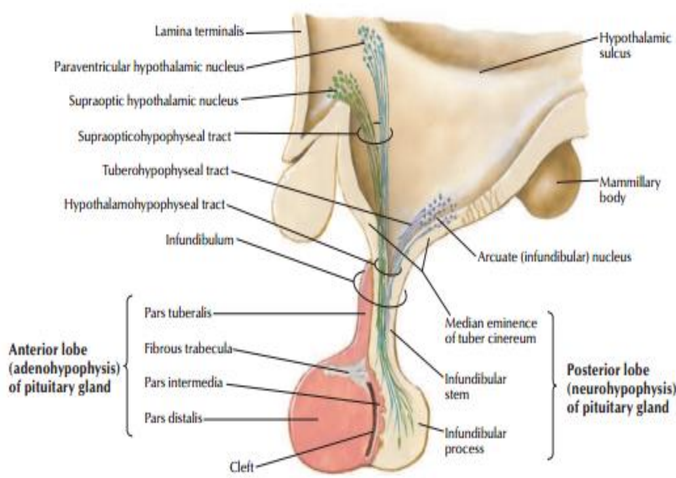


Fig (2.3) The pituitary gland (frank H.et al 2015)

The pituitary gland is an appendage of the ventral surface to the brain and derives its name from the Latin word, pituita, meaning mucus, as originally it was thought to transfer mucus from the brain through the cribriform plate of the ethmoid on to the nose. It is also called the hypophysis, from the Greek word meaning grow under. Is a reddish-grey, ovoid body, weighing about 500 mg, although it gets smaller with advancing age. It lies in the base of the skull in a depression of the sphenoid bone called the pituitary fossa or sella turcica. The sella turcica is immediately behind the superior part of the sphenoid air sinuses so that its floor forms part of the roof of each sinus [Passmore, R, and Robson, J.S. 1976].

2.1.1.3.1 Anatomy of the pituitary gland

2.1.1.3.1.1 Embryogenesis of the pituitary gland

The pituitary gland originates from two discrete parts of the developing embryo (Fig 2.4) Rathke's pouch, a dorsal evagination of the stomodeum immediately anterior to the buccopharyngeal membrane, and the infundibulum, a ventral extension of the diencephalon just caudal to the optic chiasm. Another dorsal evagination of the stomodeum, the pouch of Sessel, arises just posterior to the buccopharyngeal membrane. This structure contributes to the formation of the hypophysis in lower vertebrates but not in primates. Nonetheless, it sometimes persists in human beings and can be the source of certain tumors [Amar et al 2003, Sadler TW et al 200].

During the third week of gestation, the infundibulum develops as a ventral diverticulum in the floor of the third ventricle. It extends from the median eminence as the infundibular stem and ends in an expansion called the infundibular process. Simultaneously, an ectodermal placode appears in the roof of the stomodeum and invaginates to form Rathke's pouch, which grows dorsally. In the second month of development, Rathke's pouch flattens itself around the anterior and lateral surfaces of the infundibulum, and these two structures subsequently integrate (Fig 2.4). The connection between Rathke's pouch and the oral cavity passes between chondrification centers of the developing pre-sphenoid and basi-sphenoid bones of the skull. Expansion of sphenoidal mesenchyme in the sixth week of gestation causes this connection to regress in most cases. In about 1% of newborn skulls, however, a remnant of this passage, the basipharyngeal canal, is visible at autopsy or by radiographs. Similarly, small remnants of Rathke's pouch may occasionally persist in the roof of the oropharynx as the pharyngeal hypophysis (Fig 2.5). With further development, cells in the anterior wall of Rathke's pouch (pars distalis) proliferate rapidly and form the anterior lobe of the pituitary gland, also known as the adenohypophysis (Fig 2.6). Differential growth of these cells relative to the surrounding mesenchyme produces a small basin, open above and separated into two compartments by a cellular median septum. Each compartment, or fossa of Atwell, is initially filled with mesenchyme. These fossae subsequently disappear as a result of further cellular proliferation by Rathke's pouch derivatives. The median septum forms the pars medialis, whereas the lateral portions form the pars lateralis of the anterior lobe [Amar, A.P. and Weiss, M.H., 2003].

Along with the pars tuberalis, the infundibular stem comprises the pituitary stalk. The infundibular process gives rise to the posterior lobe of the pituitary gland, also known as the pars nervosa or neurohypophysis. The latter consists of neuroglial cells (pituicytes) as well as the nerve fibers and terminals of cells originating from hypothalamic nuclei. Pituicytes are specifically adapted to support the secretion and transport of hormones released by the neurohypophysis. They also have phagocytic properties. The lumen of the infundibulum is obliterated during development, but a small proximal pit, the infundibular recess, persists in the floor of the third ventricle (Fig. 2.6) [Amar et al 2003, Larsen WJ.1997].

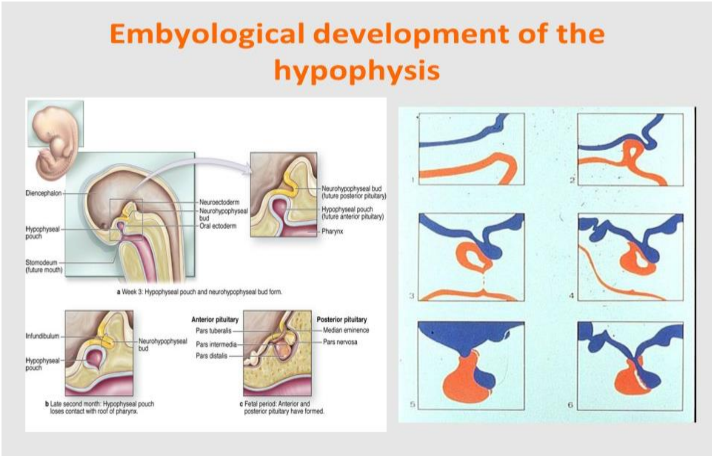


Fig (2.4) The embryological development of the pituitary gland. (www.slideplayer.com)

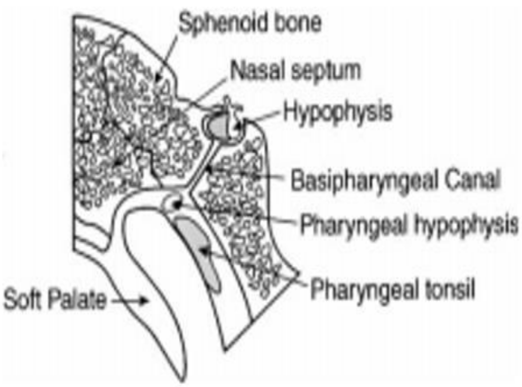


Fig (2.5) Remnants of the course of Rathke's pouch (Neurosurg Clin N Am. 2003)

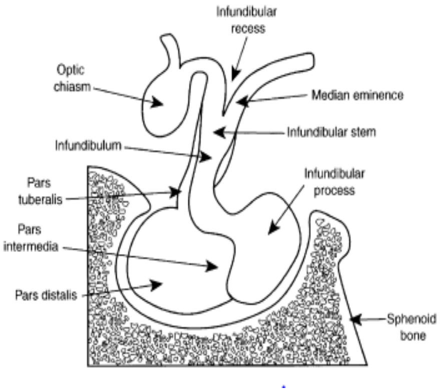


Fig (2.6) Mid sagittal section of the adult pituitary, showing the constituents of the adenohypophysis, intermediate lobe, and neurohypophysis (Neurosurg Clin N Am. 2003).

2.1.1.3.1.2 Histogenesis

By the third and fourth months of gestation, cells of the anterior lobe arrange themselves as cords around blood sinusoids. The glandular organization is induced by the surrounding mesenchyme. Simultaneously, the portal system of blood vessels develops and is fully established by the end of the first trimester. Anterior lobe cells further differentiate into histologically discrete populations characterized by the affinity of their cytoplasm for selected dyes (acidophils, basophils, and chromophobes). The relative density of these cells comports with the bilateral symmetry achieved during morphogenesis of the adenohypophysis. Basophilic cells are concentrated in the pars medialis. Conversely, acidophils tend to be distributed in the pars lateralis. The adenohypophysis begins to function during the first trimester. Corticotropin, b-endorphin, luteinizing hormone (LH), and follicle stimulating hormone (FSH) can all be detected early in gestation. Thyrotropin-releasing hormone (TRH) secreting cells develop early in the second trimester. Growth hormone (GH) and prolactin (PRL) become increasingly synthesized during the second half of pregnancy. Neurosecretory activity of the posterior lobe begins in late fetal life [Amar, A.P. and Weiss, M.H., 2003].

2.1.1.3.1.3 Pituitary lobes

The pituitary is usually divided (in practice) into anterior and posterior parts, which actually refers to groupings of four subparts

2.1.1.3.1.3.1 Anterior pituitary gland

Microscopic anatomy (Gross anatomy)

The adenohypophyses constitute well-defined acini, consisting of cells that produce and secrete hormones. There are six cell lines, of which five are hormone-producing cell types called somatotrophs, lactotrophs, corticotrophs, thyrotrophs, and gonadotrophs. Also, a nonhormone producing sixth cell type in the anterior pituitary called the folliculostellate cells. The anterior pituitary gland encompasses the following structures

1. Pars Distalis This is located at the distal part of the gland, and most of the hormones get secreted from this region. It forms the major bulk of the anterior pituitary. It is composed of follicles of varied sizes. Based on the staining methods used, the hormone-producing cells are classified below

Acidophils, are composed of polypeptide hormones, and their cytoplasm stains red to orange in color. The somatotrophs and lactotrophs are the acidophils.

Basophils, are composed of glycoprotein hormones, and their cytoplasm stain blue to purple in color. The thyrotrophs, gonadotrophs, and corticotrophs are the basophils.

Chromophobes, do not stain well. They may represent stem cells that are yet to differentiate into mature hormone-producing cells.

2. Pars Tuberalis The tubular stalk is divided into pars tuberalis anteriorly and posteriorly. It extends from the pars distalis. The pars tuberalis encircles the infundibular stem, which is composed of unmyelinated axons from the hypothalamic nuclei. The hormones oxytocin and vasopressin accumulate in these axons, forming ovoid eosinophilic swellings along the infundibular stem. They make up the 'herring bodies'.

3. Pars Intermedia This is present between the pars distalis and the posterior pituitary gland. It is made up of follicles containing a colloidal matrix and includes the remainder of the Rathke's pouch cleft. Though it is mostly nonfunctioning, they produce melanocyte-stimulating hormone, endorphins, and have some pituitary stem cells.

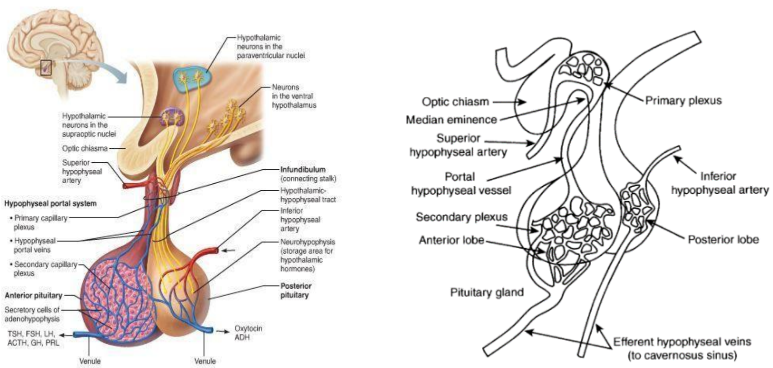
The hypothalamus is where the initial primary signal hormones get synthesized to stimulate the pituitary gland. Their synthesis is in the cell body of the neurons following which the axons project to terminate at the gland in the fenestrated portal capillaries. Then they travel via the bloodstream to the pituitary gland to stimulate the specific cells or inhibit it [Ganapathy, M.K. and Tadi, 2019].

2.1.1.3.1.3.2 The posterior pituitary gland

Microscopic anatomy

This portion of the gland is a specialized neuroendocrine structure. The posterior pituitary is a combination of pars nervosa and the infundibular stalk. They contain axons that have originated from hypothalamic neurons, specifically the axon terminals of the magnocellular neurons of the paraventricular and supraoptic nuclei. Glial cells called pituicytes encircle the axons. The pituicytes have elongated processes that run along with the axons; these are absent in a typical astrocyte and is due to the transcription factor expression TTF-1. The axons together form the hypo-thalamo-hypophyseal tract, which terminates near the posterior lobe sinusoids. The terminals of the axons are close to the blood vessels to aid in the secretion of the hormones. The precursor hormones are packed into secretory granules, called the herring bodies. These precursor hormones then get cleaved during transport to the posterior pituitary. Neurophysins are proteins that are essential for the posttranslational processing of the hormones. The posterior pituitary is not glandular, like the anterior pituitary. Thus they do not synthesize hormones [Ganapathy, M.K. and Tadi, 2019].

2.1.1.3.1.4 Blood Supply and Lymphatic's The pituitary gland has a rich blood supply, with both a portal circulation (to the anterior pituitary) and arterial supply (to the posterior pituitary and pituitary stalk) [Balint Botz, et al 2018].



A B

Fig (2.7) The blood supply of the pituitary gland A (www.pinterest.com) Diagram B of pituitary gland blood supply (Neurosurg Clin N Am. 2003)

The pituitary gland is a well-vascularized tissue, and its blood supply connects with the hypothalamus via the hypo-thalamo-hypophyseal portal system.

The superior hypophyseal artery supplies the anterior lobe. It originates from the internal carotid artery or the posterior communicating artery. Together these two arteries form the primary plexus and supply blood to the median eminence. The hypothalamic cells end at the median eminence. The primary plexuses receive regulatory factors. The capillaries form venules that lead to the formation of portal hypophyseal veins. Secondary plexuses drain into the cavernous sinus. The intermediate lobe receives its blood supply from the anastomoses between the anterior and posterior lobe capillaries. Small branches from the superior hypophyseal artery supply the pituitary stalk and parts of the optic nerve and chiasm.

The inferior hypophyseal artery supplies the posterior lobe primarily the pars nervosa, and it originates from the meningohypophyseal trunk, which is a branch of the internal carotid artery. The posterior lobe drains into the cavernous sinus. This accounts for the typical pattern of contrast enhancement seen on dynamic MRI imaging fig (2.7) [Balint Botz, et al 2018, Go JL et al 2017].

2.1.1.3.1.4 The Relations

Anterior Sphenoid sinus.

Posterior Dorsum sellae, the basilar artery, and the pons

Superior Diaphragma sellae has a central aperture that allows the passage of the infundibulum and separates the anterior lobe from the optic chiasm.

Inferior Body of the sphenoid, with its sphenoid air sinuses.

Lateral Cavernous sinus and its contents fig (2.8) [Wineski et al 2018].

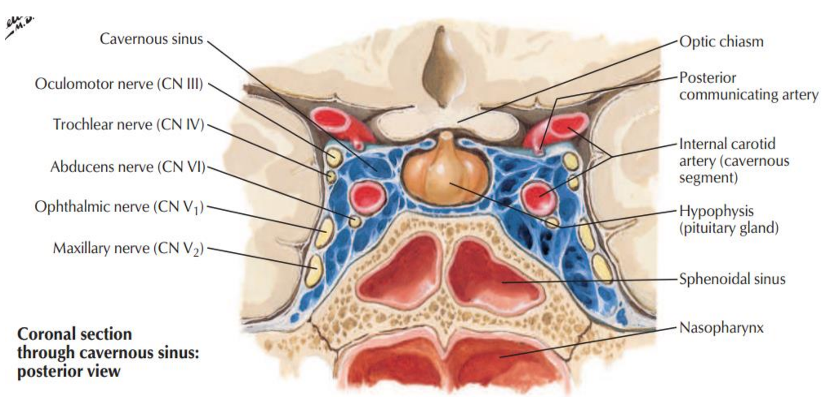


Fig (2.8) Relation between pituitary gland and surrounding area (Netter, F.H, 2014)

2.1.1.3.1.5 Size and age-dependent changes

The pituitary gland volume changes depending on hormonal status, most dramatically during pregnancy when it can be markedly enlarged, sometimes mistaken for an adenoma. The size of the pituitary also changes with age. Generally speaking, young adults have larger glands than older individuals, and hormonally active individuals (puberty/pregnancy) have the largest glands. These plump glands completely fill the pituitary fossa, and have a convex upper border, whereas older individuals will have a largely empty pituitary fossa, with a deflated and thinned gland lying on the floor of the sella. Although one should always be wary of measurements, they can serve to quantify what may otherwise seem overly subjective impressions. These are reasonable maximal figures for the height of the gland (Elster's rule)

Children (<12 years): 6 mm (upper surface flat or slightly concave)

Puberty 10 mm (upper surface convex; more striking in females)

Young adult Male: 8 mm, Female: 9 mm, and Pregnancy: 12 mm

Older adult (>50 years): gradually decreases in size

There is a slight increase in size in the perimenopausal period for women, but still remaining smaller than a pituitary of a young woman [Balint Botz, 2018].

2.1.1.3.1.6 Morphology of pituitary gland

According to the upper surface of the gland in sagittal or coronal view

Concave, Grade 1, Grade 2 (different than G1, less than the center of gland 2 mm)
Flat called Grade 3
Convex, Grade 4 up to more Grade 3 (but less than 2 mm.), Grade 5 (rather round shape) [Balint Botz, 2018].

2.1.1.3.2 Physiology of the pituitary gland

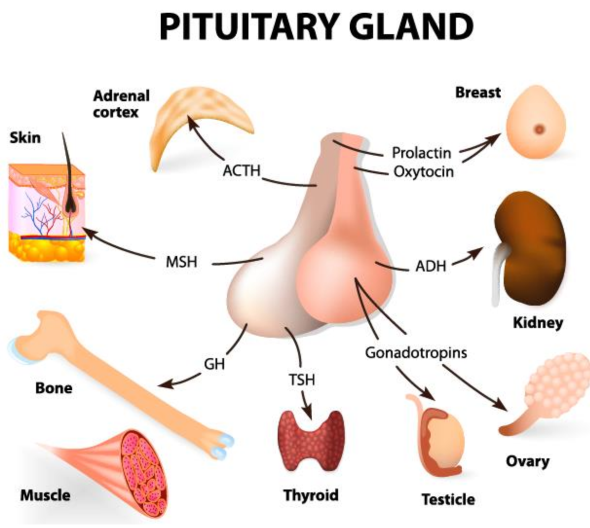


Fig (2.9) The pituitary gland hormones (www. Pinterest.com)

2.1.1.3.2.1The hormones produced and secreted from the anterior pituitary

Adrenocorticotropic Hormone (ACTH) The release of this hormone from the gland is in response to the corticotropin-releasing hormone (CRH) from the hypothalamus. The CRH reaches the target location via the portal system and cleaves the pro-opio-melanocortin (POMC) into three major substances are the ACTH, melanocyte-stimulating hormone, beta-endorphins. They then travel to reach the adrenal cortex, via the bloodstream to facilitate the release of cortisol. The negative feedback from the cortisol regulates the CRH and ACTH. They aid in the secretion of glucocorticoids during stress.

Prolactin (PRL) This hormone is under the direct control of the hypothalamus. Dopamine inhibits the release of prolactin. The suckling of the baby in the postpartum period will inhibit the release of dopamine, thus disinhibiting prolactin release. When there is a drop in the dopamine levels due to disease or drugs, the patient will present with galactorrhea. Their primary function is to stimulate the growth of the mammary glands and participate in milk production.

Luteinizing Hormone (LH) and Follicle-Stimulating Hormone (FSH) The gonadotropin-releasing hormone (GnRH) that is secreted from the hypothalamus acts on the gonadotropin cells to secrete the LH and FSH. In males, the LH acts on the Leydig cells and secretes testosterone from the testes. The FSH acts on the Sertoli cells and secretes inhibin B for spermatogenesis. In females, the LH acts on the ovaries to initiate the production of the steroid hormone, and its surge causes ovulation. FSH acts on the granulosa cells and initiates follicular development for ovulation by the mature Graafian follicle. The steroid sex hormones regulate the LH and FSH through negative feedback.

Growth Hormone or Somatotropin (GH) The GH gets secreted from the somatotrophs in response to the growth hormone-releasing hormone released from the hypothalamus. GH has anabolic properties and stimulates the growth of the cells in the body. The GH release is under the regulation of the negative feedback from the increased blood levels of GH and IGF-1.

Thyroid Stimulating Hormone (TSH) TSH secretion from the gland thyrotrophs occurs in response to the thyrotropin-releasing hormone from the hypothalamus. This TSH acts on the thyroid gland to stimulate the release of T3 and T4. The TSH gets regulated by the blood levels of T3 and T4 [Ganapathy, M.K. et al 2019, Lechan RM et al, 2016].

2.1.1.3.2.2The hormones secreted from the posterior pituitary

The following are the two hormones released from the posterior pituitary.

Oxytocin They participate in the milk let-down or milk ejection reflex during lactation, myoepithelial, and smooth muscle contraction, uterine contraction. This hormone is available for exogenous administration to patients with postpartum hemorrhage. Five IU of oxytocin is the recommended intravenous injection dosage to prevent postpartum hemorrhage, and it is given following the delivery of the anterior shoulder of the fetus.

Arginine Vasopressin (AVP) or Antidiuretic Hormone (ADH) These hormones aid in the regulation of water content and prevents water depletion. It maintains the tonicity of the blood and blood pressure during an event of volume loss. The vascular smooth muscles express the V1 receptors, which, in response to the AVP, causes arteriolar contraction. The renal collecting duct and the tubular epithelium express V2 receptors, which in response to AVP, up regulate the aquaporin two channels and increases free water reuptake fig (2.9) [Ganapathy et al 2019, Fujimoto M 2006].

2.1.1.4 Sellar Anatomy and relation

The bony walls of the sella turcica surround the fossa in the anterior, posterior, and inferior margins. The pituitary gland, along with the sella turcica, constitutes the sellar region. Tuberculum sellae makes up the anterior wall, and dorsum sellae makes up the posterior bony wall. Anterosuperior to the tuberculum is the sulcus chiasmaticus. The margins of the dorsum sellae form rounded structures called the posterior clinoid process. The anterolateral margin of the sella turcica forms the anterior clinoid process. These two clinoid processes aids in the attachment of the dural folds. The roof of the sphenoid sinus forms the floor of the pituitary fossa. The diaphragma sellae is a dural fold with a central aperture, and it covers the sella turcica as a roof incompletely. The adenohypophysis is separated from the optic chiasm by the diaphragma. It is continuous with the dura. The pituitary stalk and the blood vessels travel via the central aperture [Ganapathy, M.K 2019].

2.1.1.5 Parasellar and Suprasellar Anatomy

The cavernous sinus and the suprasellar cistern encompasses the parasellar region. The lateral walls of the pituitary fossa are made up of dura mater, and it contains the cavernous sinus. The cavernous sinus consists of the internal carotid artery, sympathetic fibers, cranial nerves III, IV, V, and VI. The suprasellar cistern encompasses the optic chiasm, part of the third ventricle, hypothalamus, and the tuber cinereum. This tuber cinereum is a gray matter lamina. Researchers identified an increased concentration of type IV collagen in the pituitary gland and surrounding tissue, including the capsule. This tissue has clinical importance as it has implications in the adenoma progression and invasion of adjacent structures [Ganapathy, M.K 2019].

2.1.1.6 Optic Nerve (Optic chiasm)

The optic nerve is composed of the axons of the cells of the ganglionic layer of the retina. The optic nerve emerges from the back of the eyeball and leaves the orbital cavity through the optic canal to enter the cranial cavity. The optic nerve then unites with the optic nerve of the opposite side to form the optic chiasma. In the chiasma, the fibers from the medial half of each retina cross the midline and enter the optic tract of the opposite side, whereas the fibers from the lateral half of each retina pass posteriorly in the optic tract of the same side. Most of the fibers of the optic tract terminate by synapsing with nerve cells in the lateral geniculate body. A few fibers pass to the pretectal nucleus and the superior colliculus and are concerned with light reflexes.

The axons of the nerve cells of the lateral geniculate body pass posteriorly as the optic radiation and terminate in the visual cortex of the cerebral hemisphere. The average optic chiasm is about 3.5 mm in height and 15 mm in width. It is found directly inferior to the hypothalamus, making it susceptible to disturbance secondary to hypothalamic disorders. It is located relatively superior to the sella turcica, and therefore the pituitary gland, which it contains, making it susceptible to secondary pituitary disorders [Ireland, A.C et al 2020, Wineski, L.E. et al 2018].

2.1.1.7 Internal Carotid Artery (intra-cavernous carotid distances)

The internal carotid artery begins at the bifurcation of the common carotid artery at the level of the upper border of the thyroid cartilage. It supplies the brain, the eye, the forehead, and part of the nose. The artery ascends in the neck embedded in the carotid sheath with the internal jugular vein and vagus nerve. At first, it lies superficially; it then passes deep to the parotid salivary gland. The internal carotid artery leaves the neck by passing into the cranial cavity through the **carotid canal** in the petrous part of the temporal bone. It then passes upward and forward in the **cavernous venous sinus** (without communicating with it). The artery then leaves the sinus and passes upward again medial to the anterior clinoid process of the sphenoid bone. The internal carotid artery then inclines backward, lateral to the optic chiasma, and terminates by dividing into the **anterior** and the **middle cerebral arteries one Internal Carotid Artery Branches are cerebral arterial circle (circle of Willis)**: The cerebral arterial circle is a roughly circular network of arteries ringing the sella turcica at the base of the brain. It is formed by anastomoses between branches of the two internal carotid arteries and the two vertebral arteries. The internal carotid contributes to the **anterior communicating**, **anterior cerebral**, **middle cerebral**, and **posterior communicating arteries** to the network. The vertebral arteries merge to form a single **basilar artery**, which divides into the **posterior cerebral arteries**. These anastomose with the posterior communicating arteries to complete the circle. Cortical and central branches arise from the circle and supply the brain [Wineski, L.E. et al 2018].

2.1.2 Physiologic Variants

There is a difference between the weight of the gland in females and males. In females, during pregnancy, the size of the gland may even double. The gland may be flattened laterally due to the pressure of the carotid arteries. The height of the gland ranges between 3 to 11 mm. If the gland did not fill the hypophyseal fossa, the subarachnoid cisterns would encroach upon the fossa. There are variations in the size and degree of pneumatization of the sphenoid sinus. The sellar type is the most common type of pneumatization of the sphenoid sinus. This pneumatization has clinical relevance as there can be complications from the transsphenoidal resection surgery due to these variations. The distance between the optic chiasm and the tuberculum sellae ranges between 1.5 to 8 mm. The common variations in the gland anatomy must be taken into consideration as they may prove to be hazardous and may lead to life-threatening complications during surgical procedures [Ganapathy, M.K et al 2019].

2.1.3 Radiological investigations

Pituitary imaging is important not only in confirming the diagnosis of pituitary lesions but also in determining the differential diagnosis of other sellar lesions. Plain skull radiographs are poor at delineating soft tissues, and infrequently requested these days for diagnosing sellar and parasellar pathologies. The radiographic size of sella is not a sensitive indicator of pituitary gland abnormality, as the empty sella may itself lead to enlargement of size. Thus the plain radiographs have been replaced by cross-sectional imaging techniques such as CT scanning and MRI.

CT scan, though less frequently used for evaluating sellar and parasellar lesions, is a useful examination depicting soft tissue calcification, bony destruction, and surgically relevant bony anatomy. CT scans are valuable, particularly when MRI is contraindicated, such as in patients with pacemakers or metallic implants in the brain or eyes. However, less optimal soft tissue contrast and radiation exposure are two important drawbacks that limit the judicious use of CT scan for evaluating pituitary lesions.

Currently, MRI is the examination of choice for sellar, and parasellar pathologies due to its superior soft tissue contrast, multiplanar capability and lack of ionizing radiation. In addition, MRI also provides useful information about the relationship of the gland with adjacent anatomical structures and helps to plan medical or surgical strategy. MRI techniques in diagnosing pituitary lesions have witnessed a rapid evolution, ranging from non-contrast MRI in late 1980s to contrast-enhanced MRI in mid-1990s. The introduction of dynamic contrast-enhanced MRI has further refined this technique in diagnosing pituitary microadenomas. Recently, a variety of advanced MR techniques have been evolved which are particularly helpful in evaluating specific cases. These include 3D volumetric analysis of pituitary volume, high-resolution MR imaging at 3 Tesla (T) for evaluating pituitary stalk, diffusion-weighted imaging, MR spectroscopy, magnetization transfer ratio, and intraoperative MRI [Chaudhary, V. et al 2011].

2.1.4 Surgical Considerations

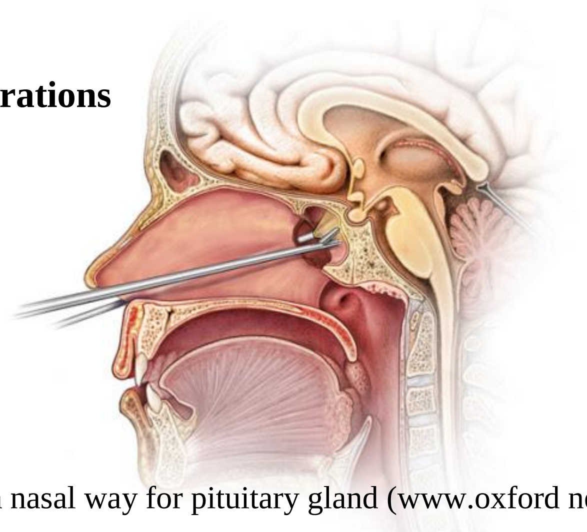


Fig (2.10) The surgical para nasal way for pituitary gland (www.oxford neurosurgeon.com)

There are multiple surgical approaches for the management of pituitary neoplasms. A nonfunctioning adenoma only gets surgically resected when the tumor causes compression or mass effect to the adjacent structures like the optic chiasm causing bitemporal hemianopsia field defect. This specific visual field defect is due to the compression of the nasal retinal fibers that decussate within the optic chiasm. A prolactinoma only gets surgically resected if they fail medical management with dopaminergic medications. Transsphenoidal surgery is a commonly chosen procedure for resection, especially in Cushing disease.
The transcranial, microscopic transsphenoidal, and the endoscopic endonasal approach are the different methods for surgery. Microscopic transsphenoidal surgery is the commonly used method for pituitary resection. However, the endoscopic approach is more favorable as the duration of the surgery is reduced, shorter hospital stay, minimally invasive, has a lower chance of developing complications, and the patients experienced less post-operative pain. Researchers are studying new imaging techniques for better visualization of the adenomas using a high field intraoperative magnetic resonance imaging (MRI), as they may provide better spatial resolution. Stereotactic radiosurgery may have a role in patients who are not willing to repeat surgical management for recurrent or residual adenomas [Ganapathy et al 2019].

2.1.5 MRI, Posterior Pituitary Brightness (PBS) phenomena and MRI Crossection anatomy image

Medical magnetic resonance imaging(MRI) uses the signal from the hydrogen atoms nuclei to create an image. The computers of an MRI system control and coordinate many processes ranging from turning on and off gradients and the RF coils to data handling and image processing. **T1-weighted** A sequence where signal contrast in the image is determined predominantly by differences in T1 relaxation times. A short TE to minimize T2-weighting and a short TR is used (e.g. TR50–700 ms and TE 10–25 ms [Liney, G et al 2010].

The normal pituitary bright spot seen on unenhanced T1-weighted MRI is thought to result from the T1- shortening effect of the vasopressin stored in the posterior pituitary.

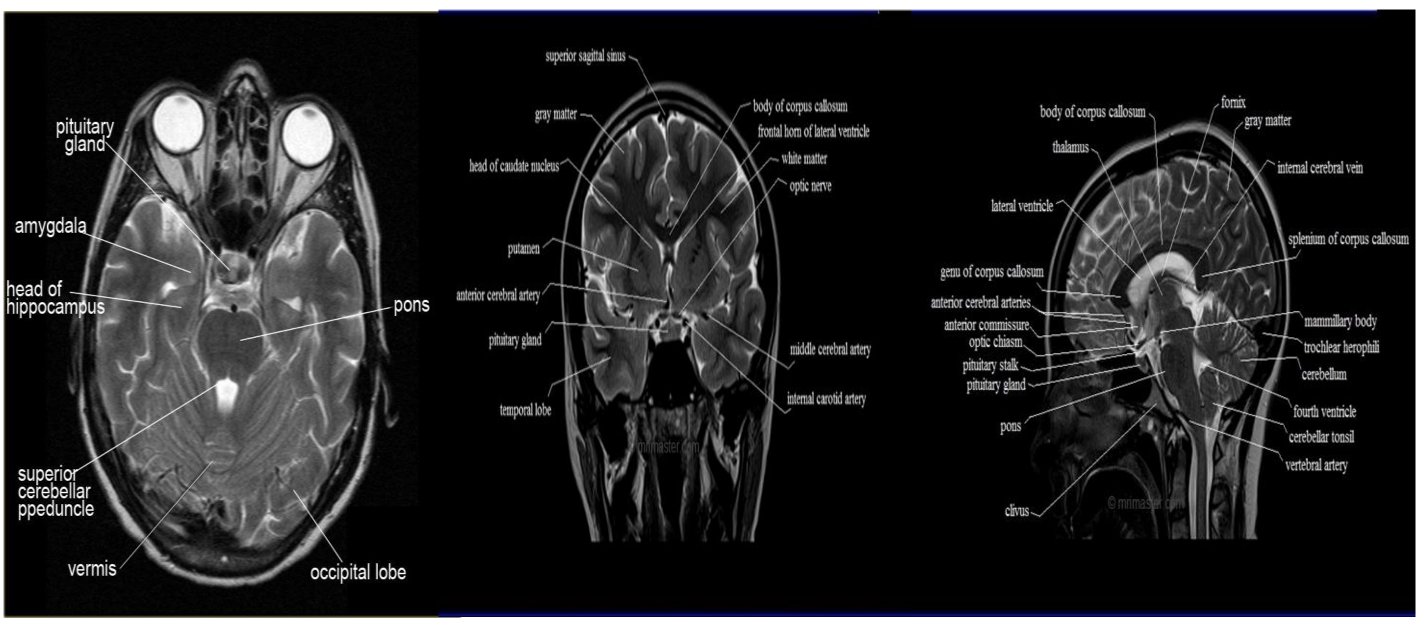


Fig (2.11) Crossection MRI for pituitary gland axial, coronal and sagittal* view (www. Pinterest.com) (www. MRI master.com)*

2.2 Previous Studies

In the important early study, Di Chiro and Nelson et-al 1962-1963 attempts were made to estimate the volume of the sella turcica from radiographs. The formula of Di Chiro and Nelson, which was based on that for an ellipsoid, used the length (L) and height (H) of the pituitary fossa measured on a lateral skull radiograph and the width of the floor (W) measured from a postero-anterior projection. It incorporated a factor which corrected for geometrical magnification and what the authors called "the empirical error found in a small series of 15 cases". Using this formula, Volume=0.5 (L x H X W), Di Chiro and Nelson (1962) found that the sellar volume ranged from 240 to 1,092 mm3 (mean=595 mm3) in 173 normal adults (p. 1001 of their publication quotes a range of 233-1,092 mm3 but on p. 1006 the range is 240-1,092 mm3). On (1963) multiplied the lateral area of the pituitary fossa by the width of its floor and, after correction for magnification, found that the volume of the fossa ranged from 466 to 1,306 mm3 (mean=860 mm3) in 250 normal adults. Du Boulay and El Gammal (1966) noting the disagreement between these authors and the wide range of normal measurements, judged sellar enlargement subjectively. They considered that quotation of the actual dimensions of the sella in their own series "would impart a spurious appearance of exactitude".

M. S. F. McLachlan et al 1968 Estimated pituitary gland dimensions from radiographs of the sella turcica a post mortem study the Preparations were made from 50 adults who died from non-endocrine diseases and without evidence of raised intracranial pressure. They included 27 women aged 22-84 years and 23 men aged 36-75 years. After removal of the brain at necropsy, a block was cut from the sphenoid to include the intact pituitary gland with the carotid syphon on either side. Antero-posterior and lateral radiographs were taken with the center of the block held 4 cm from a non-screen film using a focus-film distance of 180 cm. Subsequent measurements were made without correction for magnification (linear magnification=2 percent). In 31 of the specimens, the whole preparation was fixed in 15 percent formol saline immediately after removal (i.e. the pituitary gland was fixed in situ in the sella). After fixation, the gland was carefully removed from the sella by fracturing the dorsum. As much as possible of gland coverings were removed. The pituitary stalk was cut off flush with the superior surface of the gland. The length and width of the gland were measured by calipers and the height by a micrometer screw gauge. Gland volume was estimated by weighing the towel-dried specimen in air and in normal saline. In the other 19 specimens, the gland was removed from the fossa in the fresh state and the linear measurements and volume measured immediately and again after fixation for one week in 15 percent normal saline. No differences were apparent between glands fixed in situ and those fixed after dissection. The mean reduction in volume due to fixation was 3.1 percent. The change in linear dimensions was too small to be measured.

The glands were examined histologicaly and no major abnormalities likely to lead to a significant alteration in weight were found. Sellar dimensions on the radiographs were measured independently of gland measurements. The widths of the fossa floor and the dorsum sellae were measured directly from the anteroposterior radiograph to the nearest 0-5 mm. The lateral area was measured by projecting the lateral film on white cardboard (linear magnification X10). The sellar outline was traced and cut out. The weight of the cut-out was compared with a standard of known area. The length and height of the fossa were also measured from the cut-out. The projection system was found helpful in resolving problems with endpoints. The author definitions the Sellar outline was considered to run from the tuberculum sellae around the sellar margin to the most anterior point on the convexity of the tip of the dorsum. A straight line was then drawn from here to the tuberculum. We considered this line to represent the usual position of the diaphragm. (This is a rather over-simplified representation of diaphragm position and takes no account of possible convexity or concavity.) The area thus enclosed was regarded as the lateral area of the sella. Length of the sella was defined as the longest dimension of this profile measured parallel to the line of the diaphragm. Where more than one contour was seen on the dorsum the most posterior line was chosen as the posterior limit of the fossa. Height was defined as the greatest dimension measured at right angles to the line of the diaphragm. Where, on the lateral film, two contours were seen on the sellar floor we measured to the midpoint between them. If there were three contours on the sellar floor we chose the middle one. Here we have followed Di Chiro and Nelson (1962). The width was as defined by Di Chiro (1960. the distance between the highest points of the lateral edges of the plateau of the sellar floor. The width of the dorsum was that of its "waist" as defined by Bloch and Joplin (1959), the width of the dorsum at the level of maximal narrowing, usually just below the posterior clinoids. The result of the study was in the Gland dimensions a highly significant difference in gland volume exists between the sexes. Mean female volume is 147 mm3 greater than that of the males. Mean linear dimensions of the gland in the females are all slightly greater than in the males.in Sellar dimensions, there is no significant difference in linear sellar dimensions between the sexes. The product of the three linear dimensions and of lateral area and width showed slightly higher mean values in the females, but this was not statistically significant.

Stephen N. Wiener et al 1985 in study title Measurement of Pituitary Gland Height with MR Imaging, the height of the pituitary gland is the most important measurement in the detection of an intrasellar mass. This determination is currently made from direct or reformatted coronal contrast-enhanced computed tomographic (CT) views of the sella turcica using 1.0-1.5 mm slice thicknesses. One can also obtain pituitary gland measurements using sagittal magnetic resonance (MR) images, with a slice thickness of 10.0 mm. The purpose of the study report is to demonstrate the equivalency of the two methods for measuring pituitary gland height, and to suggest that MR may be clinically preferable to CT for this measurement. So the Subjects and Methods was that MR Procedure, Sagittal 10.0 mm slices of the head were obtained using a 0.15 T resistive MR imager (Picker). Patients were positioned supine in the scanner with the head gently immobilized to minimize motion artifacts. Multislice spin-echo pulse sequences were used with repetition times (TRs) of 500 or 850 msec and an echo time (TE) of 40 msec. This matrix was interpolated to 256 x 256 for display purposes. The direction of phase encoding was selected to cause the maximum resolution to be in the direction of the pituitary height. The height of the pituitary gland was measured using an electronic cursor on views that were magnified two times using linear interpolation. CT Procedure, direct coronal CT scans of the pituitary were obtained using a GE model 8800 CTIT scanner. The patients were positioned with hyperextension of the head in the supine position with the CT gantry positioned for optimal coronal projections. One hundred ml of Renografin 60 containing 29 g of organically bound iodine was injected intravenously. Images were collected using the standard head scanning protocol (320 x 320 image matrix with 1.5 mm slice thickness and pixel size of 0.8 mm). After completion of the test, views were magnified electronically using linear interpolation to obtain images with three times magnification. These were used for direct pituitary gland height measurement using an electronic cursor. Patient Population The height of the pituitary gland was measured on sagittal MR images for 42 normal patients who had neither clinical nor chemical evidence of pituitary disease. There were 17 men and 25 women aged 19- 83 years. The measurements were compared with the range of pituitary height values for the normal population from previously reported CT studies. Another 13 patients with known pituitary tumors were evaluated using both CT and MR. The patients were 26-68 years; there were five men and eight women. These were used to compare CT and MR measurements in the same patients. The results for the group of 42 normal patients, a mean pituitary gland height of 5.4 mm (0.9 mm SD) were measured from the sagittal MR images. Included in the 3-9 mm range, the pituitary gland height measured 3 mm in one patient, 5 mm in 26. 6 mm in 12.7 mm in two, and 9 mm in one. For the group of 13 patients with pituitary tumors, CT measurements demonstrated a mean pituitary gland height of 15.5 mm (range, 5- 35 mm; 7.1 mm SD). For the MR measurements, the mean pituitary gland height was 14.5 mm (range, 5-32 mm; 6.2 mm SD.

Pratiksha Yadav et al 2017 in a study title MRI Evaluation of Size and Shape of Normal Pituitary Gland, Age and Sex Related Changes, say that for complete assessment of pituitary gland, we should be aware of its normal anatomy with the physiological variations in its size and shape in different age groups in both males and females. Measurements of the normal pituitary gland for various age ranges are helpful to diagnose pathologies in pituitary gland and the aim is to study the size, shape and mean normal volume of normal pituitary gland in different age groups of both gender with Magnetic Resonance Imaging (MRI). Mean height of pituitary gland in female patients of each age group was greater than that of male patients in the same age group. Height of pituitary gland reached a maximum in the 21 to 30 years of age group in both males and females, after which, there was a decline in the pituitary height in the subsequent age groups. The overall mean pituitary height in the age group 1-10 years came out to be 5.3±1.4 mm. In the age group 11- 20 years, mean pituitary height was 6.2±1.1 mm. In the age group 21-30 years 6.8±1.9 mm, 31-40 years age group 6.3±1.8 mm, in 41-50 years age group 6.5±1.5 mm and individuals above 50 years of age, mean pituitary height was observed as 7±2.1 mm.

In all the age groups and both the sexes, the most common shape was flat which was seen in 46% of people followed by convex in 31.2% and concave shape in 22.8% people. The mean pituitary volume in the age group 1-10 years came out to be males 210±0.73 mm3 and in females 200±0.75 mm3. In the age group 11-20 years mean pituitary volume in males was 340±127 mm3 and in female's 280±123 mm3. In the age group 21-30 years, mean pituitary volume in males was 430±116 mm3 and in females 440±180 mm3. In the age group 31-40 years, mean pituitary volume in males was 380±140 mm3 and in females was 440±111 mm3. In 41-50 age groups mean pituitary volume in males was 400±159 mm3 and in females it was 420±116 mm3. In individuals above 50 years of age the mean pituitary volume was observed in males as 410±168 mm3 and 420±174 mm3 in females. Conclusion was knowledge of physiological variation in the size and shape of pituitary gland is necessary to compare the abnormal increase in the size. In the cases where there is a borderline abnormality in the size and shape of pituitary gland, it should be further evaluated by dynamic contrast study on MRI. Pituitary size and shape evaluation needs to compare with the normal range of height and volume of the normal pituitary gland in various age groups in both gender in population.

Philip Oluleke Ibinaiye et al 2015 in a study title the Magnetic Resonance Imaging Determination of Normal Pituitary Gland Dimensions in Zaria, Northwest Nigerian Population the objectives was to determine the dimensions of normal pituitary gland using T1-weighted magnetic resonance images (MRI) and to determine their relationship with age and sex .the materials and methods was Cranial MRI scans of 100 individuals with clinically normal pituitary function (58 males and 42 females) and in the age range 14–82 years were reviewed in order to obtain volumetric measurements of the pituitary gland. The height, width, and depth of the pituitary were obtained from mid-sagittal and coronal planes, while the volume was calculated from these measured parameters. The data obtained were 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. Results: The mean pituitary volumes were 334.1 ± 145.8 mm3 and 328.1 ± 129.2 mm3 while the mean pituitary heights were 6.45 ± 1.7 mm and 6.46 ± 1.57 mm in males and females, respectively. Although there was no statistically significant difference between pituitary height and pituitary volume in both sexes, they correlated negatively with increasing age (r = −202, P = 0.04 and r = −410, P = 0.000, respectively). Both parameters were highest in pubertal subjects and declined steadily with age, with a second peak occurring only for pituitary height in the sixth decade. The mean pituitary widths (9.08 ± 2.59 mm and 9.21 ± 1.86 mm) and depths (10.59 ± 1.71 mm and 10.49 ± 1.57 mm) in males and females, respectively, did not show remarkable changes with age and sex in the individuals studied. Conclusion: With this study, we have provided reference values in Nigerian population for the dimensions of normal pituitary gland, in order to facilitate assessment and diagnosis in patients with abnormalities of the hypothalamic–pituitary axis.

Tika Ram Lamichhane et al 2015 in a study title the Age and Gender Related Variations of Pituitary Gland Size of Healthy Nepalese People Using Magnetic Resonance Imaging say that the pituitary gland is the master endocrine gland of the human body. Its size varies with age and in various pathological conditions including pituitary adenomas. Magnetic Resonance Imaging (MRI) is the standard tool for the imaging of pituitary gland without using any harmful ionizing radiations. The aim of the study was to obtain standard reference values for the anterior-posterior (AP), height, transverse dimensions and volume of pituitary gland of healthy population and to analyze the potential diagnostic values of dimensions of pituitary gland. These dimensions were measured using standard spin echo sequences with 6 mm thickness in 0.3T permanent magnet MRI. A group of 170 subjects were recruited at Institute of Medicine, Radiology and Imaging Department, Tribhuvan University Teaching Hospital (TUTH) during April 23, 2014 to June 20, 2014. These individuals demonstrated no evidence of abnormalities to the central nervous or endocrine systems prior to the study. The size and shape of a normal pituitary gland are affected by age and gender. The anterior – posterior, height, transverse dimension and volume of pituitary were observed to be 10.3 mm, 6.1 mm, 13.6 mm and 466.8 mm3 respectively. In this study, we had found that the size of the pituitary gland of the Nepalese people reflected the normal values as we expected in healthy people. The pituitary gland volume changes depending on hormonal status. Generally, younger adults have larger glands. Hormonally active individuals (puberty / pregnancy) have the largest glands. Younger has convex upper border with completely filled pituitary fossa, whereas older individuals will have a largely empty pituitary fossa. Reliable maximal height of pituitary gland is children (less than 12 years) - 6mm (upper surface flat or slightly concave), puberty-10mm (upper surface convex, more in females), young adults male- 8mm and female-9mm, and pregnancy-12mm shows that the pituitary volume is maximum for female in all age group. The minimum volume was obtained for the age group (40-50) years and the maximum value of pituitary volume was obtained for the age group (50-60) years in male. There was decreased trend up to 50 years and then sudden increased value up to 60 years.

The maximum volume of pituitary was obtained for age group (40-50) years and minimum volume of pituitary was for age group (30-40) years for female. Up to 30 years, the value of pituitary volume was increasing but after that pituitary volume was decreased. In the age range (30-50) years, the pituitary volume has increasing trend. The pituitary volume showed decreasing trend after age of 60 years. The results obtained in this study demonstrated a gradual linear increase in pituitary gland volume over the first thirty years of life. The volume of the pituitary gland exhibited a growth trend with age prior to the age of 20, and there was evidence of a growth spurt in children in the early teenage years (10 to 14 years old), which was more prominent in females compared with males. These results indicated that the growth of the pituitary gland was more prominent in adolescents, particularly in females. The largest difference in pituitary gland volume was observed between the females and males at the ages of 10 to 20 years. Beyond 20 years of age, the dimensions of pituitary gland were not changed much. If there was any difference, that might be due to limited number of sample sizes. The shape of the superior surface of the gland (SS) was observed in all 170 cases. Convex upper border was more common in females in less than 20 years cases. In males, frequency of flat upper surface was more common. We found a higher frequency of convex upper border in female than in male. This difference was much higher in 10-20 year age group. In females, frequency of convex upper margin peaked in 10-20 years age group and in males, it was found in 20-30 year age group. There was no gender difference in the shape of the upper border in 20-30 year age group, though the frequency of flat upper margin was higher in this age group. Mid sagittal height of the pituitary gland reflects the variations in the pituitary morphology more accurately. Statistically significant differences in the mean height of the gland for various age groups in both sexes have been observed. The size and shape of a normal pituitary gland varies considerably and is affected by age, gender and the hormonal environment. The pituitary gland size reflects the level of associated hormones in the human body and is important in the diagnosis of pituitary diseases. The development of the human body is accompanied by changes to the pituitary gland. However, minor changes in pituitary gland height are often difficult to detect as the morphology of the pituitary gland and sella turcica can interfere with accurate measurements. Variations in pituitary gland shape between individual means that any assessment of pituitary gland size is likely to be subjected to a high degree of imprecision unless a true volume is measured. Therefore, an increasing number of studies have measured the pituitary gland volume in an attempt to have a more precise assessment of the pituitary gland.

C. Keanninsiri et al 2009 studied the Size and Shape of the Pituitary Gland with MR Imaging from Newborn to 30 Years, A Study at Siriraj Hospital MRI can provide the best visualization of structures in cranio - spinal region, especially the anatomy of the pituitary gland. This study was a retrospective with the purpose to determine the size and shape of the pituitary gland in normal puberty groups of both gender at age 1-30 years at Siriraj Hospital. Two planar views of the MRI, sagittal and coronal views for measurement the height, width and the shape of pituitary gland. The sample size (299 cases, 149 male and 150 female) were included the patients in both in-patient and out-patient groups at Siriraj Hospital, during age 1-30 years old and divided into six groups. All cases have Medical Record and MRI brain scan, without pathology history related to the pituitary gland or hormonal disorders, surgery and treated by hormone therapy. The mean and standard deviation of the height of pituitary gland in group 1 (1-10 years) were 5.4 ± 1.2mm in male, n = 50, 5.1 ±1.3mm in female, n = 50, group 2 (11-20 years) were 6.8 ± 1.7mm in male, n = 50, 5.8 ±1.3mm.in female, n = 50 and group 3 (21-30 years) were 5.4 ± 1.3mm in male, n = 50, 5.9 ±1.5mm in female, n = 50 and statistically significant different in female ($p<0.001$) but no significantly different in male ($p = 0.181$). The mean and standard deviation of the width of pituitary gland of group 1 (1-10 years) were 10.8 ± 1.9mm in male, n = 50, 10.2 ±2.2mm.in female, n = 50, group 2(11-20 years) were 12.9 ± 2.0mm in male, n = 50, 13.5 ±1.5mm in female, n = 50 and group 3 (21-30 years) were 13.4 ± 1.7mm in male, n = 49 and 13.8 ± 1.7mm in female, n = 50 and significant different for both sexes ($p<0.001$). The most frequency grade shape of “flat” was shown in all groups except female groups 2(11-20 years) higher frequency of “convex” for both sagittal and coronal views. The study was analyzed by two experienced neuroradiologists. This aim to the demonstrated of database in Thai people with age range newborns to 30 years which an average size and shape of pituitary gland acquired from MR Imaging can apply to in clinical medicine.

A. Tsunoda, O. Okuda et al 1997 studied the MR Height of the Pituitary Gland as a Function of Age and Sex: Especially Physiological Hypertrophy in Adolescence and in Climacterium. The objective was to clarify the age- and sex-related changes in pituitary height. In the results of the present study the mean pituitary height was 5.1 mm (SD, 1.1). The mean and range of each subgroup classified by age and sex are given. There were no subjects with a pituitary height of 9 mm in the 20- to 29-yearold age group and none with a height of 8 mm in the other age groups. The pituitary height in female subjects (mean, 5.35 mm; SD, 1.2) was significantly greater (t = 5.739, P.0001) than that in male subjects (mean, 4.93 mm; SD, 1.0). The mean pituitary height in female subjects in each age group was greater than that in male subjects in the same age group. However, statistically significant differences were observed only in the 10- to 19-year-old group (P, .05), the 20- to 29-year-old group (P, .0001), and the 50- to 59-year-old group (P, .0001). The pituitary height of both males and females peaked in the 20-to-29 age group, and declined between the 20-to-29 and 70-to-79 age groups, except in the 50-to-59 age group in women, in which the mean pituitary height increased again. Both male and female subjects younger than 45 years, of whom the females were considered to be in the premenopausal state, had greater pituitary heights than subjects older than 45 years, of whom the women were considered to be in the postmenopausal state (t = 10.31, P , .001). In the present study, an empty sella was defined as a sella that regardless of size was completely filled with cerebrospinal fluid or had a pituitary height of less than 2 mm.

The frequency of empty sellae was 4.3% for all subjects. It tended to be higher in the elderly group, but this difference was not statistically significant (x2 = .091), that changes in the endocrine milieu may be reflected in pituitary morphology. The increase in pituitary height during puberty may be related to the hyper secretion of luteinizing hormone during this period. The greater pituitary height in young subjects, both male and female, may reflect physiological neuroendocrine differences between younger and older subjects. The decline in pituitary height with age may also reflect the endocrinology of aging and a physiological pituitary atrophy. It has been reported that basal serum concentrations of gonadotropic hormones (luteinizing hormone, follicle-stimulating hormone) decline after puberty up to the fifth decade. In women, however, concentrations of these hormones begin to increase dramatically in the fifth and sixth decades, apparently due to an age related decline in circulating gonadal steroids (loss of feedback) and an increased "drive" from gonadotropin-releasing hormones. If it is true that the endocrine milieu is reflected in a person's pituitary height, it seems reasonable to assume that women have greater pituitary height in this period.

Muhammad Faisal Ikram et al 2008 in study title Pituitary Height on Magnetic Resonance Imaging Observation of Age and Sex Related Changes, the Objective is to establish measurements of selected pituitary parameters in cases with normal pituitary gland in<30 year old selected samples from Karachi. The Methods was total of 220 subjects of <30 years of age with normal pituitary morphology were evaluated by using T2 weighted Magnetic Resonance (MR) Imaging. Pituitary height (PH) and shape of the superior surface of the gland was observed on mid sagittal sections. Data was stratified into six groups on the basis of age and sex to observe the differences. The Results was after the second month of life, the pituitary height increased gradually to achieve its peak in the second decade of life in the females

(6.3 ± 1.4 mm, n = 43) and the third decade of life in the males (5.9 ± 1 mm, n =41). PH decreased gradually thereafter. Significant difference was observed in PH in different age groups in both gender. Gland was significantly higher in females than males in the second decade. Higher frequencies of convex superior surface followed the same pattern. This study provided the reference values for the Pituitary height and the shape of the superior surface of the pituitary gland, which may contribute to establish credible reference value.

S. C. Sanjay et al 2014 studied the Variation in size and shape of a normal adult female pituitary gland, so normal pituitary gland shows variation in size and shape. There is a recognized need for more normative data on female pituitary size in the Indian population hence the study was done using magnetic resonance instrument regarded as modern tool with less error. It was noted that the gland was more convex/globular in the younger age group but as advanced the superior surface became more concave. The mean height of pituitary gland was 6.27 mm ± 0.56, mean length was 9.10 mm ± 0.78and the mean width was 11.22 mm ±0.82. The size of pituitary gland also changed with age. The height decreased significantly as age advanced. The width initially increased up to 40 years and later decreased. The results of the study can be applied to clinical practices particularly when clinical symptomatology of patients with physiologic pituitary hyperplasia can mimic pituitary tumor.

Samuel M. Wolpert et al 1984 in research about size, shape, and appearance of the normal female pituitary gland by using CT, One hundred seven women 18-65 years old were studied who were referred for suspected central nervous system disease not related to the pituitary gland or hypeothalamus. High-resolution, direct, coronal, contrast-enhanced computed tomography (CT) was used to examine the size, shape, and density of the normal pituitary gland. There were three major conclusions: (1)

the height of the normal gland can be as much as 9 mm; (2) the superior margin of the gland may bulge in normal patients and (3) both large size and convex contour appear to be associated with younger age. It was also found that serum prolactin levels do not appear to correlate with the CT appearances. Both low- and high-density areas were seen within the gland, and may be due to tumors, cysts, infarcts, or metastases. Noise artifacts inherent in high-detail, thin section, soft-tissue scanning may be a limiting factor in defining reproducible patterns in different parts of the normal pituitary gland. In results the heights and configurations of the glands and their relations to the age of the patients were the heights varied between 1 and 9 mm (mean 5.7 mm). Larger glands were seen in the younger women. The superior margins of the glands were convex in 19, again more often in the younger than in the older women. The superior margins of the glands were concave in 33 patients, more often in the older than in the younger women. Empty sellae (gland heights 2 mm or less with the infundibuli extending down to the superior margins of the sellar contents) were seen in six patients, all aged 43 or more. Partially empty sellae (gland heights 3-4 mm) were seen in a further 13 patients.

A D Elster et al 1991 studied the Size and shape of the pituitary gland during pregnancy and postpartum: measurement with MR imaging. Cranial magnetic resonance (MR) imaging was performed in 38 pregnant and postpartum women and 30 non pregnant age-matched control subjects to establish standards for pituitary gland size and shape during this period. Gland height and infundibulum width were measured on midline T1-weighted sagittal images. Gland convexity or concavity was graded qualitatively. Throughout pregnancy, gland height increased linearly by approximately 0.08 mm/wk. No gland exceeded 10 mm in height during pregnancy. Increases in gland convexity also correlated with progression of pregnancy. The largest glands were seen in the immediate postpartum period; during this period, five of 12 glands measured 10.0-11.8 mm. beyond the first week postpartum, glands rapidly returned to normal size, apparently regardless of the status of breast-feeding. The mean diameter of the infundibulum was 2.2 mm (range, 0.8-4.0 mm). The pituitary gland enlarges throughout pregnancy but should probably not exceed 10 mm during most of this period. Size of up to 12 mm may be acceptable immediately postpartum.

Martin Côté et al 2014 studied the Normal dimensions of the posterior pituitary bright spot on magnetic resonance imaging and the Objective of study The normal pituitary bright spot an area of T1 hyper intensity is normally observed to in the posterior part of the sella turcica on MR images of the brain. This phenomenon, often referred to as the pituitary bright spot (PBS), is thought to result from the T1 shortening effect of stored vasopressin in the posterior lobe of the pituitary and is observed in 100% of children and in 52% to 100% of adults without pituitary disease. The (PBS) may be absent in up to 48% of normal subjects, more often in older patients. Individual variations in the appearance of the (PBS) have been observed. Physiological conditions such as very young age, pregnancy, or lactation may result in an enlarged (PBS). An abnormal (PBS) can also be seen in various pathological processes. Central diabetes insipidus (DI) results from low blood levels of vasopressin and may be primary or secondary to a number of causes. In primary central DI, the (PBS) has been found to be absent in 25% to 100% of cases. Secondary central DI is a feature of Langerhans cell histiocytosis, germinoma, teratoma, craniopharyngioma, idiopathic giant cell granulomatous hypophysitis, and Wolfram syndrome. When DI was a presenting symptom of one of these conditions, the (PBS) was always absent. In conditions in which the posterior pituitary is depleted of its vasopressin granules, the hyperintense T1 signal can also be lost. An absent (PBS) was observed in 32% of patients with uncontrolled diabetes mellitus and in a patient with severe anorexia nervosa. Finally, when the pituitary stalk is interrupted, the vasopressin synthesized in the hypothalamus does not reach the posterior pituitary. The absence of a normal (PBS) in these cases is often accompanied by an ectopic bright spot due to the storage of vasopressin granules in another anatomical location. A patient with pituitary dwarfism was found to have an absent (PBS) with an ectopic bright spot. Acquired section of the pituitary stalk of traumatic or surgical origin has also been found to result in an absent (PBS) and ectopic bright spot a large area of T1 hyperintensity is seen in a number of pathologies resulting in accumulation of blood, material with high protein content, or fat—all substances with a high T1 signal. Some of the most common lesions causing high T1 signal in the sella include Rathke's cleft cysts and hemorrhagic pituitary adenomas. Other, less common causes of sellar T1 hyperintensity include abscesses, cholesterol granulomas, dermoid cysts, and lipomas. The objective of this paper was to defne a range of normal dimensions of the pituitary bright spot and to illustrate some of the most commonly encountered pathologies that result in absence or enlargement of the pituitary bright spot and in Results All of the studies evaluated were found to have pituitary bright spots, and the mean dimensions were 4.8 mm in the long axis and 2.4 mm in the short axis. The dimension of the pituitary bright spot in the long axis decreased with patient age. The distribution of dimensions of the pituitary bright spot was normal, indicating that 99.7% of patients should have a pituitary bright spot measuring between 1.2 and 8.5 mm in its long axis and between 0.4 and 4.4 mm in its short axis, an interval corresponding to 3 standard deviations below and above the mean. In cases where the dimension of the pituitary bright spot is outside this range, pathological conditions should be considered. The pituitary bright spot should always be demonstrated on T1-weighted MRI, and its dimensions should be within the identifed normal range in most patients. Outside of this range, pathological conditions affecting the pituitary bright spot should be considered.

James M. Provenzale et al 2006, in study title Approaches to Imaging of the Sella, Notes on "The Volume of the Sella Turcica" As Di Chiro and Nelson pointed out, other fundamental issues exist when measurements of sellar volume are used to infer changes within the pituitary gland. For instance, the sella contains more than solely the pituitary gland, such as a perihypophyseal venous plexus; connective tissue; and, on occasion, benign abnormal structures such as an arachnoid cyst. Therefore, the pituitary gland can be expanded by the presence of a mass lesion at the expense of other sellar contents without changing the volume of the sella. As Di Chiro and Nelson stated, "considerable enlargement of the pituitary may be unobservable roentgenologically." In other cases, the pituitary gland occupies only a small amount of the sella even though the sella is normal or large—the empty sella syndrome. In essence, in the absence of cross-sectional techniques that could directly visualize the contents of the sella, Di Chiro and Nelson had to use the size of the container (i.e., the sella) to infer the size of its contents. The two are often, but not always, correlated.

Sung-Eun e. Kyung et al 2014 studied the Enlargement of the sella turcica in pseudotumor cerebri. The Object was that the sella turcica usually appears partially empty in MR images obtained from patients with chronic elevation of intracranial pressure. The authors measured the size of the sella turcica to determine if enlargement of the pituitary fossa explains the partially empty sella associated with pseudotumor cerebri. Measurements were obtained for 48 patients with pseudotumor cerebri and 48 controls. Neuro-imaging frequently reveals a partially empty sella in patients with pseudotumor cerebri. Several theories have been advanced to explain this finding. One explanation is that compression or atrophy of the pituitary gland occurs from herniation of the subarachnoid space into the sella turcica. Another possibility is that elevated intracranial pressure causes expansion of the sella turcica.

We compared the size of the sella turcica in patients with pseudotumor cerebri and in normal control subjects to determine if bony enlargement of the sella plays a role in the phenomenon of the partially empty sella. In control subjects, the median sellar area was 64 mm^2 (interquartile distance 23 mm^2) and the mean sellar area was 65 ± 16 mm^2. In patients with pseudotumor cerebri, the median sellar area was 87 mm^2 (interquartile distance 38 mm^2) and the mean sellar area was 90 ± 30 mm^2. Therefore, the mean sellar area was 38% greater in patients with pseudotumor cerebri than in controls (2-tailed t-test, $p < 0.0001$). The 95% confidence interval (82–99 mm^2) for patients with pseudotumor cerebri did not overlap the interval (61–70 mm^2) for control subjects. In patients with pseudotumor cerebri, there was a strong correlation between the area of the sella turcica and the percentage of the sella that was empty (Pearson's correlation coefficient, $r = 0.67$, $p < 0.001$). This correlation implies that the sella turcica appears partially empty because of bony enlargement of the pituitary fossa. In control subjects, the sella turcica had the following dimensions: opening = 9.3 ± 1.7 mm, length = 9.9 ± 1.5 mm and depth = 7.1 ± 1.2 mm. In patients with pseudotumor cerebri, the corresponding dimensions were 9.9 ± 1.7 mm, 11.0 ± 1.6 mm, and 8.7 ± 2.2 mm. The sellar opening was increased by 6%, the sellar length by 11%, and the sellar depth by 23%. The mean gland area was 42 ± 13 mm^2 (95% CI 39– 46 mm^2) in controls and 34 ± 14 mm^2 (95% CI 30–38 mm^2) in patients with pseudotumor cerebri. The pituitary gland had a smaller midline cross-sectional area in patients with pseudotumor cerebri (2-tailed t-test, $p < 0.05$). However, as explained below, this small reduction in gland cross-sectional area does not necessarily signify a reduction in gland volume. Conclusions our results indicate that chronic elevation of intracranial pressure causes expansion of the pituitary fossa. Little or no reduction occurs in the size of the actual gland. Because the pituitary tissue becomes molded to the walls of a larger container, the sella turcica appears partially empty.

William T.C. Yuh, MD et al 2000, in study title the MR Imaging of Pituitary Morphology in Idiopathic Intracranial Hypertension The aim of this study was to investigate the morphologic changes of the pituitary gland in patients with the clinical diagnosis of idiopathic intracranial hypertension (IIH). Quantitative measurements of the area of the pituitary gland and the sella turcica on the mid sagittal T1-weighted MR image that had optimal visualization of the pituitary were performed Qualitative and quantitative analyses of pituitary morphology were performed in normal subjects (n 523), patients with the clinical diagnosis of (IIH) (n 540), and patients with acute increased intracranial pressure (AICP; n 537) caused by acute head trauma. The loss of pituitary height (concavity) on the sagittal T1-weighted image was classified into five categories: I=normal, II= superior concavity that was mild (<1/3 the height of the sella), III =moderate (between 1/3 and 2/3 concavity of height of sella), IV = severe (>2/3concavity of height of sella), and V = empty sella. The area ratio of pituitary gland to sella turcica measured in the mid sagittal plane was quantified. Clinical records were retrospectively reviewed to correlate with magnetic resonance (MR) findings. Using moderate concavity (>1/3) as the minimum criterion for abnormality, (IIH) patients had an 85% incidence of morphologic changes with 80% sensitivity and 92% specificity. Empty sella (almost complete concavity of the sella) was found in only 2.5% of patients with (IIH). Quantitative analysis of the pituitary gland/sella turcica area ratio showed a significant decrease in patients with (IIH) ($P < 0.0001$) but no significant difference between the normal subjects and (AICP) patients. A posterior deviation of the pituitary stalk was seen in 43% of patients. No enlargement of the ventricles or sulcus effacement was seen in (IIH) patients. Routine brain MR examination of patients with (IIH) frequently shows morphologic changes of the pituitary gland ranging from various degrees of concavity to (rarely) the extreme case of an empty sella. The etiology is unknown and may be related to the severity and duration of elevated (CSF) pressure. Such findings may be useful to facilitate the diagnosis of (IIH), particularly in patients with equivocal clinical findings or when (IIH) is not suspected.

Jan Hoffmann et al 2013 studied the Morphometric and volumetric MRI changes in idiopathic intracranial hypertension and say that, our aimed was validating established imaging features of idiopathic intracranial hypertension (IIH) by using stateof-the-art MR imaging together with advanced post-processing techniques and correlated imaging findings to clinical scores. Methods was Twenty-five (IIH) patients as well as age-, sex- and body mass index (BMI)-matched controls underwent high resolution T1w and T2w MR imaging in a 1.5 T scanner, followed by assessment of optic nerve sheaths, pituitary gland, ventricles and Meckel's cave. Imaging findings were correlated with cerebrospinal fluid (CSF) opening pressures and clinical symptom scores of visual disturbances (visual field defects or enlarged blind spot), headache, tinnitus (pulsatile and nonpulsatile) and vertigo. (CSF) as well as ventricle volumes were determined by using an automated MRI volumetry algorithm. The Results was that, So-called 'empty sella' and optic nerve sheath distension were identified as reliable imaging signs in (IIH). Posterior globe flattening turned out as a highly specific but not very sensitive sign. No abnormalities of the lateral ventricles were observed. These morphometric results could be confirmed using MR Volumetry (VBM). Clinical symptoms did not correlate with an increase in lumbar opening pressure. Our study results indicate that lateral ventricle size is not affected in (IIH). In contrast, abnormalities of the pituitary gland and optic nerve sheath were reliable diagnostic signs for (IIH).

N. Satogami et al 2010 studied the Normal Pituitary Stalk: High-Resolution MR Imaging at 3T Measurements the diameter and the length of the pituitary stalk and the depth of the infundibular recess of the third ventricle were assessed for each subject. Both the AP and transverse diameters of the pituitary stalk were measured on T2-weighted oblique-axial images at 2 levels (at its insertion on the pituitary gland and at the level of the optic chiasm). These levels were chosen for measurement because Simmons et-al 1984 measured the transverse diameter of the pituitary stalk on 1.5T MR imaging at these 2 levels. The length of the pituitary stalk and the depth of the infundibular recess were evaluated on the median sagittal MPRAGE image. The length of the pituitary stalk was defined and measured as the distance from the tip of the infundibular recess to the junction of the pituitary stalk and the pituitary gland along the course of the pituitary stalk. Six of 29 subjects (2 men and 4 women) had a convex superior margin of the pituitary gland in the current study, but there were no subjects in whom the superior gland margin protruded through the diaphragma sellae. Thus, the junction of the pituitary stalk and gland was angular and was identifiable in all subjects. The depth of the infundibular recess was defined and measured as the distance from the tip of the infundibular recess to the floor of the third ventricle at the anterior edge of the infundibular recess. Because the posterior wall of the infundibular recess often made a smooth transition to the floor of the third ventricle, or the tuber cinereum, the third ventricular floor at the posterior edge of the recess or at the midpoint of a line defined by the anterior and posterior margins was difficult to adopt as the superior extent of the infundibular recess. The ratio of the length of the stalk to the depth of the infundibular recess was also calculated for each subject, the results was that, the AP and transverse diameters of the pituitary stalk were 2.32±0.39 mm and 2.16 ±0.37 mm at the pituitary insertion, respectively, and 3.25± 0.43 mm and 3.35± 0.44 mm at the level of the optic chiasm. No significant differences were observed between the AP and transverse diameters at each level. The length of the stalk was 5.91 ±1.24 mm, and the depth of the infundibular recess was 4.69± 0.87 mm. The stalk showed central hyperintensity with a peripheral rim of isointensity in 20 subjects (69%) and homogeneous isointensity in 9 subjects (31%).

Thinesh Kumran et al 2015 in interested study in title of Factors Influencing Disconnection Hyperprolactinemia and Reversal of Serum Prolactin after Pituitary Surgery in a Non-Functioning Pituitary Macroadenoma To investigate factors influencing disconnection hyperprolactinemia, including tumour volume, degree of pituitary stalk displacement and extent of tumour growth based on a modifed Wilson-Hardy classifcation in a non-functioning pituitary macroadenoma and to confirm reductions in serum prolactin levels after endoscopic transphenoidal surgery. Results: In 40 patients, the mean tumour volumes were 10.58 ±7.81 cm3 pre-operatively and 3.1 ± 3.45 cm3 post-operatively. There was a 70% reduction in tumour volume post-operatively ($P < 0.01$). The mean serum prolactin was 457 ± 66.93 mIU/L pre-operatively and 297 ± 16.73 mIU/L post-operatively. There was a 65% reduction in prolactin serum levels after surgery ($P < 0.01$). The mean pituitary stalk angles were 93.45 ± 3.89 degrees pre-operatively and 51.45 ± 1.46 degrees post operatively ($P = 0.01$). The mean pituitary stalk angle in the control group was 50.4 ± 8.80 degrees. Hence, there was a 98% reduction in pituitary stalk angle after surgery ($P < 0.01$). This study showed a linear correlation between the pre-operative and post-operative tumour volumes and serum prolactin levels ($P = 0.01$ pre-and post-operative) and between serum prolactin levels and pituitary stalk angle ($P = 0.20$ pre-operative; $P = 0.01$ post-operative). Conclusion: Tumour volume and pituitary stalk angle displacement have positive predictive values for disconnection hyperprolactinemia in non-functioning pituitary macroadenoma. However, a larger sample size and further objective studies are needed to confirm these findings. A pituitary tumour may disrupt dopamine release by compressing the pituitary stalk and may therefore be accompanied by modest hyperprolactinemia. This clinical syndrome is called stalk effect, pituitary stalk compression syndrome or disconnection hyperprolactinemia. It is sometimes clinically difficult to differentiate a prolactin-secreting tumour from disconnection hyperprolactinemia because some cases demonstrate high serum prolactin levels. Karavitaki N et-al suggested that a serum prolactin level > 6000 – 8000 ml U/L indicates macroprolactinoma, whereas levels < 2000 – 3000 ml U/L indicate a non-functioning pituitary tumour. A positive correlation with increased intrasellar pressure causing hyperprolactinemia was reported by Baha et al in The Journal of Clinical Endocrinology and Metabolism in 2000. Donal skinner et al 2008, proposed an alternative hypothesis in which the suprasellar tumour secretes a specific pars tuberalis factor that stimulates prolactin secretion, and the candidates for the hypothesised factor were the preprotachykinin A derived tachykinins, substance P and neurokinin A. These tachykinins have been shown to stimulate prolactin release. One of the objective, to review is the relationship between pituitary tumour volumes and pituitary stalk angle deviation. This study showed a linear correlation between pituitary tumour volume and pituitary stalk angle (P = 0.01). This correlation was also observed in suprasellar extension of pituitary tumours (P < 0.01). All patients showed a postoperative regression in stalk angle with a decrease in pituitary volume. Such a correlation was not observed between pituitary stalk angle deviation and increased serum prolactin, which we expected to see. However, the correlation coefficient showed a linear but clinically no significant correlation (P = 0.20). Based on our study involving 40 patients with confirmed non-functioning pituitary macroadenoma, we found a positive correlation between pituitary tumour volumes and serum prolactin levels and between serum prolactin levels and pituitary stalk angles. In addition, we observed post operatively a 70% reduction in tumour volume, 60% reduction in serum prolactin level and 98% reduction in displaced pituitary stalk angle. Hence, some of these findings are clinically significant in confirming our hypothesis of a positive correlation among pituitary volumes, increased prolactin levels and displaced pituitary stalk angles, and the return of serum prolactin levels to near normal levels with a reduction in the displaced pituitary stalk angle. Pituitary stalk angle was calculated from sagittal T1 gadolinium-enhanced MRI. Draw horizontally line from the frontal base across the sellar incorporating a point in the roof of the sphenoid sinus and dorsum sella and is extrapolated horizontally (line A).draw perpendicularly line from line A to the origin of the pituitary stalk (line B). Line C is drawn along the pituitary stalk, and it intersects line B. The angle formed by the intersection of these 2 lines was taken as the pituitary stalk angle (calculated in degrees).

Seizo Yamashita et al 2014 in study title the radiologic morphometric study of sellar, infra sellar and parasellar regions by magnetic resonance in adults. The Objective was to evaluate variations of some anatomic structures of sellar and parasellar regions and their possible differences between gender and age groups. The Patients and methods were Magnetic resonance images (MRI) of 380 patients were performed to analyze the dimensions of the sphenoid sinus, pituitary gland, optic chiasm, intra cavernous carotid distances, distance between columella nasal - sphenoid sinus; and columella nasal-pituitary gland. The patients age ranged between 20 and 80 years (mean age 48 years). The study included 235 females (mean age 53 years) and 145 males (mean age 40 years). In this current study, we analyzed the data that 38.2% are males (n = 145) and 61.8% females (n = 235). The samples were divided according to gender into 3 age groups: 20–40 years, 41–60 years and above 60 years, in all sample, the maximum and minimum height of the pituitary gland were 3mm and 11mm respectively. No pathologies were found that could interfere with these gland dimensions. There was no significant statistically difference between the average height of the pituitary in males and females, using

"Mann–Whitney and Kruskal-Wallis" tests for two independent samples. It was still noted that twenty eight women presented a gland height greater than 7mm, while only twelve men presented this value. No difference in the pituitary width was noted between both gender. Related to the women's ages, the value of pituitary height detected U shaped behavior. The width and height of the chiasm were similar in the entire sample between the gender and age groups for the "p" of Mann–Whitney and Krusk al-Wallis tests. For two independent samples, only one difference was detected, the disparity among women of different ages, however, it is only a discrepancy in the midst of all the other similarities. Caution is necessary to ensure that there are different age groups. The distance between the intra-cavernous segments of the internal carotid between men and women, regardless of age were similar. Indications of differences between the age groups of the same gender can be observed only among men. In this gender group, the values of intercarotid distance increase likely the age, on values of "p" using Mann–Whitney and Kruskal-Wallis tests for independent samples. For males the mean of distances from the columella pituitary and columella-sphenoid sinus were higher, regardless of age, but older groups did not differ either among men or women, on the values of "p" by Mann–Whitney and Kruskal -Wallis tests for independent samples In the group from 41 to 60 years of age, males had larger widths of the sphenoid sinus than women, according to "p" by Mann–Whitney and Kruskal-Wallis test for independent samples. In our study considering all exams, regardless of age and gender, type post-sellas represented 58 patients (15.3%), while 300 (78.9%) had type sellar, and 22 (5.8%) pre sellar. Evaluate anatomic variations of sellar and parasellar regions and their possible differences between gender and age groups using RMIs have great importance in several medical fields.

S.Ö. Polat et al 2020 studied the determination of the pituitary gland, optic chiasm, and intercavernous distance measurements in healthy subjects according to age and gender. Sella turcica is a critical reference landmark related to pathologies of pituitary gland, optic chiasm, and craniofacial region. Therefore, the knowledge of this region's normal anatomy, variations or morphometry may be essential for to determine the subject's growth and evaluate orthodontic treatment results and may help neurologists and neurosurgeons in preventing damage during surgery. In the studies of the pituitary gland, optic chiasm, and intercavernous distance's anatomy, the differences between females and males and age related changes were observed whereas, in some studies no significant difference in dimensions of pituitary gland, optic chiasm, and intercavernous distance was found. Also, some different results have been reported regarding both pituitary gland and optic chiasm measurements in decades. There were very few studies assessing morphometry of the hypophysis cerebri, intercavernous distance or optic chiasm in Turkish population in literature. Knowing the normal dimensions of pituitary gland and other structures in this critical area of the brain is very important for clinical and pathological evaluations. The purpose of this study was to reveal the normative data related to the pituitary gland, optic chiasm, intercavernous distance dependent on age groups and to determine measurements with age and sex in Turkish population. The Results was that, the groups were divided into five groups according to age. The overall means and standard deviations of the measurements were: pituitary gland width, 13.09 ± ± 1.99 mm; pituitary gland height, 4.91 ± 1.10 mm; intercavernous distance, 15.93 ± 3.05 mm; optic chiasm width, 12.82 ± 1.27 mm; and optic chiasm height, 2.80 ± 0.49 mm in females, respectively whereas, the same measurements were 12.96 ± 1.74 mm; 4.79 ± 0.95 mm; 16.08 ± 3.11 mm; 13.13 ± 1.37 mm; 2.86 ± ± 0.70 mm in males, respectively. Height of the pituitary gland reached a maximum in the age group of 18 to 20 years in both females and males and there was a decrease in the pituitary gland height in the subsequent age groups. Conclusions: Knowledge of the variation in the size of pituitary gland, intercavernous distance and optic chiasm is important to evaluate the dimensions of these structures for clinical and pathological processes.

Braz. J. et al 2009 studied an anatomical study of inter carotid distances in the sellar region with a surgical perspective and say there may be significant variations in the distance between the carotid sulci on both sides of the sphenoid bone. This distance varies throughout the entire length of the carotid sulci. It is important to be aware of the anatomical variations in these distances during trans-sphenoidal surgery to avoid potential catastrophic injury to the carotid arteries. The distance between the carotid sulci was measured in 26 disarticulated sphenoid bones at the anterior most and posterior most points on the medial borders of the carotid sulci and at the level of maximal sellar depth. The shortest distance was found to be at the anterior most and posterior most points in about 35% each of all specimens studied while in about 26% of specimens the shortest distance was at the level of maximum sellar depth. The minimum inter carotid distance was found to be 7.63 mm. The present study documented significant variations in inter carotid sulci distances along the course of the carotid artery in the cavernous sinus. The knowledge of this fact may be of possible help while planning transsphenoidal surgery and in avoiding carotid artery injury.

Mubina Lakhani et al 2017 in anatomical study Sphenoid Sinus Anatomical Relations and their Implications in Endoscopic Sinus Surgery, A well pneumatized sinus has visible irregularities or ridges. These are formed due to close proximity of surrounding vessels and nerves. If the sphenoid sinus pneumatizes anterior clinoid processes, it can encroach on the optic nerve .Literature reports anterior clinoid process pneumatization to be in between 11% and 29.3%. If pneumatization extends to the pterygoid processes, the sinus is observed to extend between two nerves, maxillary nerve and the nerve of the pterygoid canal (Vidian nerve). This type of extension may reach up to the posterior aspect of the maxillary sinus, and this has been reported to be present in 37.5-43.6% of cases. On the most medial aspect of cavernous sinus is situated the internal carotid artery which lies on the lateral aspect of sphenoid sinus. The impression of the internal carotid artery may be barely noticeable or highly noticeable depending on the pneumatization of the sphenoid sinus. Internal carotid artery is seen to be bulging into the sphenoid sinus in 34% to 93% of cases. Obvious differences between races do occur. Sometimes, a thin bone usually covering the internal carotid artery is found to be dehiscent and this has been reported in approximately 4% of the cases. This condition leaves the artery exposed into the sinus cavity. Therefore, it is vital that the surgeon is informed about these variations by the radiologist in order to avoid complications during surgery. The bony septum that divides the sphenoid sinus is rarely situated in the median plane. It is very often deviated laterally to one side or the other commonly inserting itself on the carotid canal or the optic canal. The sphenoid cavity is very often divided by multiple septal. Sareen, et al reported multiple inter sinus septal in 80% of cases. At least one of these septa is reportedly inserted on the carotid canal in 87% of cases according to Fernandez Miranda, et al. Thus, intraoperative extreme caution should be practiced avoiding fracture or removal of such septa.

Uli Fehrenbach et al 2020 in study title the Obesity and pituitary gland volume – a correlation study using three-dimensional magnetic resonance imaging, Obesity has become a major health problem and is associated with endocrine disorders and a disturbed hypothalamic-pituitary axis. The purpose of this study was to correlate pituitary gland volume with patient characteristics, in particular body mass index and obesity. Pituitary gland volumes were significantly larger in females than in males ($p<0.001$) and young individuals (<35 years) versus middle-aged patients (35–

47 years) ($p=0.042$). Obese patients (body mass index ≥ 30) had significantly larger pituitary gland volumes than overweight ($25<\text{body mass index}<30$; $p=0.011$) and normal-weight (body mass index <25; $p=0.005$) patients. In males, pituitary gland volumes of body mass index subgroups showed significant differences ($p=0.038$). Obese males had larger pituitary gland volumes than overweight patients ($p=0.066$) and significantly larger volumes than normal-weight ($p=0.023$) patients. Obese females also had larger pituitary gland volumes but without statistical significance ($p>0.05$). Regression analysis showed that increased pituitary gland volume is associated with higher body mass index independent from gender, age and body height.

Chapter Three
Materials and Methods

3.1 Materials

3.1.1 Patients and duration of the study

A cross-sectional descriptive study of the pituitary gland, sellar, and para sellar region, the data obtained from 301 Sudanese participant's 123 were males' (40.9%) and 178 were females' (59.1%) who underwent MRI examination for the brain, at the Radiology and Imaging Department in Al-Amal National Hospital, Yastabshiroon Omdurman Medical Center, and The Modern Medical Center in Khartoum, the period extended from 2015 to 2020.

3.1.1.1 Inclusion criteria

The normal MRI brain images were included in the current study for Sudanese patient, aged between 20 to 60 years old, the considerations for chose these range of age were that, these a period of relative stability in growth hormone and these are The age of full Maturing, before that age(20 years old) there is a wide range of measurements that effect by growth hormone in the stage of childhood then puberty hormones in puberty age, after 60 years old the bio physiology of the human body will be dropped and some internal part become shrink and loss of it function in normal body life period.

3.1.1.2 Exclusion criteria

Any patient with abnormal MRI findings was excluded e.g. Space Occupying Lesions, Brain Tumor, Cyst, Abscesses, Cerebral Hemorrhage, Infarctions, Head Injuries, Pituitary Abnormality e.g. (micro or macroadenoma, Pituitary Hormones

Disturbance, Schizophrenic patients…etc.) Pregnancy women and any intracranial surgeries.

3.1.1.3 Sample selection and population

The sample was selected from patients who apply the qualifications and don't had any exclusion criteria and came to the MRI department for MRI Brain examination and complain of simple singe and symptoms e.g. headache, fatigue in the body….etc.

Some patients gave formal written consent, others gave oral consent to use their data in the study. Some patients answered a questionnaire to collect the data.

The demographic parameters including (age, gender, Patient history, hereditary diseases, and medications of constant use….etc.) were taking in general. All study Variables' were measure for each patient also.

3.2 Methods

3.2.1 Equipment

3.2.1.1 MRI Machines used

In Yastabshiroon Medical Center MRI was 0.2T permanent magnet (open magnet) of General Electric Health Care (GE SIGNA EXCITE). Standard head coil was used for acquiring the images. Routine MRI for the brain was done, The sagittal and axial views were displayed using the midline plane of T1-weighted image spine-echo and coronal T2 image, the matrix was 512*512, (FOV) was (24*18) (repetition time/echo time (TR/TE) of 450/10.5ms, 378/8.6ms).Slice thickness of 6.3 mm.

In Al Amal National Hospital MRI was 1.5T closed magnet, Philips Medical System (intera). Use transmit body coil type and sense head receive coil. Routine

MRI brain done were T1 axial, sagittal, and coronal spine echo image, coronal T2 image, and DWI, the matrix was 256*256, (FOV) was (24*18). Slice thickness of 5mm.

In The Modern Medical Center MRI was 1.5T General Electric Health Care (GE) (SIGNA HDe), the matrix was 256*256 slice thickness 5mm, routine MRI for the brain was done The sagittal and axial views were displayed using the midline plane of T1-weighted image spine-echo and coronal T2 image.

1.2.1.2 MRI Technique

After making sure that the patient is decent to MRI and give good instruction about exams. Routine MRI brain done using a head coil, immobilization pads, and straps, the patient lies in a supine position on the examination couch, head first with their head within the head coil. The interpupillary line was parallel to the couch and the head was straight. The patient was positioned so that the longitudinal alignment light lies in the midline and the horizontal alignment light passes through the nasion. Then start to do routine brain protocols axial sequences T1, T2 and Flair, T1 sagittal image, and T2coronal image. Additional sequence and contrast did according to the scan center, case and finding pathology in the image, in the current study contrast media did not use.

3.2.1.3 Images interpretation

Supervised an evaluation of the image a good training and experienced MRI technician's physician knowledgeable in MRI and pituitary anatomy and pathology experienced investigators, MRI image quality to be excellent, diagnostic. Excellent image quality was defined as low image noise, with motion-free, delineation of a good appearance of the pituitary border the images were considered to be non-diagnostic in the presence of severe motion artifacts, excessive image noise. All patient images were evaluated by an expert radiologist. T1 sagittal, axial, and T2 coronal were used in the current study.

3.2.1.4 Variables, and their measurement

The anatomy of the Sellar and Parasellar regions is very complex and varies widely within the normal range. They are a small area, rich in anatomical details affecting multiple physiological systems in the body and, therefore, have great importance in several medical fields.

The data that displays in the mid-sagittal image (close to mid-sagittal plain using a midline image at a section where the cerebral aqueduct was visible and also the pituitary stalk)

The shape of the pituitary gland (PG)"convex, concave, flat, empty and partial empty" depend on the superior surface of the gland (SS) (Fig-1) in appendix 1.

Convex when the upper surface of (P.G) was convex (rather round shape) A

Concave when the upper surface of (P.G) was concave B.

Flat when the upper surface of P.G was flat C.

Partial empty (PE) when the high of the gland will be 3-4mm D.

Empty sella will be when gland high less than 2mm E.

The shape of the gland is important in assessing the height and dimensions of the gland, as the height increases whenever the gland is convex in shape and when the width and depth (length) increase it turns into a concave or oblate shape.

The anteroposterior dimension “length”

Was measured as the longitudinal distance, defined by the line connecting between two corners of the pituitary gland longitudinally in the T1 sagittal section, the measurement of pituitary length can detect the tumor that affects the sella and can enlarge it (Fig-2) in appendix 1.

Vertical height

was measured as the vertical distance of the pituitary, defined by a line connecting between two maximum top-bottom points in the T1 sagittal section, the measurement of pituitary height was the most measurement can detect the pathology and adenoma (Fig-3) in appendix 1.

The Pituitary area

The cross-sectional area of the pituitary gland laterally (Fig-4) in appendix 1. Also, can use it to calculate the P.G volume. Volume =area x width x 0.5

The Opining of sella or length of the sella

Was delineated by drawing a straight line from the anterior edge of the dorsum sella to the tuberculum sella. These measurement used to specify the upper prodder of sella and the stage of diaphragm herniation and the tumor infiltrate the pituitary gland (Fig-5) in appendix 1.

The Sellar area

The cross-sectional area of the sella turcica (lateral sellar area) was defined as the region beneath the opening of sella and used to calculate the sellar volume and the enlargement of sella due to tumor or pseudotumor cerebri (Fig-6) in appendix 1.

The sphenoid sinuses shape

The sphenoid sinuses were classified into four types (Fig-7) in appendix 1.

To evaluate the type of sphenoidal sinus, pneumatization and the criteria used by [Guerrero1999 and Hamberger et al 1961] were considered, excluding the semi-sellar and the conchal. Considering the sella, two imaginary lines were drawn perpendicular to the sphenoid. The 1st line is tangent to the anterior pituitary fossa, and, the 2nd line is tangent to the posterior boundary this was similar to the method used by [Seizo Yamashita et al 2014].

Conchal – small sinus with no relation to the sella (A)
Presellar - the posterior wall of the sinus reached the sella, but did not cross the 1st line (B).
Sellar - the posterior wall of the sinus crossed the 1^{st} line reached the floor of the sella, but did not exceed the 2nd line (C).

Postsellar - when pneumatization crossed the 2nd line (D). Some study rating sellar and post sellar shape in one group. An anatomic understanding of this area helps surgeons during surgery on the pituitary gland through the nose.

The pituitary shape inside sella

Proposed mechanism of compressive changes to the pituitary gland (Fig-8) in appendix 1.
Grid (A) Anatomy of the normal pituitary gland and sella turcica. The diaphragm, a reflection of the dura, fits snugly around the pituitary stalk.
Grid (B) A small arachnoid diverticulum filled with Cerebro Spinal Fluid (CSF) can extend below the diaphragm into the sella, loss of pituitary height <1/3 the height of sella.

Grid (C) (CSF) pulsation results in an enlarging diverticulum, which begins compressing the pituitary gland with a mild posterior deviation of the stalk, loss of pituitary height between 1/3 to 2/3 concavities of the height of sella.
Grid (D) As the arachnoid diverticulum becomes sufficiently large, the pituitary gland is compressed into the postero-inferior portion of the sella, with expansion and eventual erosion of the wall of the sella The stalk has markedly deviated posteriorly. Loss of pituitary height >2/3 height of sella.

This was similar to the method used by [William T.C. et al 2000] (fig-8) in appendix 1. P.G shape in sella can help to understand the variation in gland shape in same patient during time and detect the cause of change.

The pituitary bright spot in pituitary gland

Long axis, short axis Fig (3-9 B) and area Fig (3-9 C). An area of T1 hyperintensity is normally observed in the posterior part of the sella turcica in the posterior pituitary on MR images of the brain the (PBS) may appear in the stalk and in the sella also. This phenomenon is often referred to as the pituitary bright spot (PBS) (Fig-9) in appendix 1. Sample sagittal T1-weighted MR image showing the long and short axes of the (PBS). The long craniocaudal axis is the measurement, other measurement is the perpendicular anteroposterior short axis. The (PBS) must be to know the normal range to differentiate it from pathology (hemorrhage).

The length of the pituitary stalk, depth of infundibular recess and angle of the pituitary stalk (Fig-10) in appendix 1.

The method of measurement of the pituitary stalk and infundibular recess, The length of the pituitary stalk and the depth of the infundibular recess of the third ventricle were assessed for each subject, *A* Schematic illustration of the pituitary stalk in the mid sagittal plane demonstrates the depth of the infundibular recess (D) and the length of the pituitary stalk (L). The 2 lines indicate the levels at which the diameters of the pituitary stalk were measured (PI the pituitary insertion of the pituitary stalk, OC the level of the optic chiasm). The length of the pituitary stalk was defined and measured as the distance from the tip of the infundibular recess to the junction of the pituitary stalk and the pituitary gland along the course of the pituitary stalk. The depth of the infundibular recess was defined and measured as the distance from the tip of the infundibular recess to the floor of the third ventricle at the anterior edge of the infundibular recess this was similar to the method used by [N. Satogami et-al 2010].

In diagram (C) line A is drawn horizontally from the frontal base across the sellar incorporating a point in the roof of the sphenoid sinus and dorsum sella and is extrapolated horizontally. Line B is drawn perpendicularly from line A to the origin of the pituitary stalk. Line C is drawn along the pituitary stalk, and it intersects line B. The angle formed by the intersection of these 2 lines was taken as the pituitary stalk angle (calculated in degrees) this was similar to the method used by **[**Thinesh Kumran et-al 2015].

In general, the evaluation of the pituitary stalk is important to assess the normal position of the gland and to exclude pathological conditions of the stalk itself as well as assessing the angle of the stalk is important after and before surgery in the excision of gland tumors where the angle is very high due to the pressure of the tumor on the stalk before the operation and the angle decreases immediately after the operation and begins to return to normal values as a sign of healing.

The distance between nasal implant to sphenoid and sphenoid to the hypophysis (distance from columella nasal implant)

Knowing the variations of the sphenoid sinus is crucial when trying to reach the sellar region or surrounded structures through sphenoid bone, due to inability to locate the ostium of the sphenoid sinus on MRI, the distances measures of columella-sphenoid sinus and columella-pituitary were performed on an imaginary axis passing through the nasal columella implantation and a point formed by the intersection of a vertical line tangent to the anterior wall of the pituitary fossa tangent to another floor in the medium sagittal plane this was similar to the method used by [Seizo Yamashita et al 2014]

Distance between the middle point of the nasal columella through the anterior wall of the sphenoid sinus, to the hypophysis (columella – hypophysis green line (A). And from nasal columella to sphenoid sinus distances (columella-sinus) green line (B). And from sphenoid sinuses to hypophysis (sinus-hypophysis) red line (B). And the Small Distance from Pituitary (hypophysis) (SDP) to the point of intersection of the two imaginary lines (C) (Fig-11) in appendix 1. All of these measurements are extremely important in determining the surgical instruments.

The data displaying in coronal T2 image are

Optic chiasm width (green line) in the most central portion in the coronal plane for (PG) (Fig-12) in appendix 1.

The Inter carotid distance the distance between two inter carotid artery (pink line). Distance between intra-cavernous segments of lateral carotid and sella turcica similar to the method used by [Seizo Yamashita et al 2014] (Fig-13) in appendix 1.

Sphenoid sinus width

Under the sellar point in the coronal plane (green line) [Seizo Yamashita et al 2014]. (Fig-14) in appendix 1.

The data displaying in the axial image

The pituitary width

The maximum transverse dimension is the perpendicular distance defined by the line connecting between two maximum borders of (P.G) ‘A’ and ‘B’ RT to LT in the axial section. (Fig-15) in appendix 1.

The volume of the pituitary was estimated by using the Di Chiro formula 1962

V=length X Height X width X0.5

V=Antero-posterior dimension X Craniocaudal dimension X Transverse dimension X 0.52 (This factor is obtained from the sphere volume equation coefficient and cubic volume calculation: (4/3π) (r3) / (2r)3=3.1416/6=0.52)

And use the percentage formula to calculate the ratio between the pituitary and sellar area. The percentage of sella turcica filled by pituitary was determined by tracing the contour of the gland and then dividing its area by total sellar area.

3.2.1.5 Data collection and interpretations

The data were collected by using a datasheet which contained the patient NO, age, gender, and all variable measurements, and all the selected cases were diagnosed as a normal brain (rest unremarkable pathology) the study performed all image assessments by using the radiant Dicom imager program, and all the collected data were analyzed statistically with Origin Program SPSS version 20. Categorical data were presented as frequencies and percentages. Normally distributed continuous data were presented as means ± standard deviations. The relation between variables was done by ANOVA test, Chi-square test, linear regressions, and p-value <0.05 was considered as significant. The results were displayed as tables and graphs.

Chapter Four

Results

The following tables and figures present the results of the study.

Males' candidates made up 123 cases of the sample population 40.9% while the females made up the rest 178 cases by percentage 59.1%, the total sum of cases were 300 plus one empty sella cases (301) table (4-1). The age ranged from 20 to 60 years with age 35.96 as the mean age of the distribution table (4-2). Table (4-1) and figure (4-1), (4-2) give the summary of the frequency distribution and percentage of gender, the Frequency distribution of age groups classified by gender, one empty sella cases was detected in the females group in the age group 40-49. While table (4-2) gives the values of the frequency distribution of age.

Table (4-1) Frequency distribution and percentage of gender classified accord to age and age groups

	gender	count	frequency	Percent
20-29	male	49	126	41.9
	female	77		
30-39	male	26	63	20.9
	female	37		
40-49	male	18	45	15.0
	female	27		
50-60	male	30	67	22.3
	female	37		
Total	male	123	123	40.9
20-60	female	178	178	59.1
	total	301	301	100

Table (4-1) Frequency distribution and percentage of gender, the females were a large frequency distribution and percentage than males. Frequency distribution of age group and gender cross-tabulation, the large frequency was in the age group between20 to 29 then in age 50 to 60, and females are the most common gender count appear in all age groups.

±13.780.

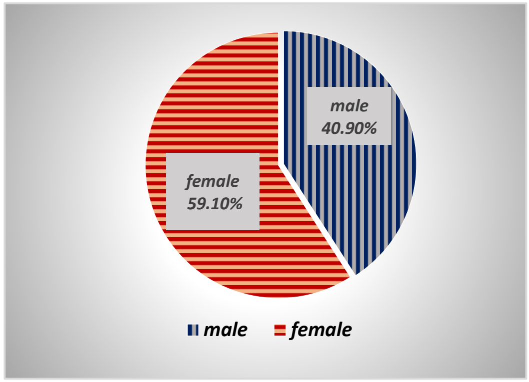


Fig (4-1) frequency distribution of gender.

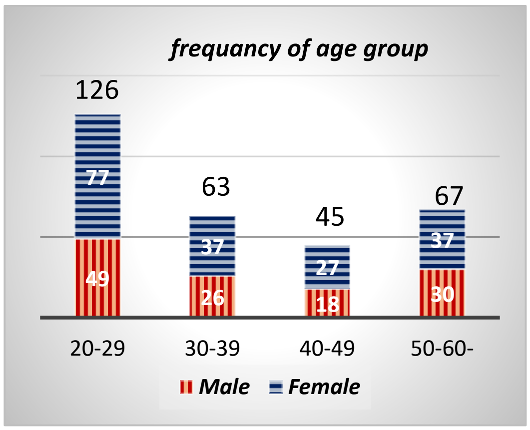


Fig (4-2) frequency distribution of age groups and gender

Table (4-2) descriptive statistics of age for all sample.

	N	Minimum	Maximum	Mean	Std. deviation
Age/year	301	20	60	35.96	13.780
Valid N(list wise)	301				

Table (4-2) Frequencies distribution of age, the minimum age was 20 years old and the maximum was 60 years old the mean of age is 35.96 with Standard deviation ±13.780.

* Table (4-3) frequency of pituitary gland shape classified accord to gender

		Frequency		Percent
Convex	male	50	127	41.9
	female	77		
Concave	male	34	80	26.4
	female	46		
Flat	male	25	57	18.8
	female	32		
	Total	**264**		
PE	male	14	36	11.9
	female	22		
	Total	**300**		
E	male	0	1	0.3
	female	1		
total		**301**		%100

Key table: (PE) partial empty sella, (E) empty sella

Table (4-3) shape of the pituitary frequency distribution, the shape of the pituitary gland can affect some variables, the current study divided the sample according to the shape and analytic according to it. the total sample were 301 when excluded the one empty sella it will be 300 and when excluded the 36 partial empty the sample will be 264, the convex shape were the high frequency distributed and it appears in females more than males by 41.9%, concave, flat, (PE) and (E) were the lower appear respectively.

*Table (4-4) frequency of pituitary shape classified accord to age groups

			Shape					Total
			convex	concave	flat	(PE)	(E)	
age group	20-29	Count	83	20	21	2	0	126
		% of Total	27.7%	6.7%	7.0%	0.7%	0	42.0%
	30-39	Count	17	18	13	15	0	63
		% of Total	5.7%	6.0%	4.3%	5.0%	0	21.0%
	40-49	Count	8	21	8	7	1	45
		% of Total	2.7%	7.0%	2.7%	2.3%	0.3	15%
	50-60	Count	19	21	15	12	0	67
		% of Total	6.3%	7.0%	5.0%	4.0%	0	22%
Total		Count	127	80	57	36	1	301
		% of Total	41.9%	26.4%	18.8%	11.9%	0.3	100.0%

In table (4-4) distribution the frequency of age groups with pituitary shape, in the age group 20-29 the convex shape appear in high frequency, concave appears in the age group between 40-49 and 50-60, the flat appears in the age group 20-29, (PE) in the age group 30-39, the only one empty case appear in female in the age group 40-49. Also, the order of shape generally was convex, concave, flat, (PE), (E).

Table (4-5) Frequency distribution for the mechanism of compressive changes of the pituitary in sella and with age groups.

age group	shape of pituitary in sella	N	Percent %
20-29	A	91	30.3%
	B	23	7.7%
	C	10	3.3%
	D	2	0.7%
30-39	A	25	8.3%
	B	11	3.7%
	C	13	4.3%
	D	14	4.7%
40-49	A	13	4.3%
	B	12	4.0%
	C	12	4.0%
	D	7	2.3%
50-60	A	22	7.3%
	B	15	5.0%
	C	20	6.7%
	D	10	3.3%
Total	A	151	50.2%
	B	61	20.3%
	C	55	18.3%
	D	34	11.2%
	total	301	100%

Key table: (A) The diaphragm, a reflection of the dura, fits snugly around the pituitary stalk. (B) A small arachnoid diverticulum filled with (CSF) can extend below the diaphragm into the sella, loss of pituitary height <1/3 the height of sella. **(C)** (CSF) pulsation results in an enlarging diverticulum, which begins compressing the pituitary gland, loss of pituitary height between 1/3 and 2/3 concavity of height of sella. (D) The arachnoid diverticulum becomes sufficiently large, the pituitary gland is compressed into the postero-inferior portion of the sella, loss of pituitary height >2/3 height of sella.

Table (4-5) showed frequency distribution for the mechanism of compressive changes of the pituitary in sella. Where the (A) and (B) shape respectively within high percentages generally and in all age groups, where the shape (C) appear in the old age group, shape (D) appear in the age group 30-39.

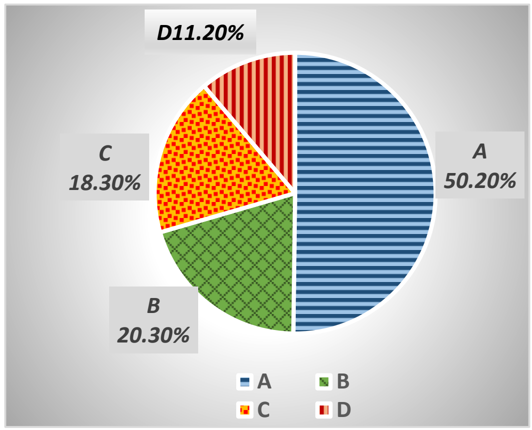


Fig (4-3) Frequency distribution for the mechanism of compressive changes of the pituitary gland in sella.

Table (4-6) the frequency and percentage of sphenoid sinus shape

		Frequency	Percent%	
Valid	conchal	12	4.0	
	Presellar	21	7.0	
	sellar	152	50.5	89
	Post sellar	116	38.5	
	Total	301	100%	

Table (4-6) distribute the shape of the sphenoid sinus that the sellar shape is the most common shape appear in current study in percentages about 50.5%, post sellar38.5%, pre sellar 7.0%and conchal 4.0%respectivly, the empty sella case had a sellar sinuses shape(151+1)

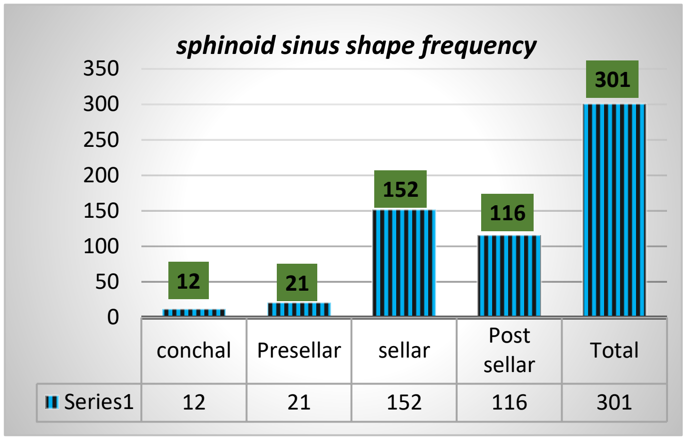


Fig (4-4) sphenoid sinus shape frequency

Table (4-7) Descriptive Statistics table for minimum, maximum, mean, and std. deviation for variables measurements (300 cases+1 empty case)

	N	Minimum	Maximum	Mean	Std. Deviation	Mean for empty sella
(PG) sagittal length/mm	300	6.13	16.20	11.12	1.62	9.7
(PG) sagittal height /mm	300	2.42	8.79	5.76	1.28	1.96
(PG) axial width/mm	300	6.18	17.00	12.00	1.87	10.5
(PG) Volume /mm^3	300	105.14	725.84	383.39	109.20	99.81
pituitary area/ cm^2	300	0.2175	0.8973	0.5632	0.1203	.3743
opening of sella /mm	300	6.04	16.30	9.87	1.64	13.1
sellar area/cm^2	300	0.3425	1.41	0.7533	0.1607	1.084
Pituitary sellar percentage %	300	34.48	96.96	75.88	13.25	34.52
long axis of PBS/mm	138	1.80	9.59	4.36	1.101	-
short axis of PBS/mm	138	1.32	4.59	2.66	0.70	-
area of PBS/cm^2	138	0.02	0.95	0.1085	0.105	-
OCW/mm	300	6.98	17.40	11.61	1.86	10.8
ICD/mm	300	8.43	29.80	17.45	3.69	14.8
Depth of stalk/mm	300	1.28	8.00	2.98	0.758	2.58
length of stalk/mm	300	1.44	12.00	3.61	1.45	8.62
Stalk(L+ D)/mm	300	3.03	20.00	6.59	1.90	11.2
Sphenoid sinuses width/mm	288	5.49	49.70	24.04	8.80	21.9
Columella implant-hypophysis/mm	300	70.40	103.30	85.61	5.16	79.8
SDP/mm	300	1.19	6.50	2.75	0.7838	3.13

Key table: PG pituitary gland, (PBS) posterior bright spot, (OCW) optic chiasm width, (ICD) inter carotid distance, (SDP) small distance to pituitary, and stalk (L + D) sum of stalk depth + length.

Table (4-7) Descriptive Statistics table for minimum, maximum, mean, and std. deviation for some variable for all sample (300 case 99.7%) +Empty sella (one case 0.3%). the posterior bright spot (PBS) was detected just in 138 cases in the pituitary, it did not appear in other 162 cases, a measurement for 288 cases of sphenoid sinus width because the conchal shape has not relation (no connection with sella) to the sella there were no measurements detected, the shape conchal detect in 12 cases from the sum of all cases. Sagittal height of empty case was 1.96mm and the gland filed 34.52%of sella with less pituitary volume 99.81.

Table (4-8) Descriptive Statistics table for minimum, maximum, mean, and std. deviation for variables exclude partial empty and empty sella (PE+E) (264 cases)

	N	Minimum	Maximum	Mean	Std. Deviation
PG Sagittal length/mm	264	6.13	16.20	11.13	1.58
PG sagittal height /mm	264	4.02	8.79	6.09	0.958
PG axial width/mm	264	7.50	17.00	12.16	1.76
PG Volume/ mm^3	264	175.48	725.84	408.73	87.80
pituitary area/cm^2	264	0.2911	0.897	0.5796	0.109
sellar area/cm^2	264	0.3425	1.279	0.7443	0.150
pituitary sellar percentage %	264	43.64	96.96	78.79	10.77
opening of sella/mm	264	6.04	14.50	9.79	1.61
Depth of stalk/mm	264	1.28	5.41	2.96	0.705
length of stalk/mm	264	1.44	8.71	3.43	1.18
stalk (L+ D)/mm	264	3.03	11.46	6.40	1.60
Hypophysis to Sphenoid /mm	264	28.40	97.80	75.89	9.45

Table (4-8) Descriptive Statistics table for minimum, maximum, mean, and std. deviation for some variable for sample after Excluded PE +E 87.7% (264 cases) pituitary height measure 6.09mm and volume measure 408.73mm^3.

Table (4-9) Group Statistics, mean and std. deviation for variables classified accord to gender.

	Gender	N	Mean	Std. Deviation	Std. Error Mean	sig
PG sagittal length /mm	male	123	11.25	1.61	.1453	0.656
	female	177	11.03	1.63	.1228	
PG sagittal height /mm	male	123	5.73	1.24	.1126	0.453
	female	177	5.78	1.31	.0987	
PG axial width/mm	male	123	12.04	1.96	.1771	0.675
	female	177	11.97	1.81	.1362	
PG volume/mm^3	male	123	388.47	111.79	10.07	0.638
	female	177	379.85	107.55	8.08	
pituitary area /cm^2	male	123	.5656	.11856	.01069	0.493
	female	177	.5615	.12189	.00916	
opening of sella /mm	male	123	9.713	1.41	.127	0.160
	female	177	9.98	1.77	.133	
sellar area/cm^2	male	123	.7489	.1409	.01270	*0.045
	female*	177	.7563	.1735	.01304	
Pituitary sellar percentage %	male*	123	76.23	12.23	1.103	*0.001
	female	177	75.64	13.95	1.04	
long axis of PBS/mm	male	62	4.47	1.16	.14	0.255
	female	76	4.26	1.04	.12	

Continue table(4-9)						
short axis of PBS/mm	male*	62	2.82	.71	.091	*0.017
	female	76	2.53	.66	.076	
area of PBS/cm^2	male	62	0.1083	0.05	.00	0.983
	female	76	0.1087	0.13	.01	
OCW/mm	male*	123	11.98	2.06	.1865	*0.005
	female	177	11.36	1.66	.1248	
ICD/mm	male	123	18.36	3.92	.3541	0.121
	female	177	16.83	3.39	.2553	
Depth of stalk/mm	male	123	2.88	.60813	.0548	*0.014
	female*****	177	3.05	.84175	.0632	
length of stalk/mm	male	123	3.57	1.34	.1215	0.395
	female	177	3.64	1.52	.1147	
stalk (L+ D)/mm	male	123	6.45	1.59	.14412	0.093
	female	177	6.70	2.08	.15699	
Sphenoid sinuses width/mm	male	122	24.40	9.27	.83	0.550
	female	166	23.77	8.49	.65	
columella implant hypophysis/mm	male	123	89.09	6.21	.56046	0.242
	female	177	83.50	4.15	.31204	
SDP/mm	male	123	2.83	.8137	.07337	0.219
	female	177	2.70	.7603	.05715	
Hypophysis to Sphenoid/mm	male*	109	78.63	10.33	.990	*0.00
	female	155	73.43	8.286	.665	

Sellar area, pituitary sellar percentage, short axis of (PBS), (OCW), depth of the stalk and hypophysis to sphenoid distance was a statistically significant $P<0.05$ between gender*****, will others values have no statistically significant $P>0.05$.

Tables (4-10) descriptive statistics for variables classified accord to age groups.

variables	Age groups	N	Mean	Std. Deviation	Std. Error	Sig. Between groups
PG sagittal length /mm	20-29	126	10.83	1.607	.14323	* 0.005
	30-39	63	11.27	1.611	.20298	
	40-49	44	10.93	1.532	.23100	
	50-60	67	11.67	1.612	.19698	
	Total	300	11.12	1.626	.09389	
PG sagittal height /mm	20-29	126	6.47	.87400	.07786	*0.000
	30-39	63	5.22	1.359	.17127	
	40-49	44	5.14	1.263	.19048	
	50-60	67	5.34	1.267	.15482	
	Total	300	5.76	1.28	.07425	
PG axial width/mm	20-29	126	12.28	1.642	.14635	*0.004
	30-39	63	11.78	1.823	.22972	
	40-49	44	12.41	1.73	.26162	
	50-60	67	11.39	2.24	.27366	
	Total	300	12.00	1.873	.10817	
PG volume/ mm^3	20-29	126	426.79	87.57	7.80	*0.000
	30-39	63	349.30	118.05	14.87	
	40-49	44	346.81	98.40	14.83	
	50-60	67	357.84	117.66	14.37	
	Total	300	383.39	109.20	6.30	
pituitary area/ cm^2	20-29	126	.5936	.10303	.00917	*0.000
	30-39	63	.5394	.12139	.01529	
	40-49	44	.5136	.118473	.01786	
	50-60	67	.5610	.13628	.01664	
	Total	300	.5632	.12035	.00694	
opening of sella/ mm	20-29	126	9.43	1.59	.141722	*0.006
	30-39	63	10.19	1.60	.202550	
	40-49	44	10.03	1.60	.24166	
	50-60	67	10.11	1.89	.23208	
	Total	300	9.83	1.69	.097977	

Continue table (4-10)

		N	Mean	Std. Deviation	Std. Error	Sig.
sellar area/cm^2	20-29	126	.7325	.144146	.012841	0.075
	30-39	63	.7878	.199598	.025147	
	40-49	44	.7321	.129426	.019511	
	50-60	67	.7739	.16326	.019946	
	Total	300	.75334	.16073	.009280	
Pituitary sellar percentage %	20-29	126	81.91	9.36	.834480	*0.000
	30-39	63	70.59	15.82	1.99	
	40-49	44	70.47	12.25	1.84	
	50-60	67	73.07	13.17	1.61	
	Total	300	75.88	13.25	.76555	
long axis of PBS/mm	20-29	67	4.3401	1.21876	.14889	.691
	30-39	24	4.4000	.77250	.15769	
	40-49	16	4.1044	.71069	.17767	
	50-60	31	4.5087	1.22660	.22030	
	Total	138	4.3610	1.10165	.09378	
short axis of PBS/mm	20-29	67	2.5372	.68440	.08361	.099
	30-39	24	2.7838	.76488	.15613	
	40-49	16	2.5844	.64793	.16198	
	50-60	31	2.8874	.67639	.12148	
	Total	138	2.6642	.70174	.05974	
area of PBS/cm^2	20-29	67	.1126	.14178	.01732	.942
	30-39	24	.0968	.04053	.00827	
	40-49	16	.1076	.07487	.01872	
	50-60	31	.1092	.04516	.00811	
	Total	138	.1085	.10513	.00895	
OCW/mm	20-29	126	11.87	1.80	.16055	0.076
	30-39	63	11.57	1.88	.23770	
	40-49	44	11.65	1.74	.26245	
	50-60	67	11.14	1.96	.23976	
	Total	300	11.61	1.86	.10741	
ICD/mm	20-29	126	17.63	3.73	.33304	0.304
	30-39	63	16.67	3.08	.38905	
	40-49	44	17.63	3.55	.53558	
	50-60	67	17.74	4.17	.51047	
	Total	300	17.45	3.69	.21334	

Continue table (4-10)

		N	Mean	Std. deviation	Std. error	Sig
Depth of stalk/mm	20-29	126	2.99	.67608	.06023	0.191
	30-39	63	2.89	.63736	.08030	
	40-49	44	3.19	.80395	.12120	
	50-60	67	2.92	.94752	.11576	
	Total	300	2.98	.75869	.04380	
length of stalk/mm	20-29	126	3.35	1.17	.10458	*0.021
	30-39	63	4.03	1.78	.22550	
	40-49	44	3.56	1.11	.16829	
	50-60	67	3.73	1.68	.20572	
	Total	300	3.61	1.45	.08394	
Sphenoid sinuses width/mm	20-29	121	24.9660	9.56931	.86994	0.505
	30-39	63	23.3038	7.67532	.96700	
	40-49	40	23.1800	7.95575	1.25791	
	50-60	64	23.5630	8.86768	1.10846	
	Total	288	24.0426	8.80402	.51878	
columella implant-hypophysis/mm	20-29	126	85.58	5.17	.4614	0.074
	30-39	63	86.20	5.35	.6744	
	40-49	44	84.08	8.19	1.23	
	50-60	67	86.93	5.17	.6322	
	Total	300	85.79	5.78	.3341	
SDP/mm	20-29	126	2.48	.6592	.0587	*0.000
	30-39	63	2.92	.71252	.0897	
	40-49	44	2.89	.67170	.1012	
	50-60	67	3.02	.96540	.1179	
	Total	300	2.75	.78383	.0452	
stalk (L+ D)/mm	20-29	126	6.34	1.52932	.1362	0.219
	30-39	63	6.92	2.13147	.2685	
	40-49	44	6.76	1.54617	.2330	
	50-60	67	6.66	2.43415	.2973	
	Total	300	6.59	1.90400	.1099	
hypophysis to Sphenoid/mm	20-29	124	74.0358	9.14107	.82089	*0.024
	30-39	48	77.3119	8.82966	1.27445	
	40-49	37	77.0486	11.32948	1.86255	
	50-60	55	78.0680	8.72946	1.17708	
	Total	264	75.8938	9.45507	.58192	

Key table: (PG) pituitary gland, (PBS) posterior bright spot, (OCW) optic chiasm width, (ICD) inter carotid distance, (SDP) small distance to pituitary, and stalk (L + D) sum of stalk depth + length.

Table (4-10) One-way (PG) sagittal length, (PG) height, (PG) axial width, (PG) volume ….etc. by age groups, statistics descriptive for variables, the sagittal length of (PG) was highest values in the old age group 50-60 years, sagittal height and the volume detect large value in the young age group 20-29 then in the old age group 50-60, axial width high value detect in the age group 40-49, the long and short axis of (PBS)were higher in the age grope 50-60, Sagittal length, sagittal height, axial width, volume, pituitary area, the opening of sella, pituitary sellar percentage, length of the stalk, (SDP), small distance to pituitary was statistically significant P<0.05 with age groups*. Other variables P>0.05.

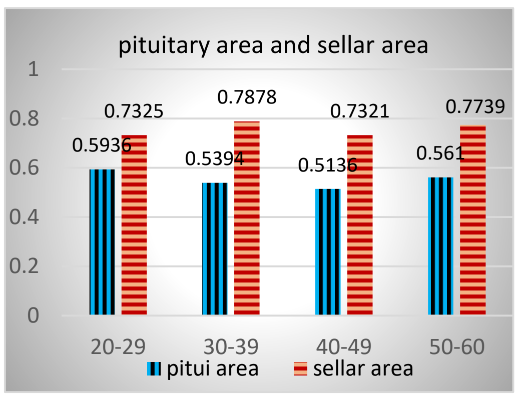


Fig (4-5) Frequency between pituitary area, sellar area and age groups

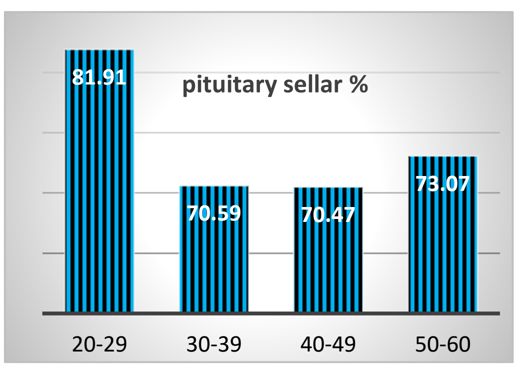
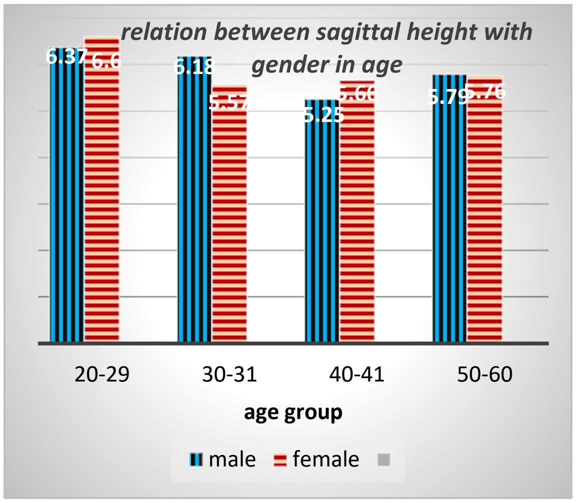


Fig (4-6) Frequency of pituitary sellar percentage in age groups.

Table (4-11) frequency descriptive table for sagittal length, height, axial width and volume classified accord to age groups and gender.

			Sagittal length/mm		Sagittal height/mm		Axial width/mm		Volume/mm^3	
age groups	Gender	N	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
20-29	male	47	10.90	1.32	6.37	.741	12.66	1.710	438.31	88.29
	female	77	10.80	1.72	6.60	.815	12.03	1.577	424.45	82.40
	Total	124	10.83	1.58	6.51	.793	12.27	1.650	429.71	84.59
30-39	male	20	11.45	1.43	6.18	.761	12.30	1.686	432.78	82.56
	female	28	11.12	1.60	5.57	.912	11.79	1.679	365.05	89.98
	Total	48	11.26	1.53	5.83	.896	12.00	1.683	393.27	92.44
40-49	male	15	11.39	1.39	5.25	.880	12.54	1.665	373.56	81.57
	female	22	10.67	1.29	5.66	1.092	12.55	1.663	375.23	79.86
	Total	37	10.96	1.36	5.49	1.018	12.55	1.640	374.56	79.43
50-60	male	27	11.78	1.76	5.79	1.132	11.31	2.041	378.75	84.36
	female	28	11.86	1.46	5.76	.660	12.25	2.076	416.41	85.71
	Total	55	11.82	1.60	5.78	.913	11.79	2.095	397.92	86.37
Total	male	109	11.28	1.50	6.04	.947	12.24	1.848	413.63	89.19
	female	155	11.03	1.64	6.13	.968	12.10	1.705	405.28	86.93
	Total	264	11.13	1.58	6.09	.958	12.16	1.764	408.73	87.80

In group 264 cases (PG) Sagittal length was higher in males in all age groups except the oldest one, (PG) sagittal height was higher in females in the age group 20-29 and 40-49 and value coverage in the age group 50-60 years. (PG) Axial width and volume appear in high value in males in the age groups 20-29, 30-39 then the value reveres for females in the age group 40-49 and 50-60 years old.



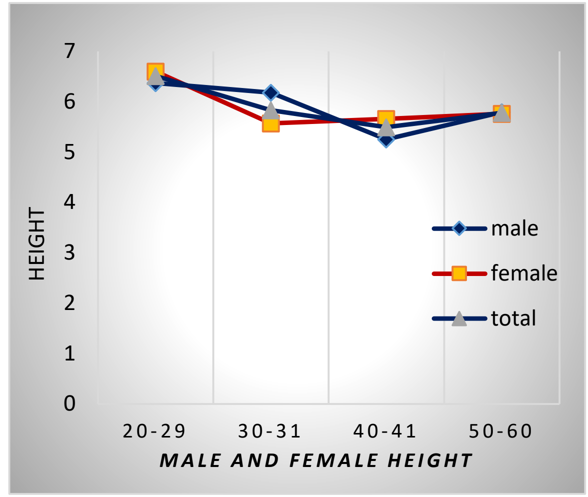
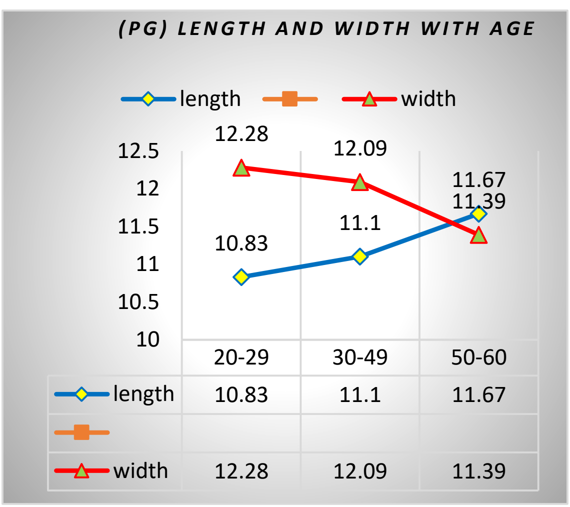


Fig (4-7) Relation between sagittal heights of pituitary with gender in age groups

Fig (4-8) males and females (PG) height related to age groups



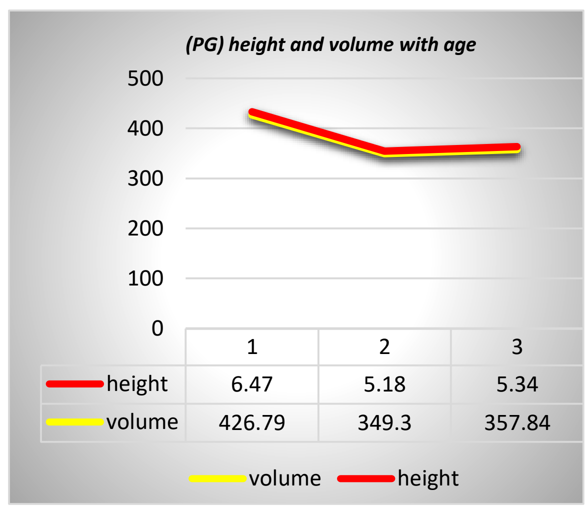


Fig (4-9) pituitary length and width related to age

Fig (4-10) pituitary height and volume related to age

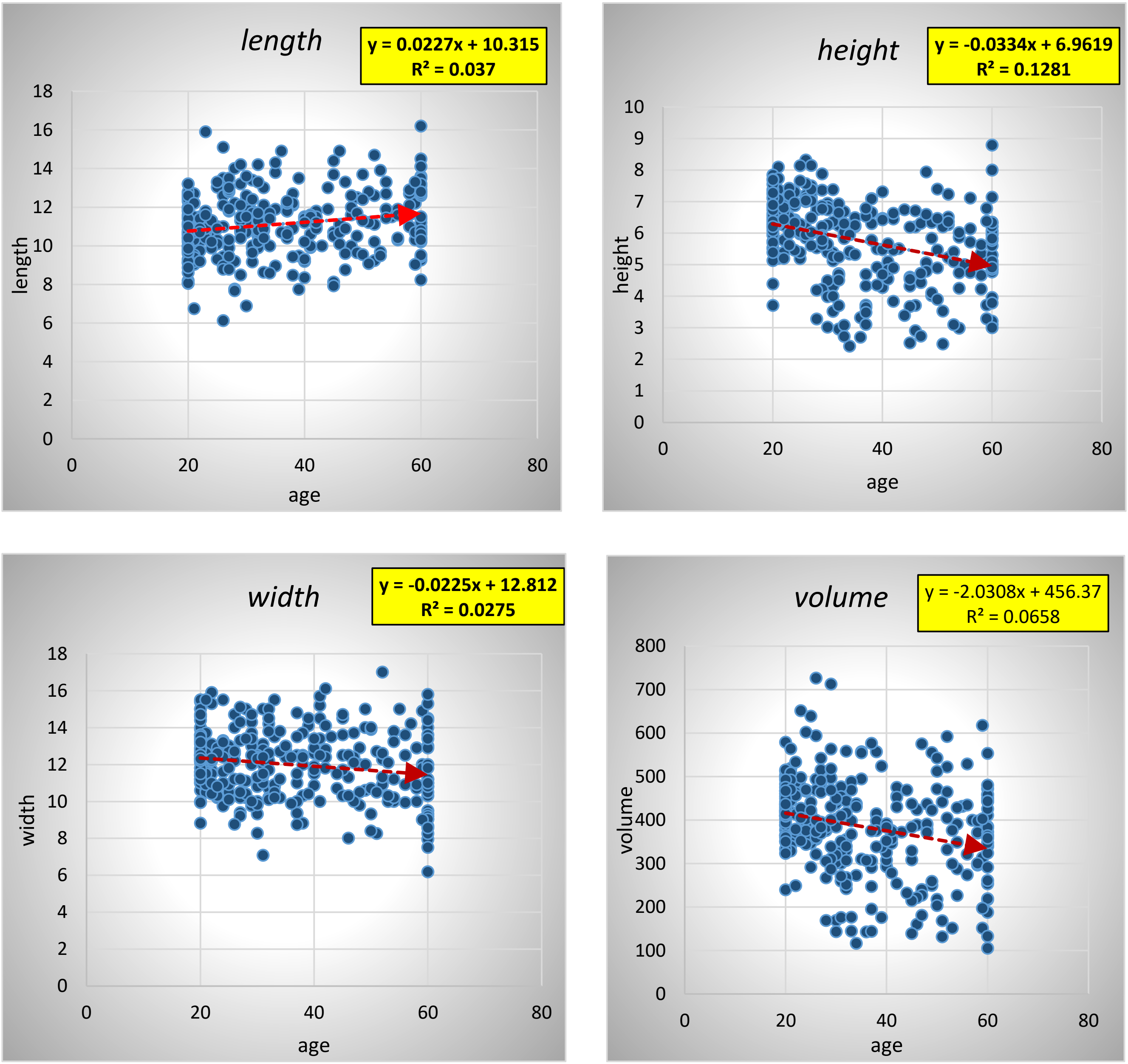


Fig (4 -11) linear regressions for length, height, width, and volume of the pituitary gland with age

Table (4-12) The distance from columella nasal implant to hypophysis classified accord to age groups and gender.

age group	Gender	Mean of Columella/mm	N	Std. Deviation	Minimum	Maximum
20-29	male	89.4224	49	3.80347	81.30	97.60
	female	83.1364	77	4.40606	73.30	97.80
	Total	85.5810	126	5.17923	73.30	97.80
30-39	male	89.8346	26	5.09109	76.30	98.30
	female	83.6486	37	3.88906	77.90	93.70
	Total	86.2016	63	5.35331	76.30	98.30
40-49	male	85.4333	18	11.92407	90.40	94.80
	female	83.1577	26	4.07236	70.40	89.00
	Total	84.0886	44	8.19359	40.40	94.80
50-60	male	90.1100	30	4.77900	80.70	103.30
	female	84.3595	37	3.93464	76.50	91.00
	Total	86.9343	67	5.17499	76.50	103.30
Total	male	89.0935	123	6.21575	90.40	103.30
	female	83.5023	177	4.15141	70.40	97.80
	Total	85.7947	300	5.78761	70.40	103.30
	Sig.	age groups P=0.074		gender P=0.242		

The columella nasal implant was higher in meals but the relation wasn't statistically significant P =0.242. And in old meals can detect the upper value there were no statistically significant p>0.05 with age groups.

Table (4-13) the sphenoid sinuses width mean, minimum, maximum and Std. deviation classified accord to age groups and gender

age group	Gender	Mean of SW/mm	N	Std. Deviation	Minimum	Maximum
20-29	male	25.0886	49	10.58926	8.27	49.70
	female	24.8826	72	8.88503	9.45	45.70
	Total	24.9660	121	9.56931	8.27	49.70
30-39	male	23.9558	26	8.88748	13.50	44.30
	female	22.8457	37	6.78837	6.92	40.00
	Total	23.3038	63	7.67532	6.92	44.30
40-49	male	23.8706	17	8.74720	11.10	48.90
	female	22.6696	23	7.47769	10.90	42.10
	Total	23.1800	40	7.95575	10.90	48.90
50-60	male	23.9800	30	7.86640	12.30	47.40
	female	23.1950	34	9.76962	5.49	45.80
	Total	23.5630	64	8.86768	5.49	47.40
Total	male	24.4048	122	9.27727	8.27	49.70
	female	23.7763	166	8.45796	5.49	45.80
	Total	24.0426	288	8.80402	5.49	49.70
Sig.	Age group 0.505			gender 0.550		

Key table: SW sphenoid sinuses width

The minimum (SW) was detect in females in age group 50-60, the maximum (SW) detect in meals in age group 20-29years old, the (SW) P. value>0.05 with gender and age groups.

Table (4-14) the sphenoid sinus width classified accord to sphenoid sinuses shapes

	N	Mean /mm	Std. Deviation	Std. Error	Minimum	Maximum	sig
conchal	12	0.00	0.00	0.00	0.00	0.00	*0.000
Presellar	21	16.6681	6.60956	1.44232	6.92	28.10	
sellar	152	22.1677	7.84101	.63809	5.49	45.70	
post sellar	116	27.8181	8.75926	.81328	10.30	49.70	
Total	301	23.1775	9.74666	.56272	5.49	49.70	

Table (4-14) the relation between the sphenoid Sinus width that connects to the sellar region and sphenoid sinus shapes was statically significant P<0.05, the larger width of the sinus appear in post sellar shape the mean 27.81then sellar, presellar respectively. So conchal shape has not relation (have no connection to sella) to the sella there are no measurements detected, the shape conchal detects in 12 cases from the sum of all sample.

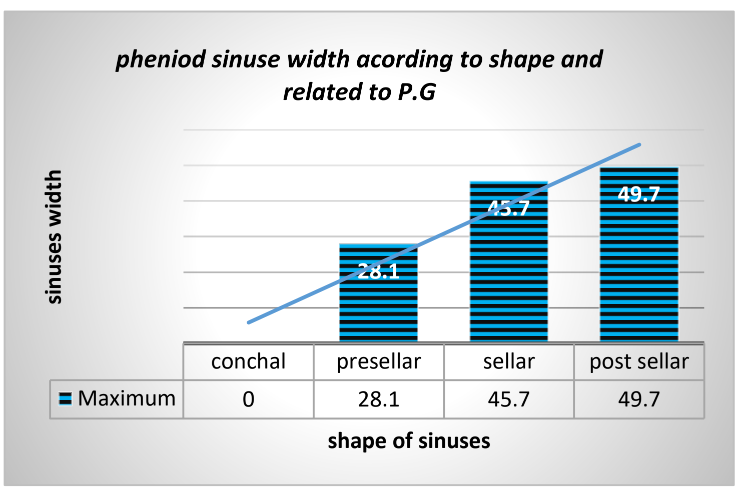


Fig (4-12) the sphenoid sinus width according to sinuses shape

Tables (4-15) the correlation between variables and pituitary shapes.

		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum	Sig.
sagittal length/mm	convex	127	10.90	1.63	.1446	6.13	15.90	0.131
	concave	80	11.25	1.55	.1739	7.74	16.20	
	Flat	57	11.48	1.48	.1962	8.78	14.40	
	PE	36	11.05	1.90	.3170	6.89	14.90	
	Total	300	11.12	1.62	.0938	6.13	16.20	
sagittal height/mm	convex	127	6.72	.6575	.0583	5.26	8.79	*0.000
	concave	80	5.32	.8657	.0967	4.02	7.36	
	Flat	57	5.78	.6795	.0900	4.39	7.28	
	PE	36	3.31	.4563	.0760	2.42	4.00	
	Total	300	5.76	1.28	.0742	2.42	8.79	
axial width /mm	convex	127	12.22	1.66	.1476	7.94	15.90	*0.001
	concave	80	12.01	1.95	.2187	7.50	16.10	
	flat	57	12.23	1.71	.2268	8.26	17.00	
	PE	36	10.83	2.23	.3727	6.18	14.70	
	Total	300	12.00	1.87	.1081	6.18	17.00	
Volume /mm^3	convex	127	443.77	80.55	7.14	266.74	725.84	*0.000
	concave	80	357.30	84.06	9.39	175.48	578.81	
	flat	57	402.83	70.99	9.40	239.47	591.57	
	PE	36	197.55	59.85	9.97	105.14	339.54	
	Total	300	383.39	109.20	6.30	105.14	725.84	

Continue table (4-15)								
pituitary area/cm^2	convex	127	.6058	.0980	.0087	.3942	.8973	*0.000
	concave	80	.5556	.1177	.0131	.3224	.8283	
	flat	57	.5550	.1120	.0148	.2911	.8574	
	PE	36	.4429	.1266	.0211	.2175	.7870	
	Total	300	.5632	.1203	.0069	.2175	.8973	
opening of sella/mm	convex	127	9.34	1.54	.137	6.04	14.00	
	concave	80	10.193	1.62	.181	7.28	14.50	*0.000
	flat	57	9.994	1.53	.203	7.03	13.63	
	PE	36	10.845	1.56	.260	8.01	16.30	
	Total	300	9.873	1.64	.0948	6.04	16.30	
sellar area /cm^2	convex	127	.7191	.1215	.0107	.4421	1.08	*0.000
	concave	80	.8119	.1766	.0197	.4670	1.27	
	flat	57	.7056	.1417	.0187	.3425	1.11	
	PE	36	.8191	.2114	.0352	.4981	1.41	
	Total	300	.7533	.16073	.0092	.3425	1.41	
Pituitary sellar percentage %	Convex	127	84.61	6.63	.5887	62.10	95.92	
	concave	80	69.19	9.68	1.08	46.30	85.79	
	flat	57	79.30	10.25	1.35	43.64	96.96	*0.000
	PE	36	54.54	9.86	1.64	34.48	79.2	
	Total	300	75.88	13.25	.7655	34.48	96.96	
long axis of PBS/mm	convex	74	4.33	1.19	.1389	1.80	9.59	0.174
	concave	29	4.72	1.15	.2153	2.66	7.13	
	flat	31	4.10	.7336	.1317	2.49	5.97	
	PE	4	4.11	.8577	.4288	3.27	5.12	

	Continue table (4-15)							
	Total	138	4.36	1.10	.0937	1.80	9.59	
short axis of PBS/mm	convex	74	2.68	.6465	.0751	1.38	4.05	0.889
	concave	29	2.57	.7526	.1397	1.51	4.33	
	flat	31	2.70	.8214	.1475	1.32	4.59	
	PE	4	2.66	.4181	.2090	2.18	3.20	
	Total	138	2.66	.7017	.0597	1.32	4.59	
area of PBS /mm	convex	74	.1126	.1330	.0154	.02	.95	0.944
	concave	29	.1091	.0586	.0108	.03	.28	
	flat	31	.0988	.0621	.0111	.02	.37	
	PE	4	.1026	.0407	.0203	.06	.15	
	Total	138	.1085	.1051	.0089	.02	.95	
OCW/mm	convex	127	11.71	1.81	.1609	6.98	16.70	*0.002
	concave	80	11.74	1.91	.2136	7.06	16.80	
	flat	57	11.92	1.92	.2555	7.95	17.40	
	PE	36	10.53	1.45	.2417	7.37	13.40	
	Total	300	11.61	1.86	.1074	6.98	17.40	
ICD/mm	convex	127	17.28	3.85	.3424	8.43	26.60	0.110
	concave	80	17.30	3.54	.3966	10.80	26.80	
	flat	57	18.48	4.01	.5313	11.40	29.80	
	PE	36	16.77	2.55	.4260	11.40	21.60	
	Total	300	17.45	3.69	.2133	8.43	29.80	
Depth of stalk	convex	127	2.90	.6433	.0570	1.46	5.41	0.201
	concave	80	3.10	.7767	.0868	1.48	4.83	
	flat	57	2.93	.7198	.0953	1.28	4.37	
	PE	36	3.108	1.07	.1795	1.75	8.00	

	Continue table(4-15)							
	Total	300	2.98	.7586	.0438	1.28	8.00	
length of stalk/mm	convex	127	3.01	.8468	.0751	1.44	5.49	*0.000
	concave	80	3.91	1.30	.1460	1.72	8.27	
	flat	57	3.68	1.34	.1786	1.75	8.71	
	PE	36	4.94	2.32	.3870	2.10	12.00	
	Total	300	3.61	1.45	.0839	1.44	12.00	
Sphenoid sinuses width/mm	convex	122	25.61	9.62	.8717	8.27	49.70	*0.015
	concave	78	22.11	7.61	.8623	5.49	47.40	
	flat	54	24.73	8.69	1.18	7.54	48.90	
	PE	34	21.72	7.30	1.25	8.87	36.90	
	Total	288	24.04	8.80	.5187	5.49	49.70	
columella implant-hypophysis /mm	convex	127	85.75	5.01	.4453	74.40	97.80	0.880
	concave	80	85.43	7.12	.7963	40.40	103.30	
	flat	57	86.19	5.85	.7759	70.40	96.60	
	PE	36	86.08	5.03	.8399	78.10	99.70	
	Total	300	85.79	5.78	.3341	40.40	103.30	
SDP/mm	convex	127	2.50	.6277	.0557	1.24	4.79	*0.000
	concave	80	2.97	.8794	.0983	1.77	6.50	
	flat	57	2.81	.8126	.1076	1.19	4.98	
	PE	36	3.05	.7725	.1287	1.80	5.56	
	Total	300	2.75	.7838	.0452	1.19	6.50	
Stalk (L+ D) /mm	convex	127	5.91	1.21	.1076	3.67	9.55	*0.000
	concave	80	7.01	1.78	.1990	3.34	11.38	
	flat	57	6.62	1.78	.23593	3.03	11.46	
	PE	36	8.04	3.03	.5051	3.85	20.00	

	Continue table(4-15)							
	Total	300	6.59	1.90	.1099	3.03	20.00	
Hypophysis to Sphenoid	convex	127	74.69	9.27	.8225	42.31	97.80	.443
	concave	80	77.98	9.96	1.11	28.40	93.60	
	flat	57	75.64	8.77	1.16	61.30	96.60	
	PE	36	79.92	8.65	1.46	62.10	94.20	
	Total	300	76.36	9.44	.5459	28.40	97.80	

ONE WAY, pituitary sagittal length, sagittal height, axial width, volume, pituitary area, opening, sellar area, percentage, long axis of (PBS)….etc. mean, minimum, maximum, Std. deviation, Std. error and P. value CSPH by pituitary shapes statistics descriptive table (4-15). The sagittal height, axial width, volume, pituitary area, opening of sella, sellar area, sellar pituitary percentage, (OCW), length of the stalk, (SDP) and stalk (L+D) statistically significant P. value <0.05 *.

Table (4-16) Relation between stalk angle and pituitary shapes, and with gender.

	N	**Mean**	**Std. Deviation**	**Std. Error**	**Minimum**	**Maximum**	**Sig**
convex	**39**	**47.3077**	**5.57213**	**.89225**	**40.00**	**58.90**	**0.639**
concave	**12**	**47.2333**	**4.93067**	**1.42336**	**40.30**	**57.80**	
flat	**16**	**49.2500**	**4.87552**	**1.21888**	**41.10**	**56.30**	
PE	**6**	**48.3333**	**5.86401**	**2.39397**	**42.40**	**58.70**	
Male	**37**	**46.77**	**5.12**	**.842**	**40.00**	**58.90**	**0.093**
female	**36**	**48.86**	**5.34**	**.890**	**40.90**	**58.70**	
Total angle	**73**	**47.8055**	**5.30254**	**.62062**	**40.00**	**58.90**	

Table (4-16) the relation between the pituitary shapes and stalk angle degree, the high degree was appear in flat shape and the lower degree appear in convex and concave but the relation was not statistically significant. In the lower row of the table (4-16) the mean of the stalk angle was 47.80 with standard deviation 5.30 (the measurements take for 73 cases in stander position in dicom imager program).

Table (4-17) Correlation between variables

		sagittal length/mm	Sagittal height /mm	axial width/mm	volume	pituitary area cm2	opening of sella mm	sellar area	sellar pituitary percentage	long axis of PBS	short axis of PBS	area of PBS
sagittal length/mm	**Pearson Correlation**	**1**	**-.058**	**-.244****	**.334****	**.530****	**.267****	**.561****	**-.044**	**.266****	**.322****	**.179****
	Sig. (2-tailed)		**.316**	**.000**	**.000**	**.000**	**.000**	**.000**	**.446**	**.000**	**.000**	**.002**
sagittal height /mm	**Pearson Correlation**	**-.058**	**1**	**.103**	**.751****	**.541****	**-.279****	**-.125***	**.755****	**.234****	**.237****	**.195****
	Sig. (2-tailed)	**.316**		**.074**	**.000**	**.000**	**.000**	**.030**	**.000**	**.000**	**.000**	**.001**
axial width/mm	**Pearson Correlation**	**-.244****	**.103**	**1**	**.481****	**-.173****	**-.075**	**-.249****	**.105**	**.029**	**.027**	**-.014**
	Sig. (2-tailed)	**.000**	**.074**		**.000**	**.003**	**.193**	**.000**	**.070**	**.615**	**.644**	**.813**
volume	**Pearson Correlation**	**.334****	**.751****	**.481****	**1**	**.584****	**-.114***	**.065**	**.586****	**.326****	**.359****	**.233****
	Sig. (2-tailed)	**.000**	**.000**	**.000**		**.000**	**.048**	**.260**	**.000**	**.000**	**.000**	**.000**
pituitary area cm2	**Pearson Correlation**	**.530****	**.541****	**-.173****	**.584****	**1**	**.015**	**.594****	**.480****	**.346****	**.377****	**.303****
	Sig. (2-tailed)	**.000**	**.000**	**.003**	**.000**		**.795**	**.000**	**.000**	**.000**	**.000**	**.000**
opening of sella mm	**Pearson Correlation**	**.267****	**-.279****	**-.075**	**-.114***	**.015**	**1**	**.440****	**-.476****	**-.089**	**-.107**	**-.088**
	Sig. (2-tailed)	**.000**	**.000**	**.193**	**.048**	**.795**		**.000**	**.000**	**.124**	**.064**	**.127**
sellar area	**Pearson Correlation**	**.561****	**-.125***	**-.249****	**.065**	**.594****	**.440****	**1**	**-.397****	**.096**	**.104**	**.093**
	Sig. (2-tailed)	**.000**	**.030**	**.000**	**.260**	**.000**	**.000**		**.000**	**.098**	**.072**	**.108**
sellar pituitary percentage %	**Pearson Correlation**	**-.044**	**.755****	**.105**	**.586****	**.480****	**-.476****	**-.397****	**1**	**.260****	**.286****	**.221****
	Sig. (2-tailed)	**.446**	**.000**	**.070**	**.000**	**.000**	**.000**	**.000**		**.000**	**.000**	**.000**
long axis of PBS	**Pearson Correlation**	**.266****	**.234****	**.029**	**.326****	**.346****	**-.089**	**.096**	**.260****	**1**	**.917****	**.637****
	Sig. (2-tailed)	**.000**	**.000**	**.615**	**.000**	**.000**	**.124**	**.098**	**.000**		**.000**	**.000**
short axis of PBS	**Pearson Correlation**	**.322****	**.237****	**.027**	**.359****	**.377****	**-.107**	**.104**	**.286****	**.917****	**1**	**.625****
	Sig. (2-tailed)	**.000**	**.000**	**.644**	**.000**	**.000**	**.064**	**.072**	**.000**	**.000**		**.000**
area of PBS	**Pearson Correlation**	**.179****	**.195****	**-.014**	**.233****	**.303****	**-.088**	**.093**	**.221****	**.637****	**.625****	**1**
	Sig. (2-tailed)	**.002**	**.001**	**.813**	**.000**	**.000**	**.127**	**.108**	**.000**	**.000**	**.000**	

Continue table (4-17)

		sagittal length/mm	sagittal height /mm	axial width/mm	volume	pituitary area cm2	opening of sella mm	sellar area	sellar pituitary percentage %	long axis of PBS	short axis of PBS	area of PBS
OCW	**Pearson Correlation**	**-.087**	**.178****	**.313****	**.245****	**.070**	**-.099**	**-.057**	**.172****	**.041**	**.021**	**-.015**
	Sig. (2-tailed)	**.134**	**.002**	**.000**	**.000**	**.227**	**.087**	**.323**	**.003**	**.483**	**.717**	**.796**
ICD	**Pearson Correlation**	**-.046**	**-.052**	**.439****	**.192****	**-.160****	**-.077**	**-.197****	**.034**	**.000**	**.035**	**-.063**
	Sig. (2-tailed)	**.424**	**.369**	**.000**	**.001**	**.005**	**.181**	**.001**	**.555**	**.997**	**.552**	**.276**
Depth of stalk	**Pearson Correlation**	**.120***	**-.049**	**-.069**	**.005**	**.145***	**.197****	**.289****	**-.159****	**-.091**	**-.094**	**.004**
	Sig. (2-tailed)	**.038**	**.398**	**.236**	**.924**	**.012**	**.001**	**.000**	**.006**	**.114**	**.103**	**.942**
length of stalk	**Pearson Correlation**	**.120***	**-.404****	**-.062**	**-.280****	**-.070**	**.318****	**.371****	**-.460****	**-.173****	**-.157****	**-.138***
	Sig. (2-tailed)	**.038**	**.000**	**.283**	**.000**	**.224**	**.000**	**.000**	**.000**	**.003**	**.006**	**.017**
angle	**Pearson Correlation**	**-.020**	**.197****	**.043**	**.172****	**.045**	**-.320****	**-.258****	**.332****	**-.005**	**-.024**	**-.041**
	Sig. (2-tailed)	**.731**	**.001**	**.454**	**.003**	**.441**	**.000**	**.000**	**.000**	**.937**	**.680**	**.480**
sinuses width	**Pearson Correlation**	**.042**	**.033**	**.171****	**.152****	**-.022**	**-.177****	**-.134***	**.132***	**.087**	**.102**	**.073**
	Sig. (2-tailed)	**.472**	**.565**	**.003**	**.009**	**.698**	**.002**	**.020**	**.022**	**.132**	**.078**	**.208**
columella implant	**Pearson Correlation**	**.124***	**-.031**	**-.055**	**.012**	**.102**	**-.073**	**.057**	**.038**	**.066**	**.091**	**.053**
	Sig. (2-tailed)	**.031**	**.587**	**.345**	**.830**	**.077**	**.209**	**.325**	**.508**	**.256**	**.117**	**.362**
SP	**Pearson Correlation**	**.209****	**-.140***	**-.162****	**-.094**	**.188****	**.175****	**.365****	**-.201****	**-.025**	**-.017**	**.016**
	Sig. (2-tailed)	**.000**	**.016**	**.005**	**.106**	**.001**	**.002**	**.000**	**.000**	**.661**	**.766**	**.788**
stalk L+ D	**Pearson Correlation**	**.139***	**-.328****	**-.075**	**-.212****	**.004**	**.321****	**.398****	**-.415****	**-.168****	**-.157****	**-.104**
	Sig. (2-tailed)	**.016**	**.000**	**.196**	**.000**	**.944**	**.000**	**.000**	**.000**	**.003**	**.006**	**.073**
columella Sphenoid	**Pearson Correlation**	**.193****	**-.051**	**-.013**	**.072**	**.123***	**.308****	**.290****	**-.264****	**.214****	**.243****	**.170****
	Sig. (2-tailed)	**.002**	**.407**	**.832**	**.244**	**.046**	**.000**	**.000**	**.000**	**.000**	**.000**	**.006**

Continue table (4-17)

		OCW	ICD	Depth of stalk	length of stalk	angle	sinuses width	columella implant	SP	stalk L+ D	columella Sphenoid
sagittal length/mm	Pearson Correlation	-.087	-.046	.120*	.120*	-.020	.042	.124*	.209**	.139*	.193**
	Sig. (2-tailed)	.134	.424	.038	.038	.731	.472	.031	.000	.016	.002
sagittal height/mm	Pearson Correlation	.178**	-.052	-.049	-.404**	.197**	.033	-.031	-.140*	-.328**	-.051
	Sig. (2-tailed)	.002	.369	.398	.000	.001	.565	.587	.016	.000	.407
axial width/mm	Pearson Correlation	.313**	.439**	-.069	-.062	.043	.171**	-.055	-.162**	-.075	-.013
	Sig. (2-tailed)	.000	.000	.236	.283	.454	.003	.345	.005	.196	.832
volume	Pearson Correlation	.245**	.192**	.005	-.280**	.172**	.152**	.012	-.094	-.212**	.072
	Sig. (2-tailed)	.000	.001	.924	.000	.003	.009	.830	.106	.000	.244
pituitary area cm2	Pearson Correlation	.070	-.160**	.145*	-.070	.045	-.022	.102	.188**	.004	.123*
	Sig. (2-tailed)	.227	.005	.012	.224	.441	.698	.077	.001	.944	.046
opening of sella mm	Pearson Correlation	-.099	-.077	.197**	.318**	-.320**	-.177**	-.073	.175**	.321**	.308**
	Sig. (2-tailed)	.087	.181	.001	.000	.000	.002	.209	.002	.000	.000
sellar area	Pearson Correlation	-.057	-.197**	.289**	.371**	-.258**	-.134*	.057	.365**	.398**	.290**
	Sig. (2-tailed)	.323	.001	.000	.000	.000	.020	.325	.000	.000	.000
sellar pituitary percentage %	Pearson Correlation	.172**	.034	-.159**	-.460**	.332**	.132*	.038	-.201**	-.415**	-.264**
	Sig. (2-tailed)	.003	.555	.006	.000	.000	.022	.508	.000	.000	.000
long axis of PBS	Pearson Correlation	.041	.000	-.091	-.173**	-.005	.087	.066	-.025	-.168**	.214**
	Sig. (2-tailed)	.483	.997	.114	.003	.937	.132	.256	.661	.003	.000
short axis of PBS	Pearson Correlation	.021	.035	-.094	-.157**	-.024	.102	.091	-.017	-.157**	.243**
	Sig. (2-tailed)	.717	.552	.103	.006	.680	.078	.117	.766	.006	.000
area of PBS	Pearson Correlation	-.015	-.063	.004	-.138*	-.041	.073	.053	.016	-.104	.170**
	Sig. (2-tailed)	.796	.276	.942	.017	.480	.208	.362	.788	.073	.006

Continue table (4-17)

		OCW	ICD	Depth of stalk	length of stalk	angle	sinuses width	columella implant	SP	stalk L+ D	columella Sphenoid
	Sig. (2-tailed)	.796	.276	.942	.017	.480	.208	.362	.788	.073	.006
OCW	Pearson Correlation	1	.287**	.069	.015	-.053	.129*	.077	-.008	.039	-.030
	Sig. (2-tailed)		.000	.235	.792	.362	.026	.183	.891	.500	.629
ICD	Pearson Correlation	.287**	1	-.131*	-.086	.193**	.282**	.032	-.144*	-.118*	-.038
	Sig. (2-tailed)	.000		.023	.138	.001	.000	.581	.012	.041	.538
Depth of stalk	Pearson Correlation	.069	-.131*	1	.424**	-.231**	-.020	-.090	.111	.722**	.009
	Sig. (2-tailed)	.235	.023		.000	.000	.729	.119	.054	.000	.882
length of stalk	Pearson Correlation	.015	-.086	.424**	1	-.181**	-.117*	-.014	.315**	.933**	.114
	Sig. (2-tailed)	.792	.138	.000		.002	.042	.806	.000	.000	.064
angle	Pearson Correlation	-.053	.193**	-.231**	-.181**	1	.197**	.158**	-.207**	-.230**	-.293**
	Sig. (2-tailed)	.362	.001	.000	.002		.001	.006	.000	.000	.000
sinuses width	Pearson Correlation	.129*	.282**	-.020	-.117*	.197**	1	.066	-.202**	-.098	-.124*
	Sig. (2-tailed)	.026	.000	.729	.042	.001		.255	.000	.091	.043
columella implant	Pearson Correlation	.077	.032	-.090	-.014	.158**	.066	1	.050	-.047	.445**
	Sig. (2-tailed)	.183	.581	.119	.806	.006	.255		.391	.419	.000
SP	Pearson Correlation	-.008	-.144*	.111	.315**	-.207**	-.202**	.050	1	.285**	.187**
	Sig. (2-tailed)	.891	.012	.054	.000	.000	.000	.391		.000	.002
stalk L+ D	Pearson Correlation	.039	-.118*	.722**	.933**	-.230**	-.098	-.047	.285**	1	.089
	Sig. (2-tailed)	.500	.041	.000	.000	.000	.091	.419	.000		.151
columella Sphenoid	Pearson Correlation	-.030	-.038	.009	.114	-.293**	-.124*	.445**	.187**	.089	1
	Sig. (2-tailed)	.629	.538	.882	.064	.000	.043	.000	.002	.151	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table (4-18) Correlations between shapes (sinuses, pituitary and shape of PG in sella)

		Shape of pituitary	shape of sinus	shape of pituitary in sella
Shape of pituitary	Pearson Correlation	1	-.108	.691**
	Sig. (2-tailed)		.061	.000
	N	300	300	300
shape of pituitary in sella	Pearson Correlation	.691**	-.113*	1
	Sig. (2-tailed)	.000	.050	
	N	300	300	300

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Chapter Five

Discussion, Conclusions, and Recommendations

5.1 Discussion

MRI is accurate diagnostic imaging for the assessment of pituitary gland size and shape. Changes were seen in size, shape, and signal intensity of the pituitary gland which reflects the changes in complex hormonal physiology of the gland, and there were pituitary abnormalities that can be encountered such as physiological hypertrophy of the gland, subtle microadenoma increased lobulated margins, inflammatory diseases…etc. [Amar, A.P. et al 2003].

The current study data were collected from the normal MRI brain, the male form (40.9%) of the study sample and the female form the rest (59.1%) the total sum of the study sample was 301cases included one empty sella case. these results explanted in table and figure (4-1).

The frequency distribution of age in current study was determined in ranged from 20 to 60 years with age 35.96 as the mean age of distribution, table (4-2). The considerations for choosing this range of age are a period of relative stability in growth hormone and these are prior to the age of full Maturing. The sample was divided into four age groups to facilitate the study of changes.

Table (4-1) and figure (4-1) (4-2) give the summary of the frequency distribution of gender and age groups also, where the high-frequency count appears in the age group 20-29 and females had a large frequency than males, the lower frequency count was in the age group 40-49.

There were some variables affect by the gland shape, for that reason the current study divided the sample into groups according to shapes. There were five pituitary gland shapes depending on the sagittal or coronal view, current study depends on the sagittal view so, the mid-sagittal section of the pituitary gland reflects the variations in the pituitary morphology more accurately.

The current study result was that, the convex shape was the high-frequency percentage 41.9% then concave in 26.4%, flat 18.8, partial empty 11.9% and empty sella by 0.3% respectively, the empty sella was seen in one patient (not associated with pathology, it caused by diaphragmatic herniation, primary type) in the age above 40 years it detected in one female 43years old- the obese female after 40 years old multiparous women and benign intracranial hypertension, were more exposed to (PE) and empty sella. In some other studies, the empty sella cases were excluded because it classified as a rare pituitary shape or because it may be associated with pathological conditions (secondary type) e.g. Acute Increased Intracranial Pressure (AICP), rathic cysts. And also some study were excluded the partial empty shape and others included it.

And the worth noting were these frequencies of shapes in current study the same frequency distribution in the gender variable females and males. The convex shape appears higher frequently in the younger age group 20-29(age of hormonally active) then in the age group 50-60, 30-39 lastly in the age group 40-49. The concave shape appears more frequently in the age group 30-39, its frequency ware convergent in all age groups. the flat shape appears more frequently in the age group 20-29, partial empty was appear in the middle age group 30-39 by a percentage of 5%from total percentage of partial empty shape 11.9% and it appears in females more than males, The decline in the pituitary upper surface due to age may explain the process of aging and a physiological pituitary change [Sharafuddin MJ, et al 1994] result showing the tables (4-3) (4-4). Previous studies had highlighted different changes in the shape of the upper surface of the pituitary at various stages of life, which also indicate the consequent change in hormonal levels [Ganapathy, M.K et al 2019].

Results of the present study in agreement with previous studies, these results were consistent with Samuel M. et al 1984, who detect that the larger gland was seen in the younger women and convex shape were the highest shape count in younger women, and a similar finding was achieved by Tika R Lamichhane et al 2015, who reported that a higher frequency of convex upper border was in females more than males in Nepalese population so that the flat shape was more common and higher in males. Also, S. C. Sanjay et al 2014 noted that the gland was more convex globular in the younger age group in females 58.30%, flat 3.1% then concave 11.10% and it was in the same order with age increase. This is, contrary to the finding by Yadav,P. et al 2017 who founded that in all age groups and both gender, the most common shape was flat, which was seen in 46%of people followed by convex in 31.2% and concave shape in 22.8%. Also, Keanninsiri, C. et al 2012, reported that the most frequent grade shape of the upper surface of the pituitary gland was the type of "flat" in males in all age groups, in females groups except age group (11-20 years), which higher frequency type of "convex". The variances in results in these studies may be attributed to racial differences.

The pituitary shape depended on the upper surface for that it had a correlation between it and height. so there was a significant statistically correlation between pituitary shape and pituitary height, pituitary width, volume, pituitary area, the opening of sella, sellar area, sellar pituitary percentage, (OCW), length of the stalk, sinuses width, (SDP), and the stalk sum $P<0.05$, table (4-15).

After clarifying the shape of the gland according to the upper surface the current study classifies the gland according to the shape inside the sella or mechanism of compressive changes of the (P.G) in sella, this was similar to William T.C et al 2000 classification and in same results of the study. In table (4-5) and fig (4-3), the current study founded that result "A" shape was a high frequency described by 50.2% generally and in all age groups, it had a relation with the convex shape of the upper pituitary surface, then the "B" shape 20.3%respectively, where the shape "C" appears in percentage after "B" shape and appears more in older age, shape "D" appear in the age group 30-39, Note here that it was a link with the partial empty appearance in the same age group. “C” and “D” come less frequently 18.3%, 11.2% respectively. These shapes had a significant statistically correlation with other shapes with $P<0.05$, table (4-18).

The other shape that studied were the shape of sphenoid sinuses, it lying under the sella and connected directly with it, these shapes had pituitary surgical importance, the sphenoid sinus varies in size, shape, and degree of pneumatization. Hamberger and Col 1961 classified into three types, conchal, presellar, and sellar depending on the pneumatic extent. Other authors using the same criteria of classification as the same as the current study, in a study of cadavers, found the presellar type in 24% and sellar in76%. The conchal shape was neglected because it did not have a relation to (P.G) [Seizo Yamashita et al 2014], the current study descript these frequencies in table (4-6) and fig (4-4), the sellar shape was the most shape appear in all gender and age group 50.5%, the post sellar 38.5% (sellar and post sellar classified in the same group 89%), presellar 7%and the last frequency was the conchal 4%which did not have a relation to the sella turcica. Seizo Yamashita et al 2014 were consistent with the current study and found that type sellar while (78.9%) type presellar (5.8%) and post-sellar represented (15.3%). These shapes had a correlation significantly with shapes of (P.G) in sella with $P<0.05$, table (4-18).

The main aim of the current study was to determine the (P.G) dimensions to achieve this aim the study measured the length, height, width and calculate the volume for the gland, the current study was found that the mean and standard deviation (mean± SD) of sagittal length was 11.12mm ±1.62, sagittal height was 5.76mm ±1.28, axial width 12.00mm± 1.87 and the volume 383.39mm^3 ±109.20 table (4-7). About the pituitary dimension, the shape must be taken into consideration, in some of the previous studies they excluded the partial empty, empty sella, or both these shapes from the measurements, any pituitary gland having a height less than 2mm [Pratiksha Yadav et al 2017] will be excluded (empty sella), Seizo Yamashita et al

2014 excluded partial empty sella, the minimum height of the gland was 3mm. the current study had done the measurements for these two groups, the results didn't find a big difference between each group, except in height and volume the mean value will increase(height 6.09mm±0.95, volume 408mm^3 ±87.8. Table (4-7) and (4-8).

The height of the pituitary gland is the most important measurement in the detection of an intra sellar mass. Lower height has been reported by Tsunoda et al 1997 (5.35mm ± 1.2 and 4.93mm ± 1.0 in males and females, respectively), Pratiksha Yadav et al 2017 detect the height and measure about 6.4mm. These variations can be explained due to the differences in the populations studied and hormones impact. In the current study, the mean of pituitary height accord to gender was (5.73mm ± 1.24 and 5.78mm ± 1.31 in males and females, respectively) table (4-9) females were found to have a little higher pituitary heights compared to males, the higher mean appears in the age group 20-29 for both gender 6.47mm. the current result was consistent with most of the previous study e.g. S. C. Sanjay et al 2014, Denk CC et al 1999, Pratiksha Yadav et al 2017 (6.6mm±1.5, 7.0mm± 1.9 in males and females, respectively), Tika Ram et al 2015 (6.0mm ± 1.0 and 6.6mm± 0.8 in males and females, respectively). Philip Oluleke Ibinaiye et al 2015, found a reverse result in the age group 21-30 (7.0mm± 1.5, 6.9mm±1.3 in males and females, respectively) the males were higher than females in these age group.

The current study found that the pituitary gland gradually increases to its maximum height at adolescence (the maximum high was 8.79mm as a normal gland high these results were lower than that Samuel M. et al 1984 and lower than Tika Ram et al 2015 that found height measure in young adult males 8mm, 9mm in females and 12mm in pregnancy women) The lowest values were recorded in the advanced age group in both gender, were declined in 30-49 years, and in above age groups value return to increase (after 50 years old) for both gender, especially in female

(Perimenopausal women) the increase in pituitary height again (second peak) was thought to reflect the increased activity triggered as a negative feedback mechanism by the waning hormonal levels in the target organs. The second peak in pituitary height in individuals in the sixth decade 50-60 years old, table (4-10) the values of the pituitary height related to age showed a U-shaped pattern as result same as Seizo Yamashita et al 2014, figures (4-7) (4-8). And consistent with Pratiksha Yadav et al 2017, Tsunoda A, et al 1997 and Kato K et al 2002. This can be clarified by fast hormonal changes in adolescence, particularly in gonadotropin levels (LH and FSH). Also, a comparatively higher pituitary height in young patients, both males and females, maybe due to physiological variations in Neuro-endocrine hormones among younger and older individuals.

In the current study, females had a high pituitary height or in near value compare with males and in the most age groups although there was a non-significant statistically correlation with gender P=0.453, and it had a significant statistically correlation with age group P<0.05, tables (4-9) (4-10). Fig (4 -11) linear regressions for height of the pituitary gland with age.

While the height of the gland is the main key figures cited when addressing pituitary gland dimensions, the current study has aimed to obtain more information about the width and length of the gland.

The mean of Axial width in the current study was 12.00mm± 1.8 (12.04mm± 1.96 mm and 11.97mm± 1.81 in males and females, respectively) tables (4-7) and (4-9). Males had the upper measure than females in young age until the age of 40 years old the females become upper measure, table (4-11). Compare with Tika Ram et al 2015 study, who say there was a contrast in measurements between age and gender, his measure comes in higher than the current study measure the width range about 13.1 to 14.5mm, current study higher value measure than Philip Oluleke et al 2015 his results for the mean axial width were 9.08mm-9.21mm for males and females respectively.

current results inconstant with S. C. Sanjay et al 2014 that say the Maximum width was noted in the third decade(in females) showed a mild decrease and there after increased in the older age group (50-60) 11.67mm± 0.5, Opine that there were no age-related effects on gland width or length. The maximum (P.G) width detected in the age groups 40-49, 20-29 and the lower measure detect in old age group 50-60 table (4-10).

There was a non-significant statistically difference between the average width of the pituitary in males and females P=0.675 but it had a significant statistically correlation with age groups P<0.05, tables (4-9) (4-10). Fig (4 -11) linear regressions for width of the pituitary gland with age.

The mean length of the pituitary gland in the current study was 11.12mm± 1.62(11.25mm ± 1.61 and 11.03mm ± 1.63 in males and females, respectively) tables (4-7) and (4-9) and the maximum length was noted in the older age groups (11.67mm ± 1.61, 50-60 years).

This result means, the changes in pituitary size in the current study due to changes in gland height and length, when the age increased the height of the pituitary gland decreases and the length of the pituitary gland increases. these results consistent with Tika Ram et al 2015 the high length measurement 11.2mm found in old age and inconstant with S. C. Sanjay et al 2014 (9.20mm±78.Maximum length was seen in the third decade 30-39 years old) and detect lower findings than current study on pituitary length, however, differed from some authors like Lurie SN et al 1990 reported there were no age-related effects on gland length.

These differences in results can be explained as due to the variances in the populations studied.

There was non-significant statistically difference between the average length of the pituitary in males and females P=0.656 but it had a significant statistically correlation in age group $P<0.05$, tables (4-9) (4-10). Fig (4 -11) linear regressions for length of the pituitary gland with age.

The volume of the pituitary gland varies depending on the hormonal condition. Commonly, adult younger individuals had a large gland. In the current study, the mean value for pituitary volume was (388.47mm^3± 111.79 and 379.85mm^3± 107.55 in males and females, respectively) it was larger in males than females consistent result with Philip Oluleke et al 2015(334.1 mm^3 ± 145.8, 328.1 mm^3 ± 129.2 in males and females, respectively) there was a non-significant statistically relation between gender and volume, as seen in the table (4-9).

The maximum mean value of pituitary volume was obtained for the age group (20–29) years (426.79mm^3± 87.57). The results obtained in the current study demonstrated a gradual increase in pituitary gland volume in the younger age 20-29 years old, which was consistent with the study by M. Suzuki et al 1990. After that, there was a decrease in volume until the age of 49 years old and then gradually increased the value up to 60 years old, these result constant with Tika Ram et al 2015. If there was any difference, that may be due to physiological variations in Neuro-endocrine hormones among younger and older individuals. Figures (4-8) (4-9) and (4-10).

In the current study, there were insignificant statistically differences between the average volume of the pituitary in males and females P=0.638 but it had a significant statistically correlation in age group $P<0.05$, table (4-9) (4-10). Fig (4 -11) linear regressions for volume of the pituitary gland with age.

About the measurement of the pituitary area and -the container that carries it- sellar area and the percentage between them, also the distance of the opening of the sella.

The pituitary area in the current study was mean 0.5632cm^2±0.12 (0.5656 cm^2±0.11, 0.5615cm^2±0.12 in males and females, respectively).

The pituitary fossa is one of the simple ways to calculate the volume by multiplied the lateral area of the pituitary fossa by the width of its floor and after correction for magnification, M.S.F. Mclahlan et al 1968.

In the current study, the mean of the sellar area was 0.7533cm^2±0.16 (0.7489cm^2±0.14, 0.7563cm^2±0.17 in males and females, respectively) the size of the bony sella is not a sensitive indicator of pituitary gland abnormality (except in tumor that extends transversally) since an empty sella can lead to an enlarged fossa, Philip Oluleke Ibinaiye et al 2015.

The knowing of the pituitary sellar percentage or ratio, can detect if there was any defect in the gland or sella e.g. shrink of the gland, atrophy, enlargement of sella, inter-cranial hypertension…etc. in current study the ratio mean was 75.88% (76.23% ±12.23, 75.64%±13.95 in males and females, respectively).

There was insignificant relation between pituitary area and gender but there was a significant statistically relation between sellar area and the pituitary sellar percentage with gender $P<0.05$. Also, there was a significant statistically correlation between pituitary area and pituitary sellar percentage with age group $P<0.05$, with no correlation of age group with sellar area table (4-9) (4-10) fig (4-5) and (4-6).

In the opening of sella the mean was 9.87mm± 1.64 (9.71mm±1.41, 9.98mm ±1.77 in males and females, respectively).

Sung-Eun E et al 2014 found that the mean gland area was 42mm^2 ± 13 the mean sellar area was 65mm^2 ± 16 and the opening 9.3mm ± 1.7, there was no big difference between male and female measurement of pituitary area, sellar area, and opening, also there was no big difference between ages.

In some pathology e.g. (IIH), A decrease in the pituitary sellar ratio was predominantly due to a decrease in pituitary gland values in the mild and moderate cases, whereas both a decrease in the pituitary gland and an increase in sella turcica occurred in severe (late) cases. The criterion of pituitary morphology proposed should be used with caution. In the elderly, the cumulative “normal” (CSF) pressure over a lifetime in normal elderly patients may be sufficient to cause diaphragm herniation and the morphologic changes in the pituitary gland. In addition, age-related atrophic change of the pituitary gland in the elderly can make the interpretation difficult, although (IIH) occurs more frequently in the younger age population, William T.C. et al 2000. Sung-Eun E et al 2014 results indicate that chronic elevation of intracranial pressure causes expansion of the pituitary fossa. Little or no reduction occurs in the size of the actual gland. Because the pituitary tissue becomes molded to the walls of a larger container, the sella turcica appears partially empty.

The pituitary bright spot (PBS) appears on T1-weighted MRI as an area of hyperintensity and its dimensions have to be in the identified normal range in the majority of subjects. Most of them appear at the midline sagittal sections. MRI-T1 sagittal and coronal sections were used carefully to identify the posterior pituitary spot with two common locations along the pituitary stalk and in Sella.

Brooks BS et al 1989, Colombo. N et al 1987 and Fujisawa. I et al 1987 and found that the (PBS) occurs in 52%, 90%, and 100 % in the normal pituitary gland. A current study founded that the (PBS) was noticed in 46% of cases, this studies the (PBS) just in the pituitary gland and ignore that one in stalk and sella.

Also, the direction of the frequency encoding gradient (FEG) was found to have an impact on the rate of detection. When the (FEG) direction was anteroposterior, the (PBS) was detected in 100% of cases in one study, whereas it was detected in only 54% of cases when it was directed caudocephalad. At least 1.2 mm in the long axis and 0.4 mm in the short axis, suggests that the true absence of a (PBS) on a good quality pituitary MRI should prompt the investigation for a pathological cause.

A current study found that the strong magnetic field affects the appearance of normal (PBS) in 0.2 T magnet the (PBS) was difficult to detect (low signal intensity) that must change the window width (WW) and window level (WL) to measure it clear.

This study was found that, the dimensions of the (PBS) in the long axis was 4.36mm±1.10 (ranged 1.80-9.59mm), the short axis was 2.66mm±.70 (ranged 1.32-4.59 mm) and the area was 0.1085cm^2 (ranged 0.02-0.95cm^2). In agreement with these findings, Martin Côté et al 2014 found that the dimensions of the (PBS) were 4.8mm± 1.2 (range 1.7–7.8 mm) in the long axis and 2.4 mm±0.7 (range 0.9–3.9 mm) in the short axis. Tables (4-7) (4-9).

The present study found that the dimensions of the (PBS) were higher in males than females. This result was consistent with Fujisawa .I et al 1987, and inconsistent result with Martin Côté et al 2014. Klyn V et al 2018 also found (PBS) was more commonly occurs in the female.

The study found a significant statistically difference between the short axis of (PBS) with the gender P<0.0.5 males longer measure than females. Found a non-significant relationship between the long-axis dimension and gender differences (p = 0.088). It was observed that the dimensions of the long axis of the (PBS) increased in 50-60 years Table (4-10).

Martin et al 2014 reported that the measurement decreased with age, a significant inverse linear correlation existed between the long-axis dimension and the subjects (p = 0.042). However, there was insignificant relationship existed between the long-axis dimension, short-axis dimensions, and age of the subject, Yamamoto A, et al 2013 reported that the signal intensity in posterior pituitary lobe reversely related with age in both gender.

There are many causes of the (PBS) in normal subjects reported in the literature. A study conducted by Martin Côté et al 2014 reported that the (PBS) rate decreased with advanced patient age and related to the higher plasma osmolality in older people. The change in plasma osmolality leads to increased secretion of vasopressin resulting in the disappearance of the (PBS). It may become smaller when less vasopressin is stored in the posterior lobe of the pituitary gland, which leads to the reduction of the (PBS) size with patient age.

The current study evaluates the stalk depth and length, so the depth mean was 2.98mm±0.75with rang (1.28- 8mm). The length measure 3.61mm ±1.45 with rang (1.44 -12.00mm). The sum of the stalk (depth+ length) the mean was 6.59mm±1.90 with rang (3.03 -20mm), current study lower in measure than N. Satogami et al 2010 their result was (Depth of the infundibular recess 4.69mm ± 0.87 with rang 3.28–6.52 Length of the stalk 5.91mm± 1.24 rang 3.26–8.66, (length +depth 10.6mm).

In the current study, there was a significant statistically correlation between gender and depth of the stalk $P<0.05$ longer in female more than male, and there were a significant statistically correlation between age group and length of the stalk shorter in young age 20-29 years, table (4-7) (4-9) (4-10).

The pituitary stalk angle was measured in current study in 73 cases the mean was be 47.80^{o}±5.30 in range about (40^{o} to 58^{o}). This angle also measured by Thinesh Kumran et al 2015 the mean was 50.4^{o} ± 8.80. Stalk angle hasn't significant relation with pituitary shape but in general it was height degree in flat shape table (4-16).

Females has a height measurement than males this relation was a non-significant also like relation with age groups. Due to the poverty in the studies on this topic, there were not able to compare current results with previous studies, but can say that current study results were within the normal range consistent with Thinesh Kumran et al 2015 Table (4-16).

the surrounding area must study to complete the assessment of (P.G), in coronal view studied the optic chiasm width (OCW) The position of the chiasm is important in the transsphenoidal and trans-frontal surgeries-in current study found that the mean was 11.61mm±1.86(11.98mm±2.06, 11.36mm±1.66 in males and females, respectively) it was wider in males more than females, tables (4-7) (4-9) (4-10) Seizo Yamashita et al 2014 who found the mean of the width of the optic chiasm (WCHI) was 12.0 mm in males and females, similar in the entire sample between the gender and age groups for two independent samples, only one difference was detected, the disparity among females of different ages, in current study (OCW) correlation was significant statistically with gender this significant depend on the physiological anatomical of gender brain. And there was a non-significant with age groups table (4-9) (4-10).

In The internal carotid distances (ICD) the mean was about 17.45mm±3.69 (18.36mm±3.92, 16.83mm±3.39 in males and females, respectively) males were long measurement than females but there was a non-significant relation between gender and in the deference age groups, results showed in the tables (4-8) (4-10) and (4-11).

Current results were exactly consistent with Seizo Yamashita et al 2014 say that the distance between the intra-cavernous segments of the internal carotid between males and females, regardless of age were similar, the men were (19.00mm for males, 17.5mm for females). Indications of differences between the age groups of the same gender can be observed only among males. In this gender group, the values of intercarotid distance increase likely the age, on values of “p”.

The measurement for 288 cases of sphenoid sinus width except for the conchal shape because there were no measurements detected (Conchal, small sinus with no relation to the sella) the shape conchal detect in 12 cases from the sum of all cases table (4-14) sellar and post sellar had a large sinus width measure, then the presellar one. In sinus width measurement the mean was about 24.04mm±8.80 (24.40mm ±9.27, 23.77mm±8.45 in males and females, respectively, the range between 5.49 to 49.70mm) males had a wider measure than females in all age groups in the current study found that the upper value in younger age 20-29.

The Current results were consistent with Yonetsu et al. 2000 the width of the sphenoid sinus decreased with increasing age. Seizo Yamashita et al 2014 (rang between 6 to 48) but he found height value in the group from 41 to 60 years of age, males had greater widths of the sphenoid sinus than females (28,22 mm for males, females respectively) The width of the sphenoid sinus increased with increasing age. These findings were not compatible with the current study table (4-13). As same as Seizo Yamashita et al 2014 say, when knowing the variations of the sphenoid sinus it was crucial when trying to reach the sellar region or surrounded structures through sphenoid bone [Rhoton et al 2002].

The variations depend on the physiological anatomical of gender brain. Although there is a difference in the measurements of the gender and ages, this difference was non-statistically significant $P>0.05$.

And as Seizo Yamashita study, due to the inability to locate the ostium of the sphenoid sinus on MRI, the distance measures of columella -sphenoid sinus and columella-pituitary were performed on an imaginary line that passes between the implantation point of the columella and the presellar point. In this way, was considered that this would be a standard of measurement.

About columella -sphenoid sinus and columella-pituitary these distances help to define the size of the specula and instruments to be used in the surgery of sellar region. The surgical approach to sellar region by Trans sphenoidal, was already an established procedure in Neurosurgery and its complications were well described by some authors. Anatomical variations of this region were the causes of complications in this procedure. The most vulnerable structures along the sinus were the internal carotid artery near the anterior wall of the sella, and optic nerves, located supero-laterally. Columella nasal implant-hypophysis the mean was 85.79mm±5.78 (89.09mm±6.21, 83.50mm±4.1545 in males and females, respectively) for males the mean of distances from the columella -pituitary (columella implant to hypophysis or distance from the pituitary gland to nasal columella) were higher, regardless of age, and the older groups did not differ either among males or females consistency with Seizo Yamashita et al 2014. Tables (4-7) (4-9) (4-10) (4-12). Although there were height measurements in males, there was a non-statically significant correlation between columella- hypophysis and age or gender it is physiological anatomy deference.

Sphenoid sinuses to the pituitary distance were measured also and the mean was be 75.89mm±9.45 (78.63mm±10.33, 73.43mm±8.28 in males and females, respectively). The sella sphenoid had a significant statistically correlation with gender and age groups $P<0.05$.

If cannot measure the columella to the sphenoid distance (sella to sphenoid)the surgeon can measure a small distance from the hypophysis and the two cross-vertical line touches the lower and anterior border of sella, pituitary sinuses, that can attend the surgeon they are very near to inter to the sella and pituitary gland it called (SDP) the mean for it was 2.75mm±0.78 (2.83mm±0.81, 2.70mm±0.76 in males and females, respectively) it ranges about (1.19 -6.50mm) these small distance had a highly significant correlation with age group it increase with age increase, $P=0.00$. And insignificant with gender tables (4-9) (4-10).

The tables (4-17) described the correlation between the variables and each other and give the significant and non-significant correlation, where the symbol ** Correlation was significant at the 0.01 level (2-tailed) and the symbol * Correlation was significant at the 0.05 level (2-tailed).

5.2 Conclusions

The current study proves background for the normal pituitary gland, sellar, and para sellar region by using MRI. and prove data for pituitary morphology and its classifications the pituitary shapes affect the dimensions of height, width, volume, pituitary area, the opening of sella, sellar area, pituitary sellar percentage, (OCW), (SDP), length of the stalk, and stalk(length+ depth).

There is a wide normal range of measurement for size and dimension of the pituitary gland that different according to gender, age, and hormones which change during age.

The anatomy of the Sellar and parasellar regions is complex and varies widely within the normal range, the current study results were close to the previous studies and in the normal range, as the results showed a linear match and statistically significant correlation in some variables with gender and age, and with each other and, these measurements have great importance in several medical fields ,good understanding for this area help the surgeon for choose the tools and detrains the risk factor, and to know the signs of healing after surgery.

The convex shape was the most common shape of pituitary gland appear in both gender and at a young age 20-29 years old, while the concave shape appears as a most common shape in old age), empty sella was less common and rear appear as primary type.

The Pituitary gland position in sella with no compressive changes was the more common positions detected and appear in all age groups.

In the sphenoid sinus shape the sellar and post sellar were the most common shapes that appear, presellar and conchal lastly, the width of the sphenoid sinus depends on the shape and did not impact by gender or age.

The pituitary gland gradually increases to its maximum height and volume in adolescence the second height peak was detected in old age after 50 years, as significantly statistical relation with age as a U-shape pattern in height. Females were higher in measurement than males but it was a non-significant statistical relation.

The relationship between axial width and age was inverse relation, and the length was in positive relation with age as a significant statistical correlation.

The pituitary area measurement was insignificant with gender, and in high significant statistical relation with age, the bigger area detects at a younger age.

Little or no reduction occurs in the volume of the actual gland, because the pituitary tissue becomes molded to the wall of its container (sella).

The sellar area was bigger in females than males with significant statistical relation with gender.

A highly significant statistical relation for pituitary sellar percentage with age and gender, males were high percentage and young were higher in percentage also.

The opening of the sella was increased with age the relationship was significant, but it was not affected by gender.

The short axis of posterior pituitary brightness (PBS) longer in males than females with significant relation.

Pituitary stalk length was a significant statistical correlation with age in positive relation.

Males Optic Chiasm Width (OCW) was wider than females the relation was significant, and the Inter Carotid Distance (ICD) was not impacted by gender or age.

There was a non-significant difference between gender and columella nasal implant to hypophysis, but the hypophysis to sphenoid distance was significant statistically related to age and gender, the small distance to pituitary (SDP) measure was highly significant statistically with age, it was increased with age.

There a significant statistical relation between some variables and each other.

5.3 Recommendations

Evaluation of the pituitary gland, sellar, and the para sellar region is recommended to be a routine in the brain exams especially for females, with considerations impact of age and gender, and also before and after any type of treatments for this region.

For further study recommend that, evaluate a wider age range than the age range used in the current study.

Evaluation between males and females as two groups, and between each group among themselves, taking account the situation with an attachment of a laboratory examination of hormones and condition clinical measurement of blood pressure and blood sugar level in the same age groups in the same circumstances and for females take terms of hormonal changes associated with pregnancy case and even the period of the monthly period in the same age groups in the same circumstances.

Use advanced MRI and high magnetic field strength one device for all samples.

Use advance 4D image programs for more accuracy.

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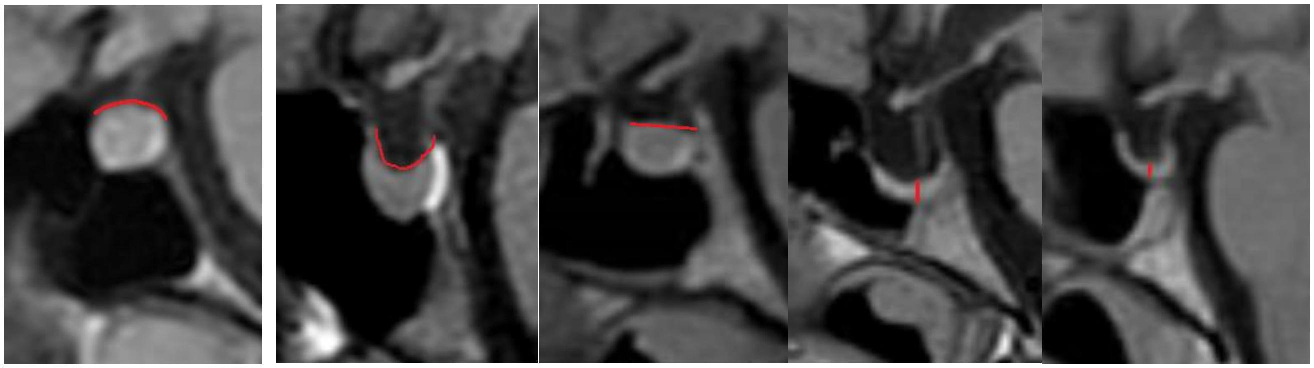
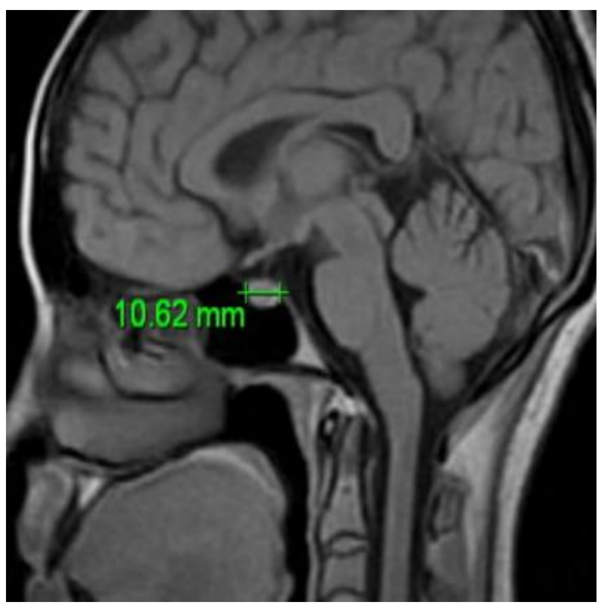
Appendixes 1

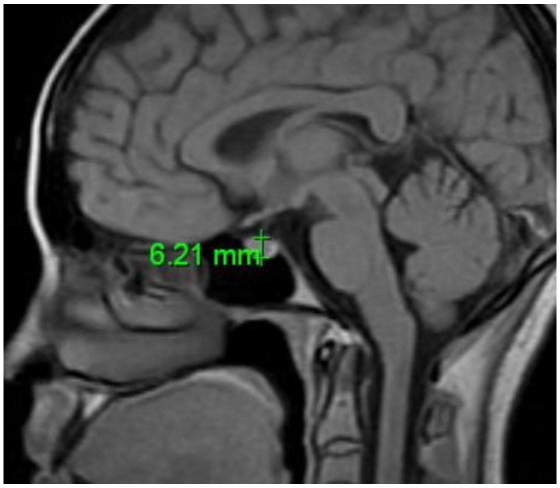


A B C D E

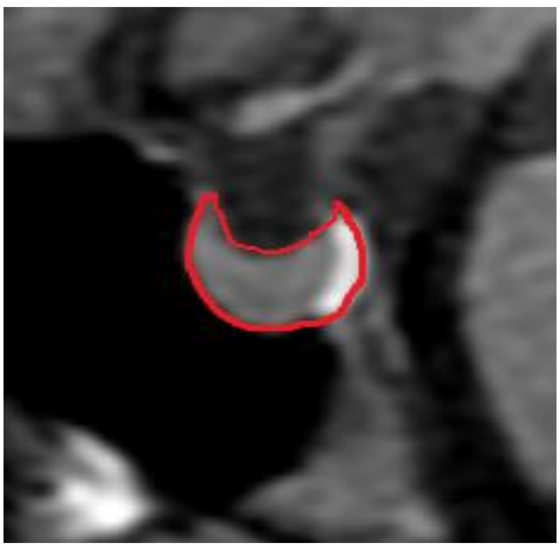
(Fig-1) MRI mid sagittal T1 section spin echo SE for pituitary gland, shapes of PG depend on the superior surface , (A)female 21 years old, , (B) female 29 years old, (C) female 24, (D) male 20 years old, (E) female 50 years old, all done in yastabshiroon medical center.



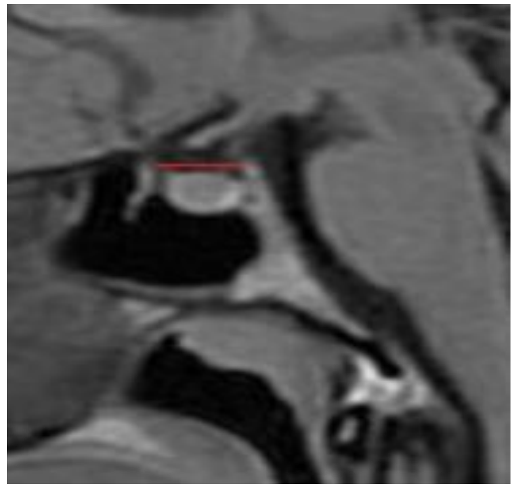
(Fig-2) The anteroposterior dimension "length" of pituitary sagittal T1 SE for female 24 years old, done in yastabshiroon medical center.



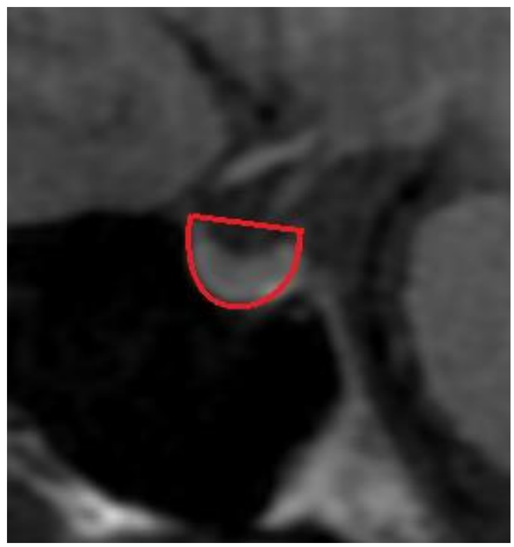
(Fig-3) TI sagittal section for pituitary height, female 24 years old, done in yastabshiroon medical center.



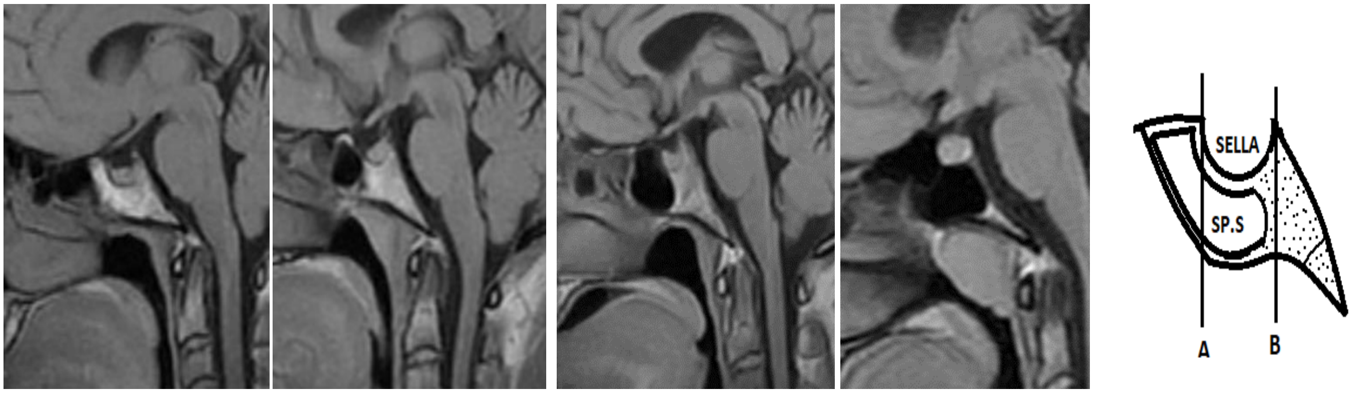
(Fig-4)T1 sagittal section for pituitary area, female 29 years old, done in yastabshiroon medical center.



(Fig-5) Distance of sellar opining, sagittal T1, female 24 years old, done in yastabshiroon medical center.

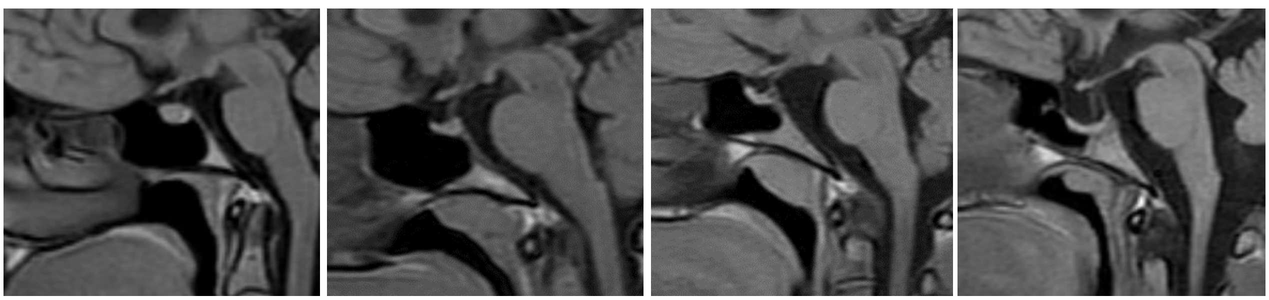


(Fig-6) T1 sagittal section for sellar area, female 25 years old, done in yastabshiroon medical center.



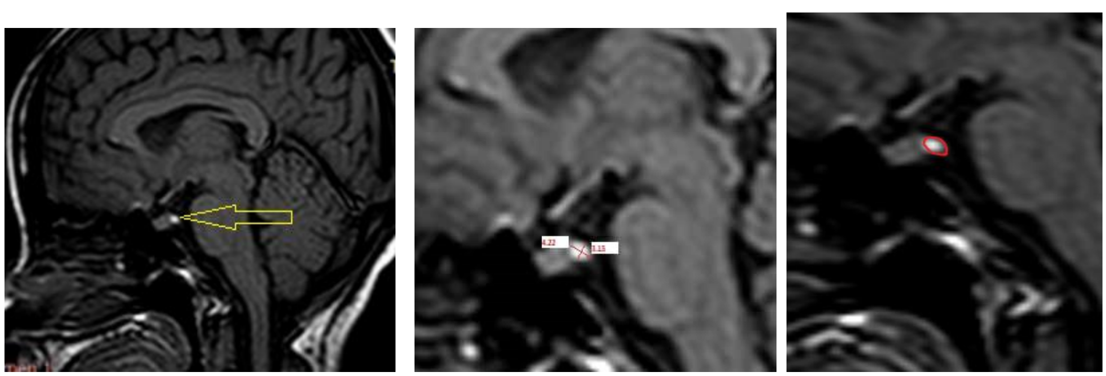
A B C D E

(Fig-7) Shapes of sphenoid sinuses pneumatization, sagittal T1, (A) female 47 years old, (B) female 26 years old, (C) female 43 years old, (D) female 21 years old, all done in yastabshiroon medical center. (E) Manual diagram.



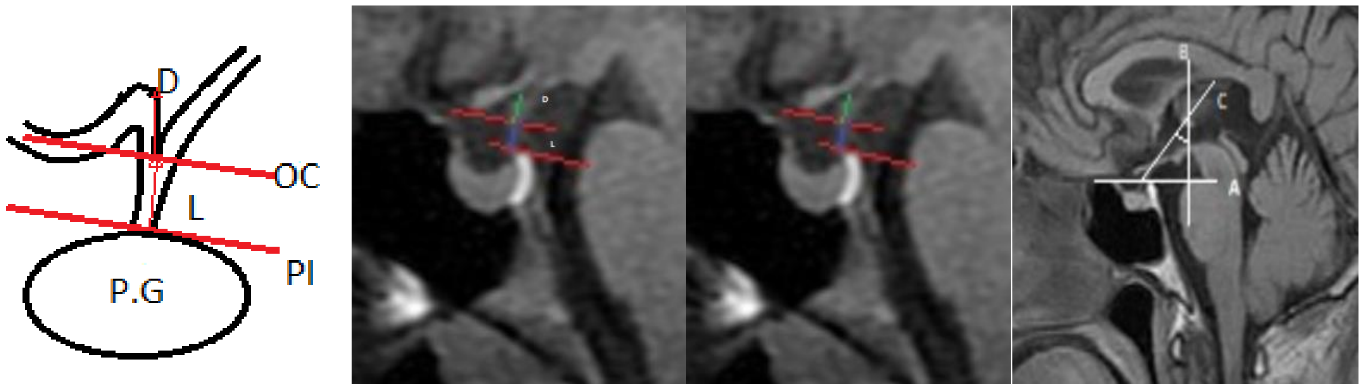
A B C D

(Fig-8) Mechanism of compressive changes of the pituitary gland, sagittal T1, A female 21 years old, B female 22 years old C female 31 years old, D male 20 years old, yastabshiroon medical center.



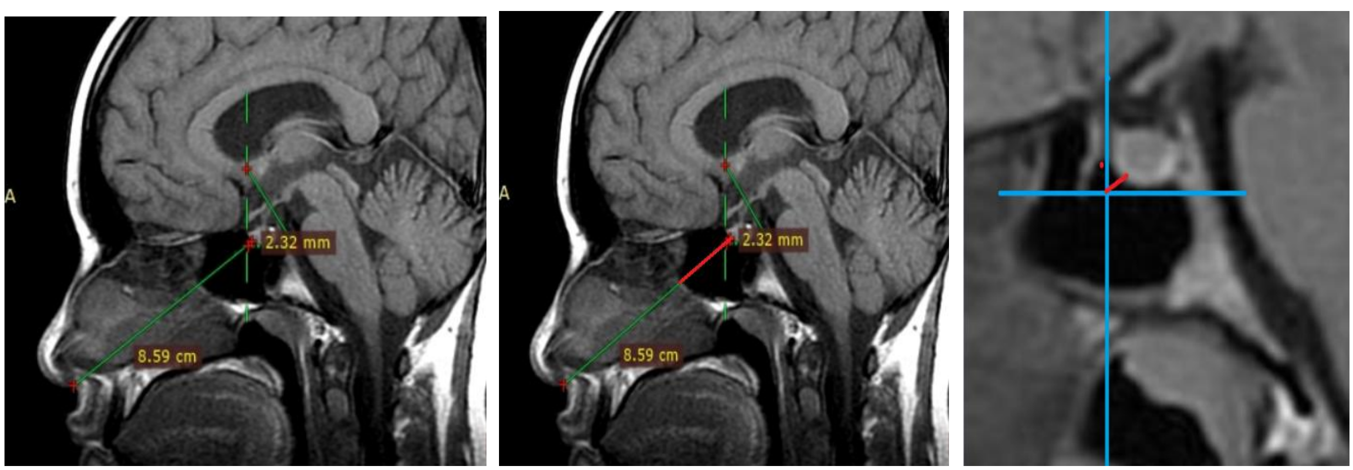
A B C

(Fig-9) T1 sagittal section showing the Posterior Pituitary Brightness (PBS), female 29 years old, Al Amal National Hospital.



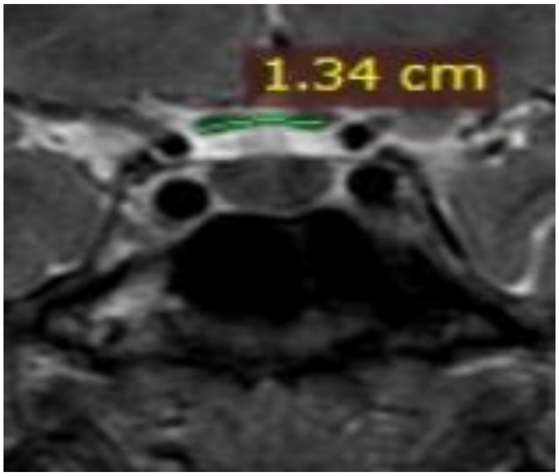
A B1 B2 C

(Fig-10) The pituitary Stalk dimensions, sagittal T1, (B) female 29 years old.

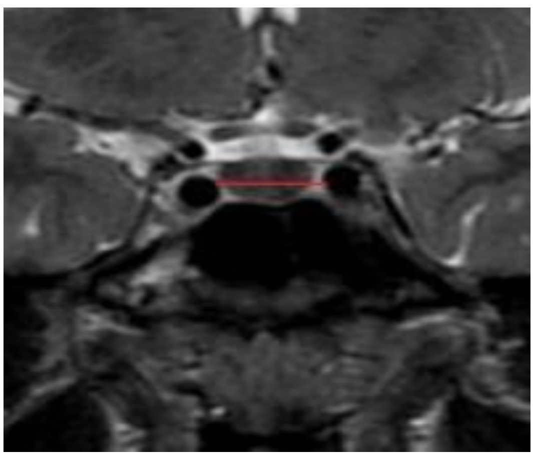


A B C

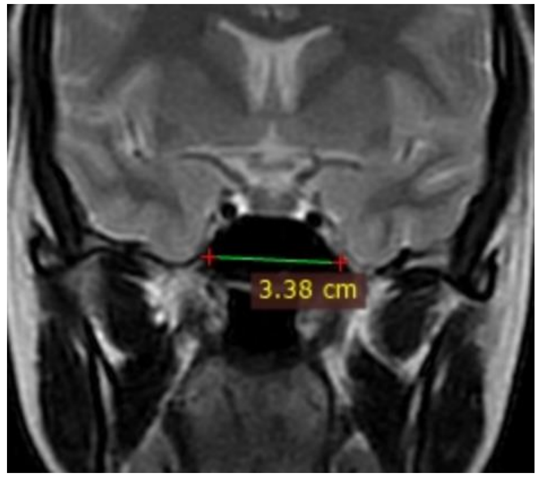
(Fig-11) the distances [A, columella nasal implant to hypophysis, green line]. [B, columella nasal to sphenoid sinuses green line, and sphenoid sinuses hypophysis red line]. [C, a small distance from pituitary to the point of intersection of the two imaginary lines (SDP)]. Sagittal T1, (A-B) female 20 years old, (C) female 24 years old, done in yastabshiroon medical center.



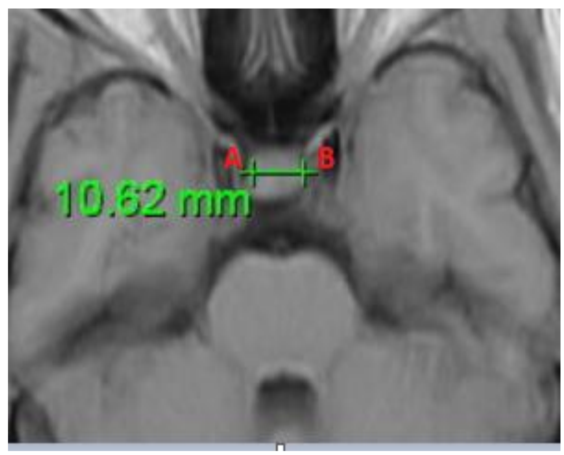
(Fig-12) Coronal T2 section showing the optic chiasm width, female 20 years old, done in yastabshiroon.



(Fig-13) Coronal T2 section showing inter carotid distance, female 20 years old, done in yastabshiroon.



(Fig-14) Coronal T2 section showing the sphenoid sinus width, male 33 years old, done in yastabshiroon.



(Fig-15) Axial T1 section showing the pituitary width, female 24 years old, done in yastabshiroon.

DATA SHEET

NO	age	gender	shape	sagittal length	sagittal dipth	axiall width	volum	pituitary aria	opining of sella	sellar aria	pituitary sellar percentage	shape of sinuses	shape of pituitary
121	33	M	P.E	10.4	2.73	10.2	144.7992	0.4169	10.9	1.209	34.48304	D	D
122	49	M	FLAT	9.65	5.84	15	422.67	0.3495	8.3	0.5079	68.81276	D	A
123	30	M	FLAT	12.4	5.65	12.5	437.875	0.5414	9.47	0.597	90.68677	C	A
124	33	F	FLAT	12.1	6.04	10.9	398.3078	0.6312	9.08	0.6779	93.11108	D	A
125	21	F	CONVEX	11.5	6.85	10.6	417.5075	0.757	8.93	0.793	95.46028	C	A
126	23	F	CONVEX	15.9	6.5	12.6	651.105	0.7367	8.62	0.86	85.66279	C	A
127	58	F	CONVEX	12.9	5.36	10.7	369.9204	0.6017	7.67	0.6723	89.49874	D	A
128	31	F	CONVEX	11.7	5.26	11.4	350.7894	0.4619	6.88	0.5139	89.8813	D	A
129	32	F	FLAT	14.2	5.24	15	558.06	0.4821	7.03	0.5304	90.89367	D	A
130	22	F	CONVEX	10.3	6.86	11.7	413.3493	0.609	7.91	0.6554	92.92035	D	A
131	58	F	CONVEX	12.1	5.63	10.9	371.2704	0.5611	9.03	0.6353	88.32048	D	A
132	21	M	CONVEX	10.2	7.38	11.8	444.1284	0.6892	8.79	0.7388	93.28641	D	A
133	28	M	P.E	7.68	3.28	13.4	168.7757	0.4292	8.53	0.6342	67.67581	D	D

long axis of PBS	short axis	aria	slice NO	OCW	ICD	depth of stalk	length of stalk	angel	sinuses width	colomela implant	sphynoid hypophisis dictanc	distance sp. to p.g	stalk	c s
0	0	0	0	11.2	15.6	3.13	3.02	17.2	28.9	98.3	2.35	9.92	6.15	88.38
3.86	2.81	0.09214	10	11.8	15.4	2.42	2.19	19.6	25.9	83.5	2.9	13.5	4.61	70
0	0	0	0	14.9	19.3	3.28	2.93	34.3	13.5	84	2.92	17.3	6.21	66.7
0	0	0	0	13.4	12.8	3.46	3.65	26.3	20.3	86.9	2.82	15.5	7.11	71.4
3.94	2.67	0.7944	10	10.4	11.5	2.97	2.75	28.2	13.6	88.1	3.84	12.6	5.72	75.5
0	0	0	0	12.3	21.4	3.73	4.86	34.9	27.6	83	2.68	15.5	8.59	67.5
3.87	3.49	0.1034	10	14.8	11	2.58	4.59	29.9	45.6	88.2	3.09	12.4	7.17	75.8
4.13	3.54	0.1268	10	9.86	16.9	2.05	2.29	23.8	35.3	87.9	2.17	18.8	4.34	69.1
4.68	4.59	0.01784	10	9.92	15.3	3.25	3.11	24.9	20.8	86.7	2.2	15.5	6.36	71.2
4.66	2.8	0.1041	10	8.4	13.4	3.08	2.37	16.9	23.5	82.6	2.79	14.9	5.45	67.7
3.99	3.69	0.117	10	12.1	19	2.94	4.33	26.7	45.8	89	2.64	11.8	7.27	77.2
4.25	2.88	0.08801	10	10.3	13.5	2.95	1.44	29.9	36.3	91.7	1.7	18	4.39	73.7

جامعه السودان للعلوم والتكنولوجيا كليه علوم الاشعه والتصوير الطبى

هل توافق على مشاركتنا فى هذا البحث العلمى : ☐ نعم بكل سرور ☐ لا

الاسم:..

العمر: .... الجنس ذكر ☐ انثى ☐ القبيله:.........................

الشكوى :

....

....

هل تعاني من احد الامراض التاليه: ضغط ☐ سكرى ☐ غده درقيه ☐

اخرى اذكرها:..

هل سبق ان اجريت عمليه جراحيه فى الراس: نعم ☐ لا ☐

اذكرها ان وجدت:

....

هل تستخدم اى علاج باستمرار: نعم ☐ لا ☐

اذكر العلاج ان وجد:

....

هل سبق ان استخدمت اى علاج للهرمونات: نعم ☐ لا ☐

اذكر المرض ونوع العلاج:

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هذا القسم خاص بالسيدات والانسات:

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هل الدوره الشهريه منتظمه :.................

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هل تعانى من اى امراض نسائيه :...

....

هل انت متزوجه,مع تحديد الفتره:...

هل لديك ابناء:...

عدد مرات الحمل والولاده والاجهاض :

....

....

هل كان الحمل طبيعا او مع المساعده واستخدام علاج او هرمونات ,مع تحديد نوع العلاج ان وجد :

....

....

شكرا على تعاونكم مع تمنياتنا لكم بالشفاء العاجل

Appendixes 2

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ORIGINAL ARTICLE

Radiology

INTERNATIONAL JOURNAL OF BIOMEDICINE

The Pituitary Gland Measurements in Sudanese Females using Magnetic Resonance Imaging

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Abstract

Background: Assessment of the pituitary gland (PG) measurements is essential for the diagnosis of many pathological conditions. For Sudanese adult females, however, there have been no studies and no reference values for PG measurements. Therefore, the aim of this study was to determine the regular dimensions of the PG, using MRI, and to correlate these measurements with age, the shape of sella turcica, puberty age, and parity in Sudanese females.

Methods and Results: This cross-sectional study was done to assess the PG measurement in Sudanese adult females (n=63) aged between 20 years and 60 years who underwent a brain MRI examination between 2015 and 2019. The study was conducted at Yastabshiroon Umodorman Medical Center (Khartoum, Sudan). The MRI brain examination found that the mean length, depth, width, and volume of the PG were 10.57±1.27 mm, 5.56±1.42 mm, 12.18±1.67 mm, and 356.38±100.22 mm³, respectively. Concerning the shape of the sella turcica, the study revealed that the convex and concave shape were more frequent than others (39.7% and 34.9%, respectively). The depth, width, length, and volume of the gland had changed significantly with pituitary shapes. The PG depth was significantly higher in nulliparous females than multiparous ones.

Conclusion: The PG measurement in adult Sudanese females decreased in the sagittal depth and volume gradually till the age of 50 years then returned to increasing after age 50. Younger females in the age group of 20-30 years had a larger depth and volume of the gland than other age groups. **(International Journal of Biomedicine. 2020;10(4):397-401.)**

Key Words: female • pituitary gland • magnetic resonance imaging • age • parity • puberty age

Introduction

The pituitary gland (PG) lies in the pituitary fossa beneath the body of the sphenoid bone. The size of the sphenoid sinus and sella turcica, including the depth and shape of the PG, usually have significant variations in different individuals.[1] MRI is an accurate diagnostic imaging method for assessing the PG size and shape. Changes are noted in the pituitary signal's size, shape, and intensity, reflecting changes in the gland's hormonal function. There are several pituitary disorders, such as physiological hypertrophy, inflammatory changes, and empty sella turcica. The shape and size of the normal PG often change during one's lifespan and are affected by age and gender.[2,3]

Previous studies have found that there is a wide variation of pituitary size associated with age and gender. The variation in PG volume depends on hormonal status. Thus, due to hormonal activity younger adults show a larger pituitary during puberty and, in females, during pregnancy.[4-8]

MRI of PG in females is essential to assess females' pituitary size and volume. It has been reported that PG is affected by age, parity, puberty age, and hormone-related factors.

Materials and Methods

This cross-sectional study was done to assess the PG measurement in Sudanese adult females (n=63) aged between 20 years and 60 years who underwent a brain MRI examination between 2015 and 2019. The study was conducted at Yastabshiroon Umodorman Medical Center (Khartoum, Sudan). Written informed consent was obtained from each patient.

The data were collected from 63 Sudanese adult females between 20 and 60 years of age, classified into 4 age groups (mean age of 35.52±11.11 years) in puberty and menopausal categories, and puberty age ranged between 10 years and 19 years. The sample was selected randomly. Inclusion criteria were Sudanese women of indicated age with no medical or pathological condition that may affect PG shape and measurement. The exclusion criteria were pituitary abnormalities or previous intracranial surgery. Any woman with a disturbance of pituitary hormones or schizophrenia was excluded from the study.

MRI technique

MRI of the brain was performed using a General Electric Healthcare (GE SIGNA EXCITE) machine with a 0.2T permanent magnet (open magnet). A standard head coil was used for acquiring the images. The sagittal and axial views were displayed using the midline plane of T1-weighted image spine-echo, matrix size was 512×512, FOV was 24×18 (repetition time/echo time of 450/10.5 ms, 378/8.6 ms), and slice thickness of 6.3 mm. Foam pads and straps were used for immobilization. The patient lay supine on the examination table with the head placed carefully in the head coil. The head was adjusted with the interpupillary line parallel to the table. The longitudinal alignment light lies were adjusted in the midline and horizontal alignment to pass through the nasion. Three axial sequences, T1-weighted image, T2-weighted image, and fluid-attenuated inversion recovery (FLAIR) were utilized. T1 sagittal image and T2 coronal image with additional sequences were used to assess the pituitary measurements. PG was measured in thin, sagittal, axial sections. The measurements were done in the Dicom imager program. The sagittal depth of PG was measured as the pituitary's vertical distance, defined by a line connecting two maximum top-bottom points in the T1-weighted sagittal section (Fig. 1A). The maximum anteroposterior diameter called (sagittal length) was measured as the longitudinal distance, defined by the line connecting two corners of the PG longitudinally (Fig. 1B) T1-weighted sagittal section. The axial width was measured by the maximum two-point distances from the right to left borders of the PG in the axial section (Fig. 1C).

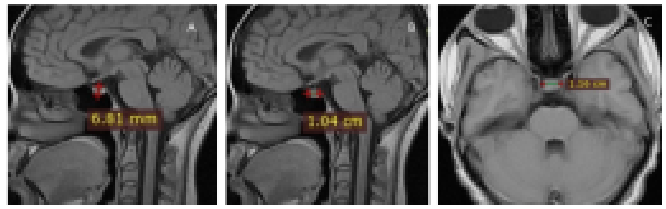

Fig. 1. MRI images show pituitary measurements taken with spin echo sequence, TR 600, TE 14. A & B - T1-weighted sagittal images; C - T1-weighted axial image taken with TR 350 and TE 7.8.

The PG volume was calculated using an ellipsoid object's formula:

Di Chiro and Nesion formula (Vol = length × depth × width × 0.5).

The shape of the PG in the sagittal view according to the upper surface was determined as: "Convex" (round shape) (Fig. 2A); "Concave" (Fig. 2B); "Flat" (Fig. 2C); Partial empty (PE) - the gland high of 3-4 mm (Fig. 2D); Empty sella turcica - the gland height ≤2 mm (Fig. 2E).

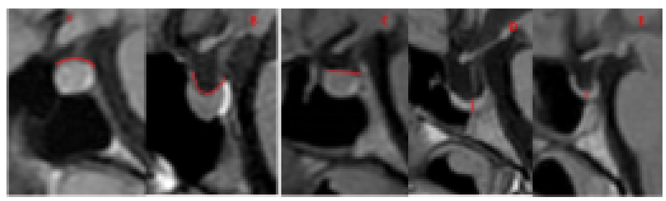

Fig.2. Different shapes of the sella turcica. A: Convex shape, B: Concave shape, C: Flat shape, D: Partial empty, E: Empty shape

Statistical analysis was performed using IBM SPSS Statistics 23. Continuous variables were presented as mean±standard deviation (SD). Multiple comparisons were performed with one-way ANOVA The linear regression model and coefficient of determination (R^2) were calculated. Pearson's correlation coefficient (r) was used to determine the strength of the relationship between the two continuous variables. A probability value of $P<0.05$ was considered statistically significant.

Results

The MRI brain examination found that the mean length, depth, width, and volume of the PG were 10.57±1.27 mm, 5.56±1.42 mm, 12.18±1.67 mm, and 356.38±100.2 2mm³, respectively (Table 1).

Concerning the shape of the sella turcica, the study revealed that the convex and concave shape were more frequent than others (39.7% and 34.9%, respectively) (Table (2).

The depth, width, length, and volume of the gland had changed significantly with pituitary shapes. It was observed that the flat shape yields the highest volume, followed by the convex, then concave, while the partially empty and empty sella turcica yield a lower volume. The sagittal depth was higher in the convex shape (6.75±0.75 mm), and axial width was higher in the partially empty sella turcica (13.02±1.59 mm). The sagittal length and volume were higher in flat-shaped sella turcica (11.76±0.7 mm and 419.89±31.72 mm³, respectively) (Table 3).

Table1.
Descriptive statistics for PG measurement

Variables	Minimum	Maximum	Mean±SD
Age, years	20	60	35.52±11.11
Puberty age, years	10	19	14.16±1.54
Sagittal length, mm	6.1	13.5	10.57±1.27
Sagittal depth, mm	2.0	8.3	5.56±1.42
Axial width, mm	8.4	15.5	12.18±1.67
Volume, mm³	98.0	563.1	356.38±100.22

Table 2.
The frequency of shapes of the sella turcica

Shape	Frequency	Percent
Convex	25	39.7
Concave	22	34.9
Flat	9	14.3
Partial empty	5	7.9
Empty	2	3.2
Total	63	100.0

Table 3.
Association of PG measurements with pituitary shape, age groups, and puberty age

Variables	Sagittal length, mm	Sagittal depth, mm	Axial width, mm	Volume, mm³
Pituitary shapes				
Convex	10.25 ±1.22	6.75±0.75	11.54±1.72	398.63±84.31
Concave	10.46±1.26	5.08±0.63	12.69±1.54	337.55±71.32
Flat	11.76±0.71	5.68±0.67	12.69±1.30	419.89±31.72
Partial empty	10.83±1.60	3.02±0.43	13.02±1.59	216.70±67.96
Empty	9.85±0.21	1.96±0.00	10.25±0.35	98.90±1.28
P-value	0.030	0.000	0.030	0.000
Age groups, years				
20-30	10.23±1.82	6.14±1.25	11.79±1.49	371.387±101.25
31-40	10.90±1.47	5.17±1.10	12.52±1.87	350.54±97.96
41-50	10.29±0.98	5.04±1.77	12.47±1.59	326.47±118.52
51-60	11.50±0.67	5.32±1.45	12.33±2.01	367.92±71.40
P-value	<0.05	>0.05	>0.05	>0.05
Puberty age, years				
10-13	10.91 ±0.87	5.45±1.41	12.25±1.72	366.83±105.56
14-16	10.24±10.72	5.80±1.45	12.02±1.69	351.98±100.51
17-19	10.72±1.32	4.79±1.06	12.81±1.46	324.29±71.07
P-value	> 0.05	> 0.05	> 0.05	> 0.05

There was a significant difference in sagittal length in different age groups ($P<0.05$); it increased gradually till the age of 40, then decreased in length in the age group of 41-50 years. It increased significantly in the 51-60 group. There was no significant difference in sagittal depth, axial width, and volume measurement in different age groups. The mean depth in the age group of 20-30 years was 6.14±1.25mm, while in the age group of 41-50 it was 5.04±1.77 mm, and then it returned to increase to 5.32±1.45mm in the age group of 51-60 years. The volume was 371.387±101.25 mm³ in the age group of 20-30 years, then it decreased to 326.47±118.52 mm³ in the age group of 41-50 years and returned to increase again after 50 years to 367.92±71.40 mm³ (Table 3).

The PG measurement has no significant association with the puberty age. Generally, the volume and depth were higher at the early puberty age than in the late one. The volume was 366.83±105.56 mm³ and 324.29±71.07 mm³ in puberty age of 10-13 years and 17-19 years, respectively. The depth was 5.45±1.41 mm and 4.79±1.06 mm in puberty age of 10-13 years and 17-19 years, respectively (Table 3).

The PG sagittal depth was significantly different among parity groups ($P<0.05$). The depth was significantly higher in nulliparous females than multiparous ones (Table 4). The other pituitary measurements (sagittal length, axial width, and volume) didn't vary significantly with parity; in general the volume also was greater in nulliparous than in multiparous women (Table 4).

Table 4.
PG measurement and parity groups

Parity	Sagittal length, mm	Sagittal depth, mm	Axial width, mm	Volume, mm³
Nulliparous	10.47±1.43	6.18±1.20	11.93±1.66	379.32±80.66
1-3	10.18±1.36	4.61±1.59	12.18±1.68	294.81±132.60
4-6	10.93±1.12	5.36±1.38	12.45±1.78	362.28±101.91
7-10	10.55±1.03	5.20±1.35	12.35±1.68	341.53±101.22
P-value	>0.05	<0.05	>0.05	

The study found no significant correlation of the PG measurements with age, puberty age, and parity (Table 5).

Table 5.
Correlation of the PG measurements with age, puberty age, and parity

Variables		Age	Puberty age	Parity
Sagittal length, mm	Pearson Correlation	0.221	-0.172	0.045
	Sig. (2-tailed)	0.082	0.178	0.728
Sagittal depth. mm	Pearson Correlation	-0.235	-0.006	-0.235
	Sig. (2-tailed)	0.064	0.963	0.064
Axial width, mm	Pearson Correlation	0.099	-0.041	0.145
	Sig. (2-tailed)	0.440	0.752	0.257
Volume, mm³	Pearson Correlation	-0.089	-0.139	-0.097
	Sig. (2-tailed)	0.490	0.277	0.451

Table 6 summarizes the association of the sella turcica shape with age groups. The convex shape was prominent in the age group of 20-30 years, while the concave shape was frequent in the age group of 31-40 years. This finding indicates that the sella turcica shape was significantly different among age groups (P=0.028).

Table 6.
Cross tabulation between age groups and shape of the sella turcica

Shape	Age group				Total
	20-30	31-40	41-50	51-60	
Convex	16	4	3	2	25
Concave	7	9	5	1	22
Flat	2	1	2	4	9
Partial empty	0	2	2	1	5
Empty	1	0	1	0	2
Total	26	16	13	8	63
P=0.028*					

There was an inverse relationship between females' age and pituitary depth and volume (Fig.3-5). From this linear correlation, the study predicts the depth and volume of the gland by identifying the female's age, as follows:

PG depth= -0.0304×age+6.6496 (R^2=0.0563)

PG volume= -0.08×age+384.81 (R^2=0.0079)

The following equations indicate an inverse relationship between the gland's volume and puberty age (Fig.5):

PG depth= -9.0162×puberty age+484.05 (R^2=0.0194)

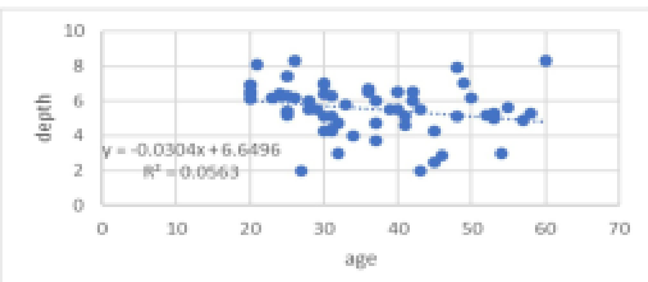

Fig.3. Linear relationship between PG depth and age.

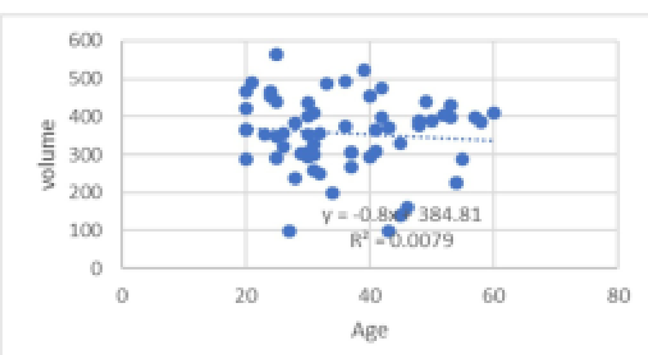

Fig. 4. Linear relationship between PG volume and age

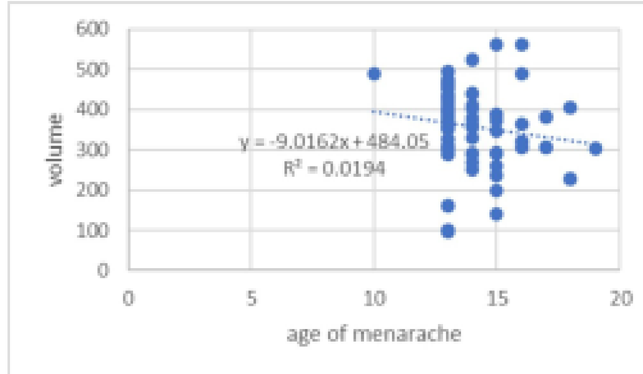

Fig. 5. Linear relationship between volume and puberty age

Discussion

The study evaluated the shape, mean volume, depth, width, and length of the normal PG in females, related to age, puberty age, and parity using MRI. In this study, females' pituitary height was higher than in a study performed by A. Tsunoda,[4] who reported a mean value of 5.35±1.2 mm. The PG height was less in this study than in a study performed by Singh et al.[10] (5.80±1.32 mm). Ibinaiye et al.[9] reported that the mean PG volume for females in North Nigeria was 328.1±129.2 mm^3. Our findings for the PG agree with data of Singh et al.[10] (354.98±130.60 mm^3).

The current study found that the convex and concave shapes were more common than other shapes. In contrast, Yadav et al.[2] found that the most common shape was flat. Singh et al.[10] found that convex in females was mostly seen in the age group of 10–29 years. In our study, convex shapes were more frequent in the age group of 20-30 years.

The current study clarified that the PG yielded the most considerable depth and volume in females of 20-30 years. The depth and volume then declined till the age of 50 years, and then returned to increasing. Yadav et al.[2] found that in the age group of 21-30 years, the mean PG volume was 440±180 mm^3, in the 31-40 group - 440±111 mm^3, in 41-50 group - 420±116 mm^3, and in females over age 50 - 420±174mm^3. Our findings agree with data of Ibinaiye et al.,[9] who reported that the PG depth and volume increased in pubertal subjects, then decreased steadily with increasing age, with a second peak noted only for pituitary height in the sixth decade.

Our study found that PG depth yielded the highest value in the age group of 20-30 years, then declined till the age of 50 years. After age 50, the depth returned to increasing. This finding is consistent with Yadav et al.[2] and Tsunoda et al.[4], who reported the same results. Tsunoda et al.[4] found that the PG height reached a peak value in the age group of 20-29 years, then returned to increasing again in the age group of 50-59. Doraiswamy,[8] on the other hand, found that the depth decreased until the age of 59 and increased from 60-69 years. In contrast, many studies found that the PG reached the highest value of depth in the third decade of life,[2,4,8] while other studies found that the PG yields the largest peak at the age of 10-19 years.[3,11] Previous studies attributed the changes in pituitary measurements to changes in hormone levels, which might be the cause of such changes in the pituitary morphology. The elevation in PG height during puberty can be related to the increased production of a luteinizing hormone during this time of growth. Also, the greater PG height was observed in young patients.[2,8,11,12]

Previous studies have reported that PG depth increases in elderly subjects, which is considered compensatory hypertrophy after a significant reduction in a gonadal steroid feedback effect. The pituitary size is greater in adolescence due to physiology hypertrophy in females, which occurs as a result of changes in hormones associated with menstruation; the reduced PG size between the second and sixth decades of life may reflect neuroendocrinology of aging and physiologic pituitary atrophy.[2,6,8,11,12]

The study found that there was a significant difference in the sagittal length of the PG measurement in different age groups. It increased gradually until the age of 40 years, then decreased at age 41-50 years and increased significantly at age 51-60 years. A significant difference in sagittal depth measurement was found in different parity groups and was more significant in nulliparous than multiparous women. In our study, the nulliparous females had a larger PG than other groups of parity. This finding is consistent with Daghighi et al.,[13] who stated that the gland's volume is greatest in nulliparous women.

Concerning the PG measurement in females with PG of different shapes, a significant difference was found between measurement in glands of different shapes as the flat shape yielded the highest volume followed by convex then concave, while the partially empty and empty sella turcica yield a lower volume.

We found no significant correlation between gland measurements, age, puberty age and parity. In general, as female age, puberty age, and parity increased, sagittal depth and volume of the PG decreased. There was an insignificant inverse correlation between the depth, the volume of PG with age, puberty, and parity. In contrast, Daghighi et al.[13] found that gravidity and parity had a significant negative impact on PG volume (P<o.o1). The insignificant relationship in our study may be due to the small sample size.

Conclusion

Thus, the mean measurements (length, depth, width, and size) of PG in females changed significantly with the pituitary shapes. The PG measurement in adult Sudanese females decreased in the sagittal depth and volume gradually till the age of 50 years then returned to increasing after age 50. Younger females in the age group of 20-30 years had a larger depth and volume of the gland than other age groups. The pituitary volume increased in females with early onset of puberty age, and in nulliparous females. The convex-shaped gland was more prevalent in younger individuals of 20-30 years. Further studies with a larger sample size with a hormonal profile should be performed for more accurate results.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgments

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Radiology

Characterization of the Pituitary Gland Shape with MR Imaging

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Abstract **Original Research Article**

Magnetic Resonance Imaging (MRI) is the standard tool for the imaging of pituitary gland. ***The aim*** of the study was to characterize the shape of the pituitary gland in relation to age and sex. ***Methodology:*** A cross sectional prospective analytical study of the pituitary glands of Sudanese people, the data was collected from 301 Sudanese subjects (123 males' percent 40.9% and 178 females' percent 59.1%) who underwent MRI examination for brain. ***Results*** the females gender are the big frequency distribution than males among study sample. The convex shape appear in females more than males in the age group 20-29 years old the concave shape appear in age group between 40-49 and 50-60, the flat appear in age group 20-29, partial empty in age group 30-39, the only one empty case appear in female in age group 40-49.***Concolusion*** the pituitary gland can be accurately determined by using MRI and should be correlated with the patient's age and sex for further correlation.
Keywords: Pituitary gland, magnetic resonance imaging, age, gender.

INTRODUCTION

The pituitary gland was first described anatomically by a Belgian scientist Andreas Vesalius in 1543.It is a small-sized gland with master functions; hence, its size and morphology have been a source of interest for many researchers. Sometimes in imaging, one takes a quick look at the contour of the superior surface of the pituitary gland or the size of the sella turcica as an indication or suggestion of enlargement of the gland. However, this would be misleading as the shape of the superior surface of the normal gland could either be flat, concave, or convex, depending on the hormonal status, age, sex, and even race of the individual. Also, the size of the bony sella is not a sensitive indicator of pituitary gland abnormality since an empty sella can lead to an enlarged fossa. Hence, there is a need for quantitative assessment. Magnetic resonance imaging (MRI) presently supersedes computerized tomography (CT) and plain radiographs in the investigation of the sella, parasellar, and suprasellar regions. MRI allows detailed visualization of the anterior and posterior lobes, pituitary infundibulum, optic chiasma, and other parasellar structures [1].

The coronal image is considered the best single view for imaging the pituitary gland, while the sagittal image best assesses the relationship of the midline structures [2].

The pituitary gland is the master endocrine gland of the human body. It controls other glands and secretes important hormones. Evaluation of pituitary size shape is the most important factors for the diagnosis of its pathology. Pituitary adenomas especially the microadenomas are diagnosed mainly with the information of pituitary size and its configuration. [3].

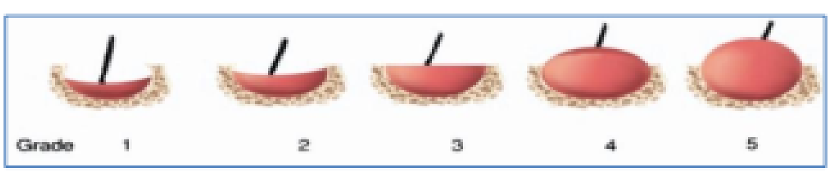

Fig-1: Scheme grade score for the shape evaluated in sagittal views

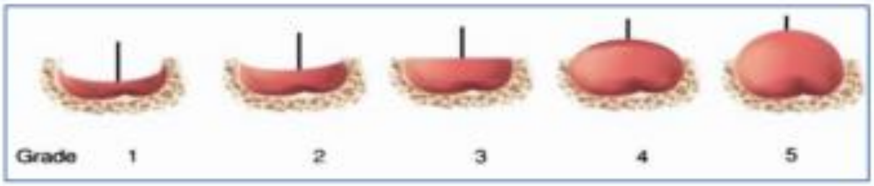

Fig-2: Scheme grade score for the shape evaluated in coronal views [4].

Grade 1 (G1) call "Concave", Grade 2 (G2) call "Concave" (different than G1, less than center of gland 2 mm.), Grade 3 (G3) call "Flat", Grade 4 (G4) up more Grade 3 (but less than 2 mm.) call "Convex", Grade 5 (G5) call "Convex" (rather round shape). C. Keanninsiri1,

Materials and Methods

A cross sectional prospective analytical study of the pituitary glands of Sudanese people, the data were collected from 301 Sudanese subjects (123 males' percent 40.9% and 178 females' percent 59.1%) who underwent MRI examination for head at the Radiology and Imaging Department in the modern medical center during the period from 2015 to 2020.

Shape variation of the pituitary gland

The data that display in mid sagittal image (close to mid sagittal plane) .Shapes of pituitary gland is:

a) Convex when the upper surface of P.G was convex (rather round shape)
b) Concave when the upper surface of P.G was concave.
c) Flat when the upper surface of P.G was flat.
d) Partial empty (PE) when the high of gland will be 3-4mm.
e) Empty sella will be when gland high less than 2mm.

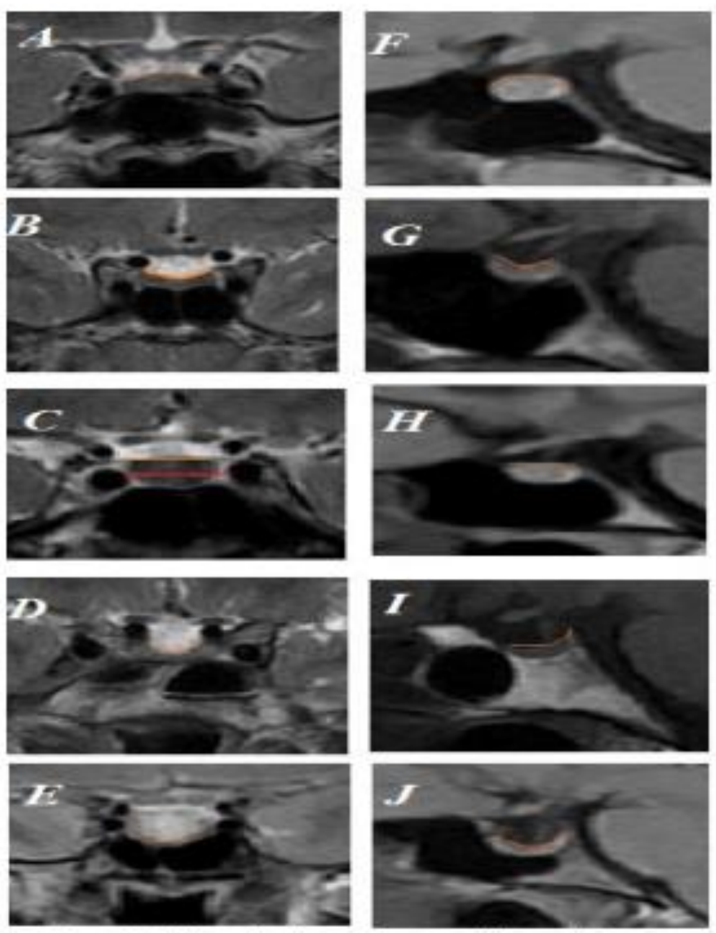

Fig-3: MR images shows the five shapes of pituitary gland convex, concave, flat, partial empty and empty sella respectively (A-D coronal sections)and(F-J) sagittal sections)

RESULTS

In this current study, we analyzed the MRI scans of 301 patients of 20 years and older; 40.9% are males (n = 123) and 59.1% females (n = 178) represented in fig-4.

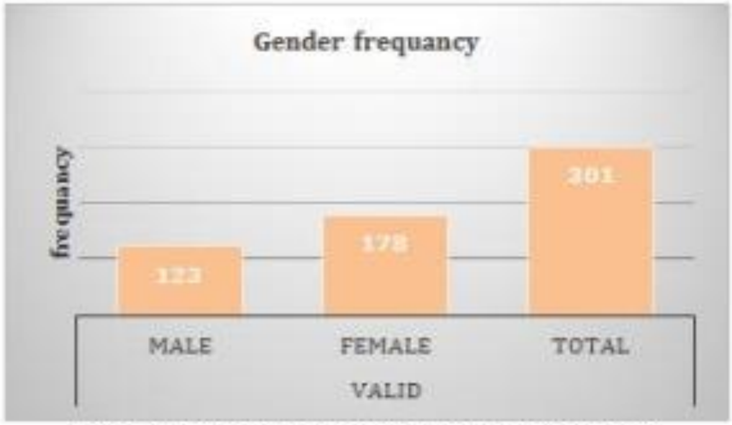

Fig-3: Distribution of participants' sex in the sample

The samples were divided according to gender into 4 age groups: 20–29 years, 30–39, 40-49 and 50-60 .Table 1 shows the frequency distribution cross-tabulation.

Table-1: Distribution of participant's age groups and sex in the sample

Age group	gender	count	frequency	percent
20-29	male	49	126	41.9
	female	77		
30-39	male	26	63	20.9
	female	37		
40-49	male	18	45	15.0
	female	27		
50-60	male	30	67	22.3
	female	37		
total		301	301	100

Table-2: Shape of pituitary frequency distribution with the gender in the sample

		Frequency		Percent	Cumulative Percent
Convex	male	50	127	41.9	42.2
	female	77			
Concave	male	34	80	26.4	68.8
	female	46			
Flat	male	25	57	18.8	87.7
	female	32			
	Total	**264**			
PE	male	14	36	11.9	99.7
	female	22			
	Total	**300**			
E	male	0	1	.3	100.0
	female	1			
total		**301**		100	100

Table-3: Shape of pituitary frequency distribution within age group in the sample

			Shape					Total
			convex	concave	flat	PE	E	
age group	20-29	Count	83	20	21	2	0	126
		% of Total	27.7%	6.7%	7.0%	0.7%	0	42.0%
	30-39	Count	17	18	13	15	0	63
		% of Total	5.7%	6.0%	4.3%	5.0%	0	21.0%
	40-49	Count	8	21	8	7	1	45
		% of Total	2.7%	7.0%	2.7%	2.3%	0.3	15%
	50-60	Count	19	21	15	12	0	67
		% of Total	6.3%	7.0%	5.0%	4.0%	0	22%
Total		Count	127	80	57	36	1	301
		% of Total	41.9%	26.4%	18.8%	11.9%	0.3	100.0%

DISCUSSION

MRI usages are more effective than other imaging methods in visualizing the soft tissue like pituitary gland MR findings .This study focused mainly on the pituitary gland shape in relation with age and sex

In this study, the authors reported MRI data on measured the shape of pituitary gland in participants. There were 40.9% are males (n = 123) and 59.1% females (n = 178)represented in figure 3 their age was range from (20–60 years).Table 1 give the summary of the frequency distribution of sex with age group, the females gender are the big frequency distribution than males.Table2 shape of pituitary frequency distribution, the shape of pituitary gland can affect some variable because of that we divided the cases according to the shape and analytic according to this divided in some relation variable. the total cases was 301 when excluded the one empty sella it will be 300 and when excluded the 36 partial empty the cases was be 264 the convex shape are the high frequency distributed and it appear in female more than male by 42.2% concave, flat, PE and E are the lower appear respectively.

Table 3 distribution the frequency of age group with pituitary shape, in age group 20-29 the convex shape appear in high frequency, concave appear in age group between 40-49 and 50-60,the flat appear in age group 20-29,PE in age group 30-39, the only one empty case appear in female in age group 40-49.

Previous studies have highlighted different changes in the shape of the upper surface of the pituitary gland at various stages of life, which also indicate the consequent change in hormonal levels [2] Results of the present study in agreement with previous studies.

Our result was that the convex shape was the high-frequency percentage 41.9% then concave in 26.4%, flat 18.8, partial empty 11.9%, empty sella by 0.3% respectively, the empty sella were seen in one patient in the age above 40 years we detect it in one female 43years old, these results were consistent with Samuel M. et al. [5], who detect that the larger gland was seen in the younger women and convex shape are the highest shape count in younger women. And the worth noting are these frequencies of shapes in our study are the same frequency distribution in the gender variable female and male, convex, concave, flat, PE, and empty sella respectively.

The convex shape appears higher frequently in the younger age group 20-29 then in the age group 50-60, 30-39 lastly in the age group 40-49. The concave shape appears more frequency in the age group 20-30, its frequency ware convergent in all age groups. the flat shape appears in more frequently in the age group 20-29, partial empty was appear in the middle age group 30-39 by a percentage of 5%from total percentage of partial empty shape 11.9% and it appears in females more than male. The decline in the pituitary upper surface due to age may explain the process of aging similar finding was achieved by Tika R Lamichhane et al. [6], who reported that a higher frequency of convex upper border in female than in male in Nepalese population so that the flat shape is higher in male. Also, S. C. Sanjay et al. [7] noted that the gland was more convex globular in the younger age group in female 58.30%, flat 3.1% then concave 11.10% and it was in the same order with age increase This is, however, contrary to the finding by Pratiksha Yadav1 et al. [8] who found that in all the age groups and both the sexes, the most common shape was flat, which was seen in 46%of people followed by convex in 31.2%, concave shape in 22.8%.

Also, C. Keanninsiri1 et al. [4], reported that the most frequency grade shape of the upper surface of the pituitary gland was the type of "flat" in male all age groups and in female groups except age group (11-20 years), which higher frequency type of "convex". As we said depends on the upper surface for that it has a correlation between it and depth (height).

Conclusion

The pituitary gland can be accurately determined by using MRI and should be correlated with the patient's age and sex for further correlation. The convex shape appears in high frequency in relation to other shapes IN THE FEMALES age group of 20-29 year old.

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Radiological Sciences

Review in Different Morphology of Pituitary Gland Using Magnetic Resonances Imaging

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Abstract **Original Research Article**

Magnetic resonance (MR) occurs in the magnetic system that contains both magnetic moments and angular momentum [1]. Various radiological modalities that had been used to study gland such as computed tomography but MRI has proved to be an accurate diagnostic modality for the assessment of pituitary gland. Normal pituitary gland shows variation in size and shape, transient changes in the shape or signal intensity of the pituitary gland appears at different stages of life [2]. The gland tends to be rounded in shape at birth and becomes more flattened with age. This review study aimed to summarize the author's articles about the shapes of normal pituitary gland when they are using the magnetic resonance imaging as imaging modalities. Authors discussed and illustrated the various shapes of gland are convex, concave most common in females and the flat shape are common in males.

Keywords: Review, Pituitary gland, magnetic resonance imaging.

BACKGROUND

The pituitary gland (hypophysis cerebri) is a reddish grey, ovoid body which lies within the hypophyseal fossa of the sphenoid bone. The gland measures about 12 mm in transverse and 8 mm in antero-posterior diameter and weighs about 500 mg. It is covered superiorly by diaphragma sellae, which is pierced centrally by an aperture for the infundibulum. Structurally the gland is divided into a larger anterior region (adenohypophysis) and smaller posterior region (neurohypophysis). They differ in structure, development, and their vascular and neural supplies. The gland produces several hormones that regulate growth, metabolism and reproduction. Deviations from the normal functions of the gland certainly derange the harmony of life [3]. Pituitary gland morphology is altered in many situations like Prolactinomas (60%)[4], somatotrophic adenoma(30%) [5] and pituitary adenomas which accounts for 10-15% of all diagnosed intracranial neoplasms[6].

Variation in the pituitary gland shape in sagittal section:

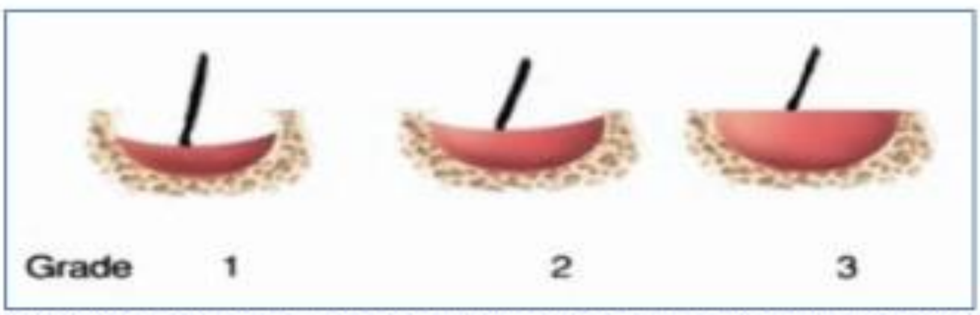

Fig-1: Scheme grade score for the shape evaluated in sagittal views Grade 1 (G1) call "Concave", Grade 2 (G2) call "Concave" (different than G1, less than center of gland 2 mm.), Grade 3 (G3) call "Flat"[7]

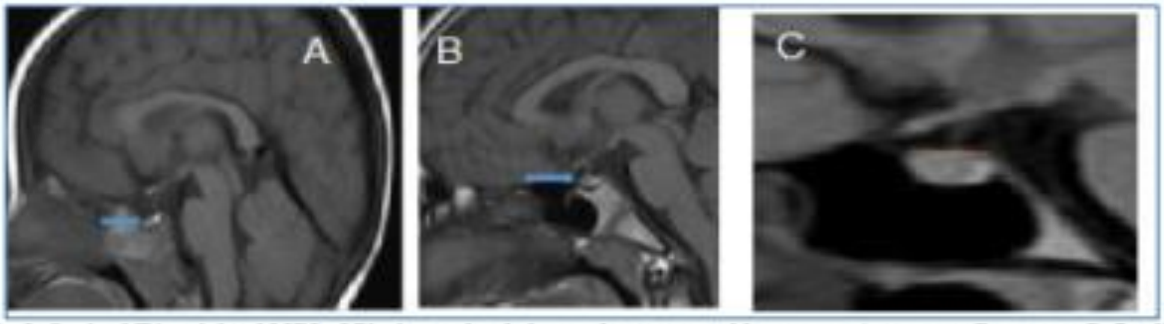

Fig-2: Sagittal T1 weighted MRI of Pituitary gland shapes demonstrated by arrows A. concave B. convex C .flat [8]

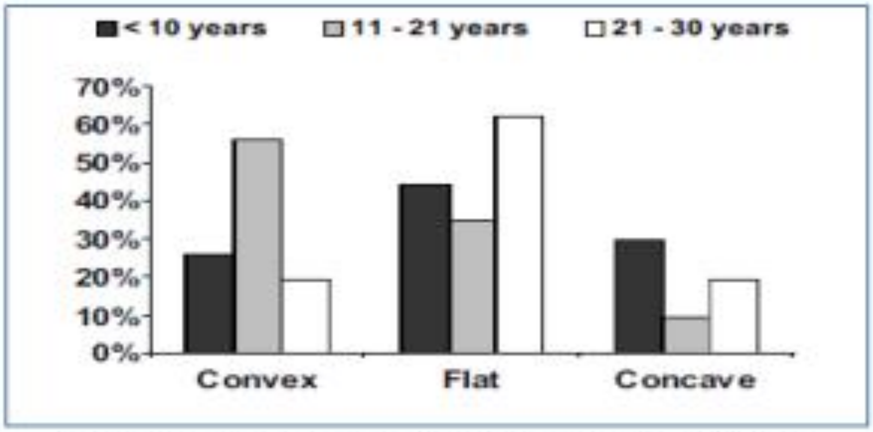

Fig-3: Shape of the superior surface of the pituitary gland in Females [8]

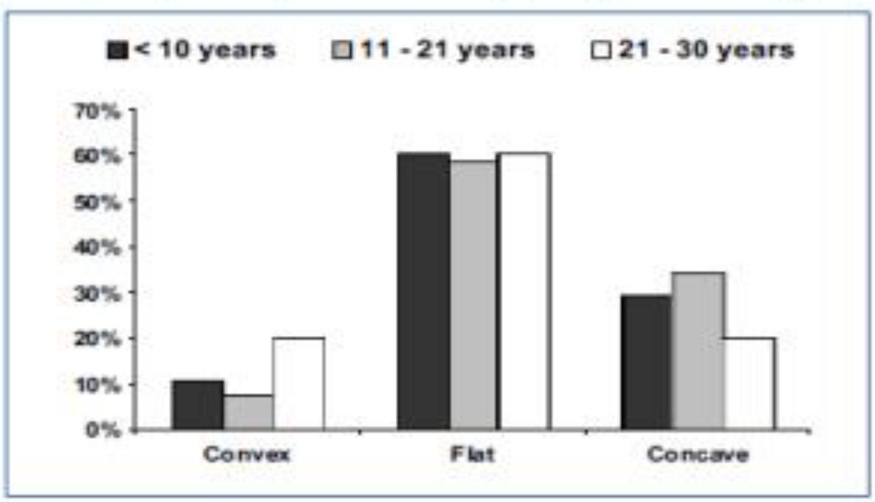

Fig-4: Shape of the superior surface of the pituitary gland in Males [8]

OBJECTIVES

This review study aimed to summarize the author's articles about the shapes of normal pituitary gland when they are using the magnetic resonance imaging as imaging modalities. Authors discussed and illustrated the various shapes of gland such as convex, concave and flat most common seen in the mid sagittal and coronal images.

MATERIALS AND METHODS

6 articles in different peer reviewed journals were selected by authors and then analyzed and summarized in table1 to compare between different findings. The manuscripts were selected according to the main objective of this review article, any manuscript that were not found as full-text were excluded from this review article. The article was accessed provided by open access internet using Google scholar search.

Table-1: Main results of research used in this review article.

Title	Authors	Source	Main finding of shapes
MRI Evaluation of Size and Shape of Normal Pituitary Gland: Age and Sex Related Changes	Yadav,P.Singhal, S.,Chauhan,S.and Harit, S., 2017.	Journal of Clinical and Diagnostic Research. 2017 Dec, Vol-11(12): TC01-TC04	The most common shape was flat which was seen in 46% of people followed by convex in 31.2% and concave shape in 22.8% [9].
Size,shape,and appearance of the normal female pituitary gland	Wolpert, S.M., Molitch, M.E., Goldman, J.A. and Wood, J.B., 1984.	American journal of Roentgenology, 143(2), pp.377-381.	The superior margins of the glands were convex in 19; The superior margins of the glands were concave in 33 patients [10].
Age and Gender Related Variations of Pituitary Gland Size of Healthy Nepalese People Using Magnetic Resonance Imaging	Lamichhane, T.R., Pangeni, S., Paudel, S. and Lamichhane, H.P2015.	American Journal of Biomedical Engineering, 5(4), pp.130-135	The shape of the superior surface of the gland (SS) was convex upper border was more common in females the flat upper surface was more common [11].
Magnetic Resonance Imaging Determination of Normal Pituitary Gland Dimensions in Zaria, Northwest Nigerian Population	Ibinaiye, P.O., Olarinoye-Akorede, S., Kajogbola, O. and Bakari, A.G.,2015.	Journal of Clinical Imaging Science | Vol. 5 | Issue 2 | Apr-Jun 2015	This study not focused in shape and reported that there no statistically significant difference between pituitary height and pituitary volume in both sexes [12].
Size and Shape of the Pituitary Glandwith MR Imaging from Newborn to 30 Years: A Study at Siriraj Hospital	Keanninsiri, C., Cheiwvit, P., Tritrakarn, S., Thepamongkhol, K. and Santiprabhop, J., 2012.	Journal of Evolution of Medical and Dental Sciences, 3(18), pp.4934-4940	The most of frequency grade of shape, in sagittal views were type of "flat" in male all groups, in female groups higher frequency type of "convex" same as coronal views [7].
Pituitary Height onMagnetic Resonance Imaging Observation of Age and Sex Related Changes	Ikram, M.F., Sajjad, Z., Shokh, I. and Omair, A., 2008.	JPMA. The Journal of the Pakistan Medical Association, 58(5), p.261.	Convex upper border was more common in females In males, frequency of flat upper surface was more common [13].

DISCUSSION

This manuscript considered attempt to enhance the role of MR imaging in assessment of pituitary gland shape and elevating accurate method for the measurement in the mid sagittal. Authors found that the mid sagittal and coronal T1-weighted images are the most practical method to evaluate the gland shape.

Table 1 shows the shape different in pituitary gland with convex shape most common in female and flat shape in male. Some authors correlated the different in shape of the gland with gender and age groups Wolpert, S.M *et al.* 1984 found that concave shape more often in the older than in the younger women vice versa to convex shape more common in younger women[10]. In agreement with Lamichhane, T.R *et al.* found a higher frequency of convex upper border in female than in male [11]. This difference was much higher in 10-20 year age group. In females, frequency of convex upper margin peaked in 10-20 years age group and in males, it was found in 20-30 year age group. There was no gender difference in the shape of the upper border in 20-30 year age group, though the frequency of flat upper margin was higher in this age group. Sanjay, S.C *et al.* also noted that the gland was more convex/globular in the younger age group (20-29) but as advanced the superior surface became more concave [14].

Flat superior surface was seen predominantly in the age group (30-39). Consistency with Ikram, M.F *et al.* Convex upper border was more common in females in < 20 years cases. In males, frequency of flat upper surface was more common. Also found a higher frequency of convex upper border in female (38%) than in male (12%) [13].

This difference was much higher in 11-20 year age group (male=7%, female = 56%). In females, frequency of convex upper margin peaked in 16-20 years age group (71%) and in males, it was found in 20-25 year age group (30%). There was no gender difference in the shape of the upper border in 21 - 30 year age group, though the frequency of flat upper margin was higher in this age group.

Keanninsiri, C *et al.* The most of frequency grade of shape, in sagittal views were type of "flat" in male all groups (1-3) 58%, 62% and 65% but no significant (p = 0.724) and 48%, 58% in female groups except in female groups 2(11-20 years) higher frequency type of "convex" equal to 54% include statistic significant (p=0.001). In coronal views most of frequency grade of shape type of "flat" was shown in 64% 64% and 67% in male and no significant (p = 0.746), 44% 38% and 60% in female but in groups 2(11-20 years) tend type to "convex" include this groups was statistic significant (p = 0.016) [7].

Conclusion

This review article considers as reference values for the shape of pituitary gland, the midsagittal MR sections reflect the gland morphology more accurately. Authors discussed and illustrated the various shapes of gland are convex, concave most common in females and the flat shape are common in males.

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