Sudan University of Sciences and Technology

Collage of Graduate Studies

Measurement of Pituitary Gland Dimension in Normal Sudanese Population using Magnetic Resonance Imaging

قياس أبعاد الغدة النخامية السليمه لدى السودانيـن باستخدام التصوير بالرنين المغناطيسي

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بِسْمِ اللّهِ الرّحْمَنِ الرّحِيم

﴿ يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ
وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ
وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ ﴾

{ المجادلة 11}

Dedication

Words that reflect the emotions we deeply hold in the heart chambers are not enough People who were and are the cornerstone and temple pillars of my bright thoughts And dreams,,,

To those who would like to dedicate this humble work

To my beloved mother, my heart who didn't forget me in every prayer and supplication

To my father who devoted his life to our happiness

To my beloved big sister, my other twin

To my brothers my strength and support

To my best friends who walk with us together forever

Acknowledgement

First of all, I am very grateful to God Almighty for enabling him to complete this message in due course and prayers and peace be upon the Compassionate Prophet Muhammad. I am extremely grateful to many people who supported me during the preparation of this study. I would like to express deep gratitude to my supervisor Professor **Caroline Edward** for her support and guidance. And express my gratitude to all the relevant authorities that have allowed me to do so. A special thanks for my best friend **Malaz** for helping me and **Awadieh** who is contributed to the analysis of the data. Finally, I would like to thanks my lovely family and nice friends for their support.

Abstract

The main objective of the study to determine normal pituitary gland Dimension in Sudanese population. In addition to correlate the findings with age and gender. The study examined 101 subjects aged between 10-90 years in both gender (41 males and 60 Females) were included in the study, all were diagnosed as normal brain MRI when the measurement was done. Data were collected at Merowe Medical City in North of Sudan from September 2019 to February 2020. A reference image was obtained for the T1 arrow, length and width measurements were taken for the pituitary gland. All measurements were taken in millimeters. The relationship between the dimensions of the pituitary gland with age and sex was studied. The study concluded that there is an association between age and measurement of the width of the pituitary gland and the no association between age and measurement of the length of the pituitary gland. The study concluded that the general measurement of the average width of the pituitary gland increases with age. And that measuring the average length of the pituitary gland increased at the age of 7-40 and 70-80 but decreased in middle age 40-70.And that the general measurement of the average width and length of the pituitary gland in females is more than that of males. The study recommended that further study should be done with larger sample of population for more accurate result, volumetric measurement may give more information than dimension measurement.

ملخص البحث

الهدف الرئيسي من الدراسة هو تحديد أبعاد الغدة النخامية الطبيعية لدى السكان السودانيين. بالإضافة إلى ربط النتائج بالعمر والجنس. فحصت الدراسة 101 شخصًا تتراوح أعمارهم بين 10-90 عامًا في كلا الجنسين (41 ذكورًا و 60 أنثى) في الدراسة ، وتم تشخيصهم جميعًا على أنهم تصوير بالرنين المغناطيسي الطبيعي للدماغ عند إجراء القياس. تم جمع البيانات في مدينة مروي الطبية في شمال السودان في الفترة من سبتمبر 2019 إلى فبراير 2020. تم الحصول على صورة مرجعية لسهم T1 وطول وعرض القياسات للغدة النخامية. تم أخذ جميع القياسات بالمليمتر. تمت دراسة العلاقة بين أبعاد الغدة النخامية مع العمر والجنس. وخلصت الدراسة إلى وجود ارتباط بين العمر وقياس عرض الغدة النخامية وعدم وجود ارتباط بين العمر وقياس طول الغدة النخامية. وخلصت الدراسة إلى أن القياس العام لمتوسط عرض الغدة النخامية يزداد مع تقدم العمر. وأن قياس متوسط طول الغدة النخامية ازداد في سن 7-40 و70-80 ولكنه انخفض في منتصف العمر 40-70 ، وأن القياس العام لمتوسط عرض وطول الغدة النخامية في الإناث أكثر من الذكور. أوصت الدراسة بإجراء مزيد من الدراسة مع عينة أكبر من السكان للحصول على نتيجة أكثر دقة ، وقد يعطي القياس الحجمي معلومات أكثر من قياس البعد .

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List of abbreviations

MRI	Magnetic Resonance Imaging
PD	proton density
CT	computerized tomography
Fig	Figure
RH	releasing hormones
ACTH	Adrenocorticotropic hormone
MSH	Melanocyte–stimulating hormone
ADH	Antidiuretic hormone
TR	Time to Repetition
TE	time to Echo
FLAIR	Fluid-attenuated inversion recovery
FMRI	Functional Magnetic Resonance
MRA	Magnetic Resonance angiography
IVC	Inferior vena cava
GE	General Electric
T	Tesla
DWI	Diffusion Wight image
RT	Right
LT	Left
PACS	Picture archiving and communication system
ROI	Region of interest
SPSS	Statistical Package Software

Chapter One

Introduction

1.1 Introduction:

The pituitary gland, also known as the hypophysis and Master gland, is a major gland of the endocrine system. It secretes hormones that control the actions of other endocrine organs and various tissues around the body. Is it a pea-sized oval structure .It is a protrusion off the bottom of the hypothalamus at the base of the brain. The hypophysis rests upon the hypophysial fossa of the sphenoid bone in the center of the middle cranial fossa and is surrounded by a small bony cavity (sella turcica) covered by a dural fold (diaphragma sellae) *(*Mancall 2011). The anterior pituitary (or adenohypophysis) is a lobe of the gland that regulates several physiological processes (including stress, growth, reproduction, and lactation). The intermediate lobe synthesizes and

Secretes melanocyte-stimulating hormone. The posterior pituitary (or neurohypophysis) is a lobe of the gland that is functionally connected to the hypothalamus by the median eminence via a small tube called the pituitary stalk (also called the infundibular stalk or the infundibulum) *(*Mancall 2011).

Hormones secreted from the pituitary gland help to control growth, blood pressure, energy management, all functions of the sex organs, thyroid glands metabolism as well as some aspects of pregnancy , childbirth, breastfeeding, water/salt concentration at the kidneys, temperature regulation and pain relief *(*Mancall 2011).

The pituitary gland is located in pituitary fossa within sphenoid bone. This region has significant variations between normal individuals, including sphenoid sinus, size of Sella including depth and size and shape of pituitary gland (Chaudhary 2011).

While in the majority of patients, it is subjectively possible to differentiate normal from abnormal, there is a significant grey area where a reporting radiologist faces dilemma whether the pituitary is within normal limits or not, often resulting in unnecessary further investigations. It is therefore important to define “normal” more accurately to reduce the “grey” zone and prevent unnecessary clinical concern and investigations. Despite its importance, only a few studies have been performed to analyze the size, shape and structure of the normal pituitary gland. The majority of the known published data is in excess of 20 years ago and these studies were specific to certain populations such as pediatrics (Lurie 1990).

Magnetic Resonance Imaging (MRI) is a medical imaging technique. Radiologist used it for the visualization of the internal structure of the body. MRI provides rich information about human soft tissues anatomy. MRI helps for diagnosis of the brain abnormality.

Images obtained by the MRI are used for analyzing and studying the behavior of the brain. Image intensity in MRI depends upon four parameters. One is proton density (PD) which is determined by the relative concentration of water molecules. Other three parameters are T1, T2, and T2* relaxation, which reflect different features of the local environment of individual protons. (Qurat-Ul-Ain et al-2014).

This report aims to produce normal data for the size, in particular the height, of the normal pituitary gland using latest 2D magnetic resonance imaging (MRI) and will also comment on the shape and stalk position. Such data is important to validate and upgrade the older scant data. While the older studies were Performed Japan or United States of America, and more recently from Africa there has been scant data from Europe. Unlike previous studies, the aim of this study is not to statistically compare the difference in pituitary gland sizes between different populations, this is purely a collection of population data using up to date technology. Morphological changes to the pituitary gland, analyzed using imaging, have been documented within normal subjects with emphasis on the change in pituitary gland height and shape during childhood, adolescence, pregnancy and post-partum (Lurie 1990).

Earlier studies were performed using computerized tomography (CT) imaging as opposed to MRI. Demonstrated that with regards to the pituitary gland, measurements were essentially equivalent using either CT or MR imaging with the technologies at the time. However, with regards to modern day technology the advancements in the imaging capabilities make MRI the modality of choice for imaging the pituitary gland (Wiener 1985).

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.

1.2Problem of study:

There is anatomical variations in shape and size of pituitary gland between peoples, Pituitary space can vary between normal subjects depending upon age, gender and other conditions. It is important to know the range of normal space to enable radiologists to suggest what might be an abnormal pituitary gland.

1.3 Project objectives:

1.3.1 General objective:

Purpose of this study is to determine pituitary gland size using MRI sagittal view in normal Sudanese population.

1.3.2 Specific objectives:

-To measure the pituitary gland diameters (length and width) in sagittal MRI images.

-To use routine protocol of MRI brain as technique for measurement the pituitary gland diameters (width and length).

-To measure the pituitary gland space for normal Sudanese.

-To study the effect of gender and puberty age in normal subjects.

-To find out the relation between pituitary space, gender and age.

1.4 The overview of the research:

Chapter one deals with introduction, problem, objectives, significance and overview of the research. Chapter two deals with literature review including theoretical background (anatomy, physiology and pathology) and previous studies. Chapter three deals with research Materials and Methods Chapter four deals with results and finally chapter five deals with discussion, conclusion and recommendation.

Chapter Two

Literature Review

2.1 Theoretical background:

2.1.1 Anatomy:

The pituitary gland, or hypophysis, is small and oval-shaped an endocrine gland It is lies at the middle of the base of the skull and is housed within a bony structure called the (sella turcica) covered by a Dural fold (diaphragma sellae), which is behind the nose and immediately beneath the hypothalamus fig (2.1) (Mancall 2011) .

The pituitary gland can be divided into two different parts:

2.1.1.2 Anterior Pituitary gland:

A major organ of the endocrine system, the anterior pituitary (also called the adenohypophysis) is the glandular fig (2.1). The anterior pituitary regulates several physiological processes including stress, growth, reproduction, and lactation.

Its regulatory functions are achieved through the secretion of various peptide hormones that act on target organs including the adrenal gland, liver, bone, thyroid gland, and gonads. The anterior pituitary itself is regulated by the hypothalamus and by negative feedback from these target organs (Mancall 2011).

2.1.1.3 Posterior Pituitary gland:

The posterior pituitary (or neurohypophysis) it is part of the endocrine system. Despite its name, the posterior pituitary gland is not a gland; rather, it is largely a collection of axonal projections from the hypothalamus that terminate behind the anterior pituitary gland fig (2.1). The posterior pituitary consists mainly of neuronal projections (axons) extending from the supraoptic and paraventricular nuclei of the hypothalamus. These axons release peptide hormones into the capillaries of the hypophyseal circulation. These are then stored in neurosecretory vesicles (Herring bodies) before being secreted by the posterior pituitary into the systemic bloodstream (Mancall 2011).

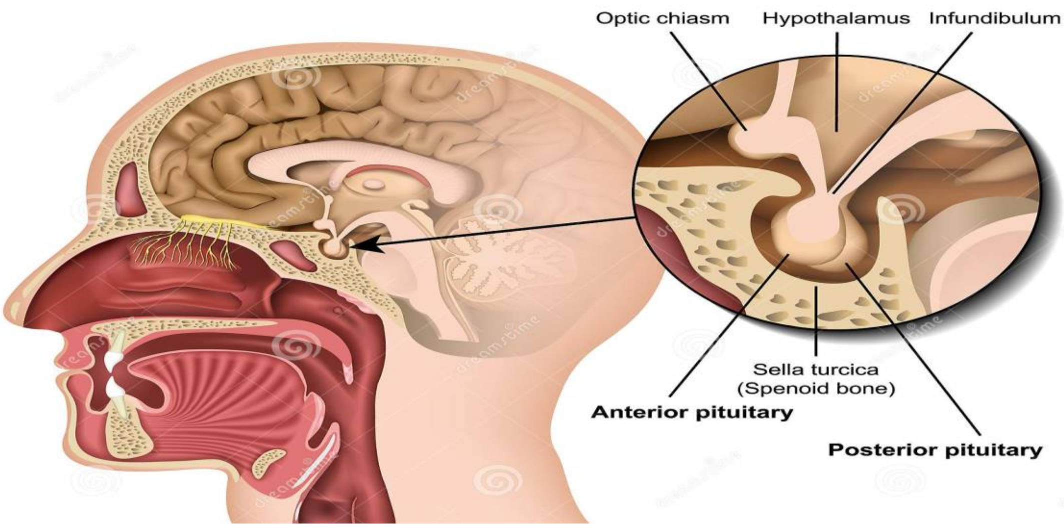

Fig (2.1) showing the region and anatomy of pituitary gland

2.1.2 Structure of Pituitary Gland:

2.1.2.1 Anterior Pituitary Gland:

The fleshy, glandular anterior pituitary is distinct from the neural composition of the posterior pituitary. The anterior pituitary is composed of multiple parts:

- Pars distalis: This is the distal part that comprises the majority of the anterior pituitary; it is where most pituitary hormone production occurs.

- Pars tuberalis: This is the tubular part that forms a sheath that extends up from the pars distalis and wraps around the pituitary stalk. Its function is poorly understood.

- Pars intermedia: This is the intermediate part that sits between the pars distalis and the posterior pituitary and is often very small in human’s fig (2.2) (Melmed, Shlomo 2011).

2.1.2.2 Posterior Pituitary Gland:

The posterior pituitary is derived from the hypothalamus and is distinct from the more fleshy, vascularized anterior lobe. The posterior pituitary is composed of two parts:

- The pars nervosa, also called the neural lobe or posterior lobe, constitutes the majority of the posterior pituitary and is the storage site of oxytocin and vasopressin.

- The infundibular stalk, also known as the infundibulum or pituitary stalk, bridges the hypothalamic and hypophyseal systems fig (2.2) (Boron 2009).

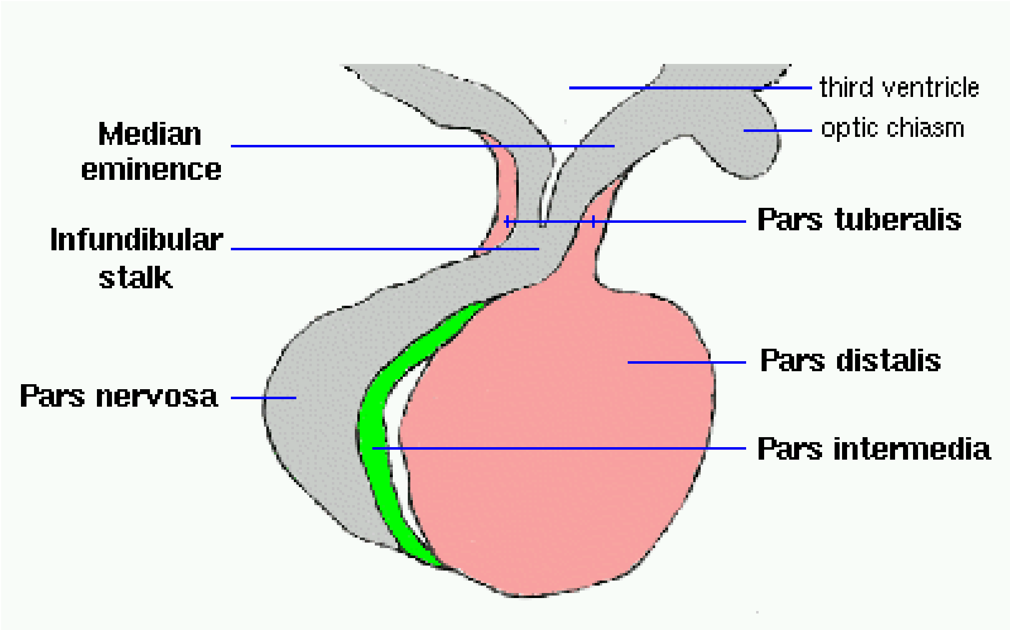

Fig (2.2) showing Structure of Pituitary Gland, the pink color is Anterior, the green color is intermediate, and the gray color is Posterior Pituitary gland

2.1.3 Physiology of Pituitary Gland:

2.1.3.1 Control of the Pituitary Gland:

Pituitary Gland Controlled by the Hypothalamus. The pituitary gland consists of two components: the anterior pituitary and the posterior pituitary, and is functionally linked to the hypothalamus by the pituitary stalk (also named the infundibular stem, or simply the infundibulum).

While the pituitary gland is known as the master endocrine gland, both of its lobes are under the control of the hypothalamus: the anterior pituitary receives its signals from the parvocellular neurons, and the posterior pituitary receives its signals from the magnocellular neurons. The pituitary gland is connected by a system of blood vessels to the hypothalamus. This system of blood vessels is known as the hypophyseal portal system, and it allows endocrine communication between the two structures. The mechanism for hormone transport via hypothalamoportal vessels involves cells that are regulated by different nuclei in the hypothalamus; for instance, neurons that release neurotransmitters as hormones in the connective link between the pituitary and the brain. The anterior lobe of the pituitary receives hypothalamic-releasing hormones from the hypothalamus that bind with receptors on endocrine cells in the anterior pituitary that regulate the release of adrenal hormones into the circulatory system fig (2.3). Hormones from the hypothalamus are rapidly degraded in the anterior pituitary, which prevents them from entering the circulatory system. The posterior lobe of the pituitary gland develops as an extension of the hypothalamus. As such, it is not capable of producing its own hormones; instead, it stores hypothalamic hormones for later release into the systemic circulation fig (2.4) (Malenka RC 2009).

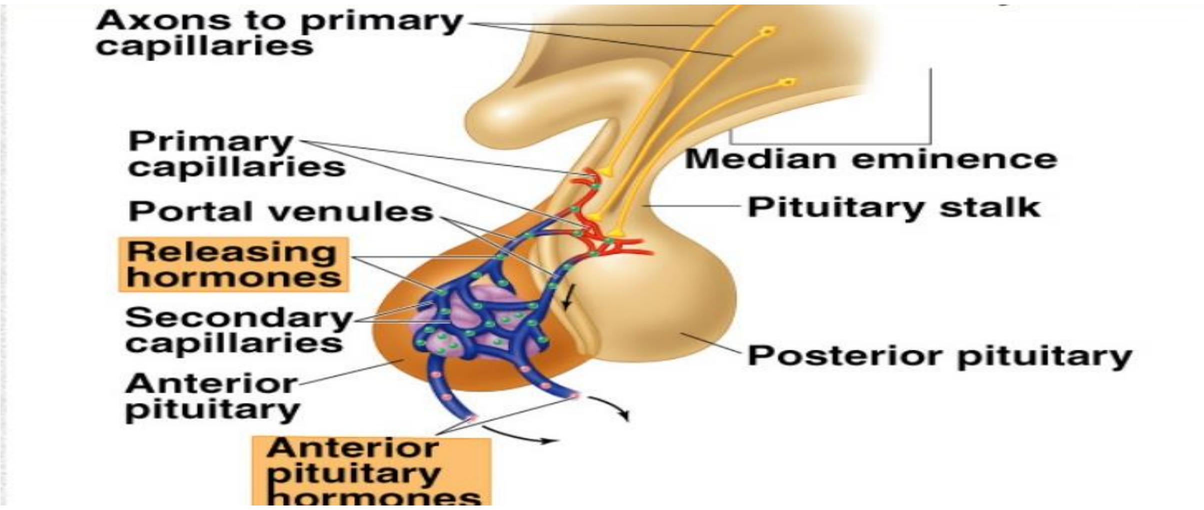

Fig (2.3) showing hypothalamic controlling the anterior pituitary

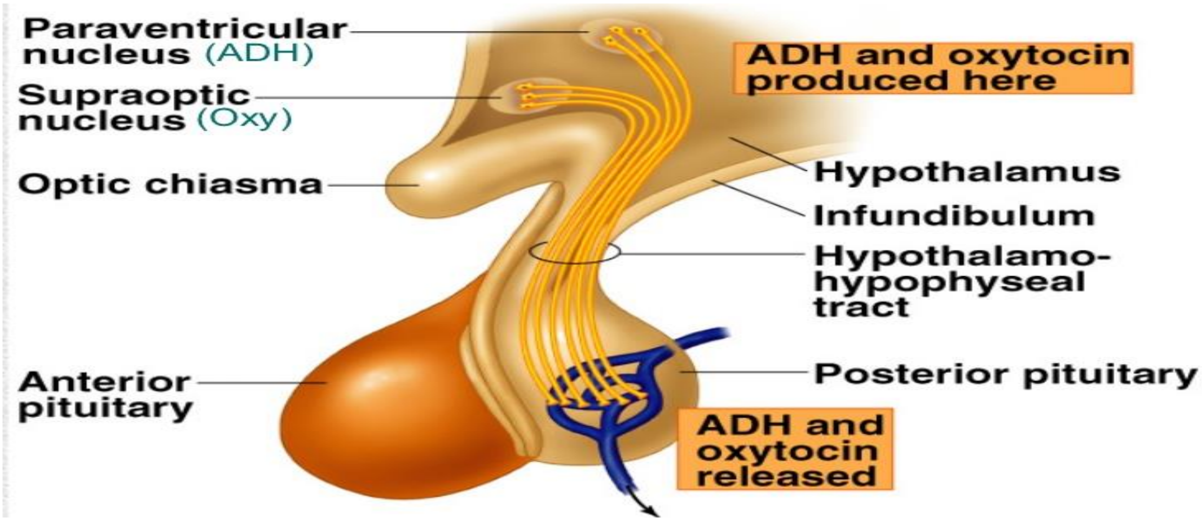

Fig (2.4) showing hypothalamic controlling the posterior pituitary

2.1.3.2 Hormones Secreted by the Anterior Pituitary Gland:

The anterior pituitary synthesizes and secretes hormones. All releasing hormones (-RH) referred to, can also be referred to as releasing factors (-RF) fig (2.5).

- Adrenocorticotropic hormone (ACTH), is a polypeptide whose target is the adrenal gland. The effects of ACTH are upon secretion of glucocorticoid, mineralocorticoids, and sex corticoids (Knepel 1984).

- Beta-endorphin is a polypeptide that effects the opioid receptor, whose effects include the inhibition of the perception of pain (Brunton 2011).

- Thyroid-stimulating hormone is a glycoprotein hormone that affects the thyroid gland and the secretion of thyroid hormones.

- Follicle-stimulating hormone is a glycoprotein hormone that targets the gonads and effects the growth of the reproductive system.

- Luteinizing hormone is a glycoprotein hormone that targets the gonads to effect sex-hormone production.

- Growth hormone is a polypeptide hormone that targets the liver and adipose tissue and promotes growth through lipid and carbohydrate metabolism.

- Prolactin is a polypeptide hormone whose target is the ovaries and mammary glands. Prolactin influences the secretion of estrogen/progesterone and milk production (Shlomo Melmed 2010).

2.1.3.3 Intermediate hormone:

The intermediate lobe synthesizes and secretes the following important endocrine hormone:

-Melanocyte–stimulating hormone (MSH). This is also produced in the anterior lobe. When produced in the intermediate lobe, MSHs are sometimes called "intermedins" (*Pocock, Gillian 2006)*.

2.1.3.4 Hormones Secreted by the Posterior Pituitary Gland:

The posterior pituitary stores two hormones secreted (but does not synthesize) by the hypothalamus for later release:

- Oxytocin, most of which is released from the paraventricular nucleus in the hypothalamus. Oxytocin is one of the few hormones that create a positive feedback loop.

- Antidiuretic hormone (ADH, also known as vasopressin), the majority of which is released from the supraoptic nucleus in the hypothalamus. ADH acts on the collecting ducts of the kidney to facilitate the reabsorption of water into the blood fig (2.5) (Malenka 2009).

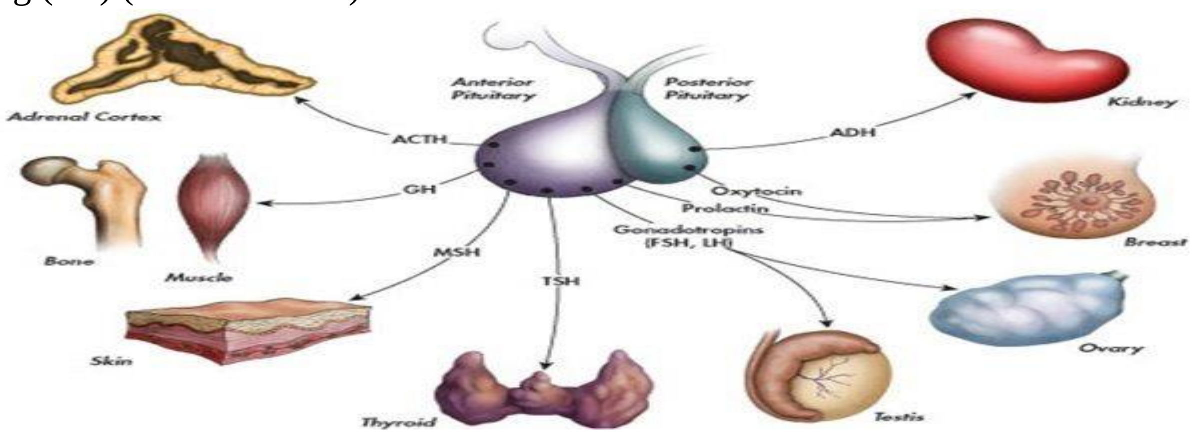

Fig (2.5) showing Hormones Secreted by the Pituitary Gland

2.1.4 Vasculature of Anterior Pituitary gland:

The vasculature of the pituitary gland is complex and unique. Whilst the anterior lobe and posterior lobe have the same venous drainage (anterior and posterior hypophyseal veins), they have an individual arterial supply (Mavis Fernandes 2018).

2.1.4.1 Vasculature of Anterior Pituitary gland:

The anterior pituitary gland receives arterial supply from the superior hypophyseal artery (a branch of the internal carotid artery). This vessel first forms a capillary network around the hypothalamus – blood from this network is then transported to a secondary capillary plexus surrounding the anterior pituitary.

Known as the hypothalamo-hypophysial portal system, this structure allows the hypothalamus to communicate with the anterior pituitary via the release of neurotransmitters into the bloodstream (Gibo 1993).

2.1.4.2 Vasculature of Posterior Pituitary gland:

The infundibulum and posterior pituitary gland receive a rich blood supply from many arteries. Of these, the major vessels are the superior hypophyseal artery, infundibular artery and inferior hypophyseal artery (Mavis Fernandes 2018).

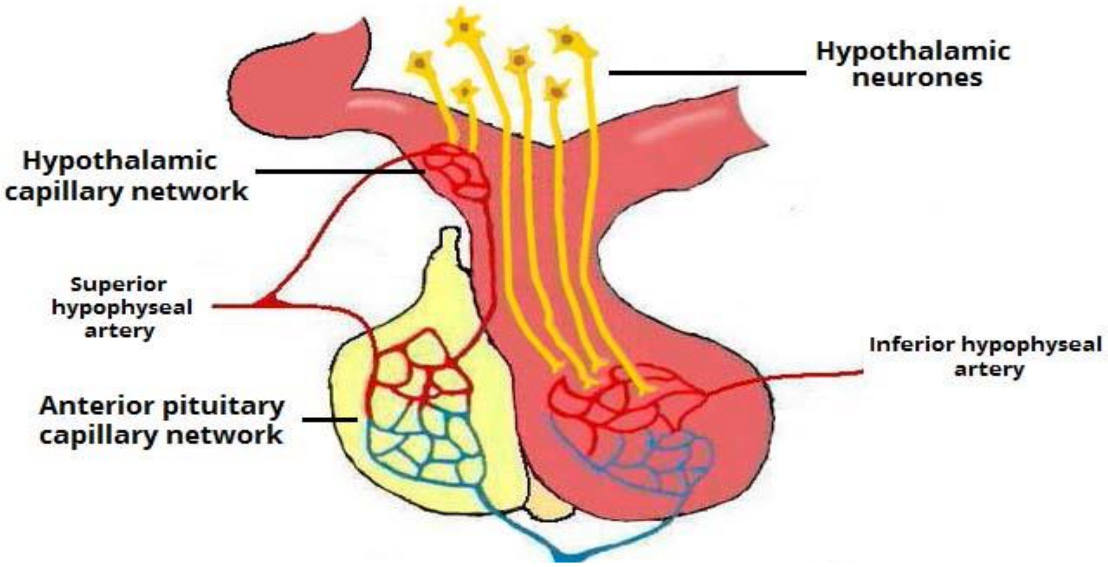

Fig (2.6) showing the vascular of pituitary gland

2.1.5 Diseases of the pituitary gland:

Some of the diseases involving the pituitary gland are:

- Central diabetes insipidus caused by a deficiency of vasopressin.
- Gigantism and acromegaly caused by an excess of growth hormone in childhood and adult, respectively.

- Hypothyroidism caused by a deficiency of thyroid-stimulating hormone.
- Hyperpituitarism, the increased (hyper) secretion of one or more of the hormones normally produced by the pituitary gland.
- Hypopituitarism, the decreased (hypo) secretion of one or more of the hormones normally produced by the pituitary gland.
- Panhypopituitarism a decreased secretion of most of the pituitary hormones.
- Pituitary tumors.
- Pituitary adenomas, noncancerous tumors that occur in the pituitary gland.

2.1.5.1 Pituitary Adenomas:

These are by far the most common tumors arising in the pituitary gland and their pathology is extensively reviewed elsewhere. Pituitary adenomas are generally divided into three categories dependent upon their biological functioning: benign adenoma, invasive adenoma, and carcinomas. Most adenomas are benign, approximately 35% are invasive and just 0.1% to 0.2% are carcinomas. Pituitary adenomas represent from 10% to 25% of all intracranial neoplasms and the estimated prevalence rate in the general population is approximately 17% (Ezzat 2004).

Adenomas exceeding 10 mm in size are defined as macroadenomas, with those smaller than 10 mm referred to as microadenomas. Most pituitary adenomas are microadenomas .A majority of pituitary microadenomas often remain undiagnosed. (Ezzat 2004). Pituitary macroadenomas are the most common cause of hypopituitarism (Foppiani 2009). While pituitary adenomas are common, affecting approximately one in 6 of the general population, clinically active pituitary adenomas that require surgical treatment are rarer (Daly 2006).

2.1.5.2 Pituitary Carcinoma:

These extremely rare malignant tumors are identified on the basis of their capacity to metastasis via the cerebrospinal fluid pathway or to extracranial tissues (Asa 1998). Brain invasion is not yet considered a criterion for malignancy, but it is likely that this possibility will be reassessed as neuroradiological techniques for the identification of brain invasion improve and that the practicality of brain sampling for the identification of invasion is reconsidered by neurosurgeons (as it has been for the identification of invasive meningiomas). Pituitary carcinomas are usually endocrinologically functional, with ACTH and PRL producing tumors being the most frequent. Carcinomas show a variable degree of nuclear atypia and cellular pleomorphism, but with significantly higher mitotic rates and cell proliferation indices than adenomas (Thapar 1996). Vascular endothelial proliferation and necrosis are uncommon features, but the primary tumors show a much lower incidence of immunoreactivity. As for invasive adenomas, it appears at present that there are no consistently expressed cellular markers of aggressive biological behavior for pituitary carcinomas (Gaffey 2002).

2.1.6 Fundamentals of Magnetic resonance images:

Magnetic resonance imaging (MRI) is a non-surgical medical test that helps clinicians diagnose and treat medical conditions. MRI used strong magnetic field, radio frequency pulses, gradient coil and computer to produce detailed images of organs, soft tissues, bones and almost all other internal body structures. Detailed MR images allow assessment of different parts of the body and determination of the presence of a specific disease. Different pulse sequences are used to differentiate tissue types, the rhythm resonance is the most frequently used sequence that uses a combination of two pulses. Repetition Time (TR) and Echo Time (TE). Magnetic resonance imaging is the test of the most sensitive head images (especially in the brain) in routine clinical practice (McRobbie 2007).

2.1.6.1 Equipment:

Patient lie on a moveable examination table that slides into the center of the magnet. Some MRI units, called short-bore systems, are designed so that the magnet does not completely surround the patient fig (2.7), others are open on the sides (open MRI) fig (2.8). These units are especially helpful for examination patients who are fearful of being in a closed space and for those who are very obese. The coil type was used is quadrature head coil 4-channal fig (2.9), with the sequence sagittal T1, coronal T2, axial T1, T2 and FLAIR (Robertson 2011).

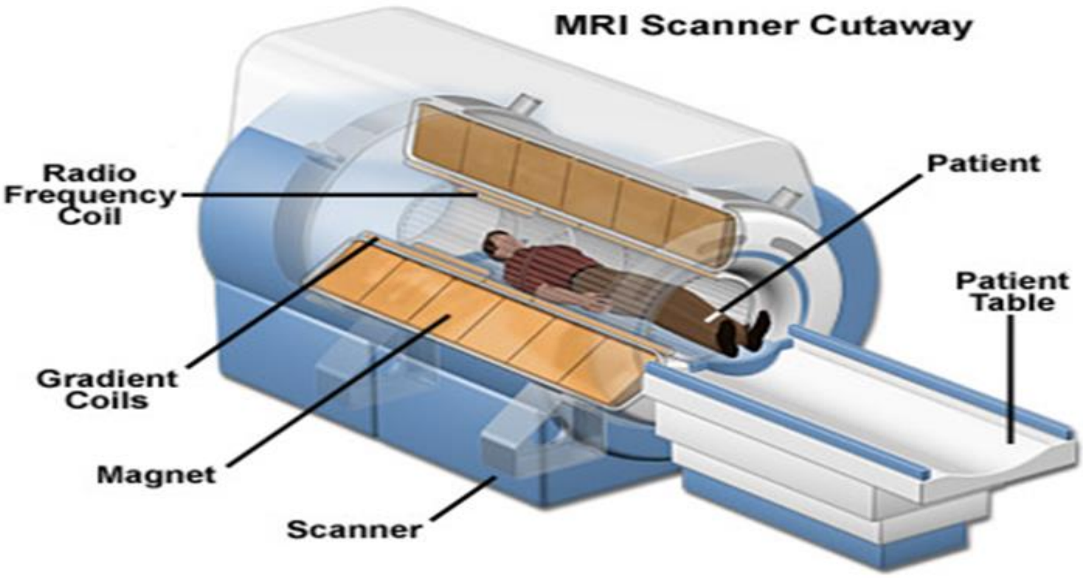

Fig (2.7) showing the close MRI machine

Fig (2.8) showing the open MRI machine

Fig (2.9) Showing the head coil

2.1.6.2 Patient preparations:

The patient was asked to remove all metal objects and wear a gown during the examination. These elements include: jewelry, watches, credit cards, and hearing aids, all of which can be damaged and may distort MRI images. Some MRI exams may require that the patient receive injection of a contrasting substance into the bloodstream. The technician asks the patients if they have an allergy, such as an iodine, drug, food or asthma allergy. The contrast material in a magnetic resonance imaging is called gadolinium. In some cases, such as acute kidney disease, a blood test may be necessary to determine if the kidneys are working properly. Pregnant women should not receive contrast injection. Indoor phobia or anxiety, gives the patient a sedative before scheduled tests (Hornak 1996)

.2.1.6.3 Patient positioning:

The patient lies supine on the examination couch with their head with in the head coil. Use cushion & straps to immobilization the patient's head,. Ask the patient to close eyes during the scan. The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the nasion. (Catherine Westbrook, 2008).

2.1.6.4 Benefits of MRI:

Magnetic resonance imaging is a non-invasive imaging technique that does not involve exposure to ionizing radiation, and MR images of the brain and other cranial structures are more clear and detailed than other imaging methods. These details make MRI an invaluable tool in early diagnosis and evaluation of many conditions, including tumors. MRIs can help clinicians evaluate brain structures and can also provide functional information (fMRI) in selected cases, the contrast material used In MRI tests at less likely to produce an allergic reaction than iodine-based contrast materials used in conventional X-ray and CT scans, MRI is the most sensitive means of detecting brain tumors, providing a variable called MR (MRA) angiography Detailed vascularization is often in the brain without the need for contrasting matter and MRI can detect stroke at a very early stage by mapping This known as diffusion.(Kanal 2004).

2.1.6.5 Limitations:

Magnetic resonance imaging generally is not recommended for patient who have been actually injured, this is because reaction devices and many types of life supports equipment's must be kept away from the area to be imaged. The examination takes longer than other imaging modalities (typically x-ray and CT) and the results may not be immediately available. (Kanal 2004).

2.1.6.6 Contraindications of MRI:

- Implants (Pacemaker or defibrillator, IVC filters).
- Pulmonary artery monitoring catheters and temporary transvenous pacing leads.
- Aneurysm clips or Ferromagnetic vascular clips.
- Intra-aortic balloon pumps.
- Metallic foreign body (i.e. shrapnel, metal splinters, welding splinters, bullets, grenade fragments).

The technologists ask the patient if he have medical or electronic devices in your body, because they may interfere with the exam or potentially pose a risk, depending on their nature and the strength of the MRI magnet (Dill T 2008).

2.2 Previous study:

C.Cem DENK (1999), Height of Normal Pituitary Gland on MRI Differences between Age Groups and Sexes. In this study showed 201 subjects were studied. They were 107 females and 94 men. Coronal and sagittal pituitary gland heights increased from birth including 11-20 years' age group. After 21 year heights decreased in both sexes. It is also observed the activity of the pituitary gland increases in the 51-60-year age range because of the negative feedback from target organs in which function diminishes. Coronal and sagittal pituitary gland heights were measured nearly equal to each other, in all subjects. In both sexes the highest coronal and sagittal values obtained in 11-20 years' age group. In puberty, pituitary gland height was greater in females than males parallel to their physiology. In 21-40 years' age group pituitary gland height was also greater in females than males. Mean pituitary gland height was greater in females than males. The mean heights of pituitary glands in 201 subjects were as follows, The mean values of the coronal and sagittal heights in females (6.1 ± 0.1 mm, 6.1 ± 0.1 mm respectively) were higher than in males (5.7 ± 0.2 mm, 5.6 ± 0.2 mm respectively).

Keannin siri C (2012), Size and Shape of the Pituitary Gland with MR Imaging from Newborn to 30 Years. 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 males 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. 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 significantly 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.

Muhammad F (2008), Pituitary height on magnetic resonance imaging observation of age and sex related changes. A total of 220 subjects (129 males and 91 female) of ≤ 30 years of age with normal pituitary morphology were evaluated by using T2 weighted (MR) Imaging. Pituitary height (PH) and shape of the superior surface of the gland was observed on mid sagittal sections. 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 genders. Gland was significantly higher in females than males in the second decade.

Suzuki M (1990), Height of normal pituitary gland on MR imaging: age and sex differentiation. The sample size 213 subjects, In the 10 to 69-year range, the pituitary heights were greater in females than in males. The groups of 0–9 years of both genders showed the minimum mean pituitary height The maximum of the mean height was observed in the 10 to 19-year age groups of both genders. The height gradually decreased with increasing age after age 20 years. There were no subjects with a height of ≥9.0 mm in females or ≥8.0 mm in males.

Philip O (2015), Magnetic Resonance Imaging Determination of Normal Pituitary Gland Dimensions in Zaria. The sample size 100 subjects (58 males and 42 females) and in the age range 14-82 years. The height, width, and depth of the pituitary were obtained from mid-sagittal and coronal planes, the data obtained were stratified based on age and sex for analysis. The mean pituitary volumes were 334.1 ± 145.8 mm (3) 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.

Chapter three

Materials and Methods

3.1 Materials:

3.1.1Subjects:

This study included 100 normal Sudanese patients, the age range between 10 to 90 years. Patient there will came for routine MRI brain without using intravenous contrast media. Both female and male will be included, any patient having pituitary gland disease or other congenital anomalies and any pathology affecting the measurement of the pituitary gland will be excluded.

3.1.2 Equipment used:

American GE MRI 1.5T and structures using a system of digital image processing.

3.1.3 Area and duration:

The data will be collected in Merowe Medical City in North of Sudan from September 2019 to February 2020.

3.2 Methods:

3.2.1 Technique used:

MRI studies were performed whole body MR systems using standard imaging head coil. Routine brain MRI was performed in 3 orthogonal planes, Patients were positioned supine in the scanner with the head gently immobilized to minimize motion artifacts. Examined general brain used head coil, (these are placed over-head but should not touch the patient). The patients are positioned so that the longitudinal alignment light lies in the midline , and the horizontal alignment light passes through the nasion Straps and foam pads are used for immobilization. T1,T2,FLAIR.DWI weighted imaging was performed in the axial, coronal & sagittal plane protocols . All images were 5mm in thick with a 0.5 mm space between slices.

In our study we used sagittal T1 only for measurements.

Plane the sagittal slices on the axial plane; angle the position block parallel to Sella Tercica. Slice must be cover the whole pituitary gland from RT to LT internal carotid arteries. an appropriate angle must be given in the coronal plane on a tilted head (parallel to the line along 3rd ventricle and brain stem) fig (3.1). (mrimaster).

Pituitary space (PS) was observed on mid sagittal section.

The data were collected from the PACS system on the selected hospitals. The cases were transferred to the workstation, at which the width & length of the pituitary gland were measured using an electronic cursor on views on the sagittal section, using region interest (ROI).

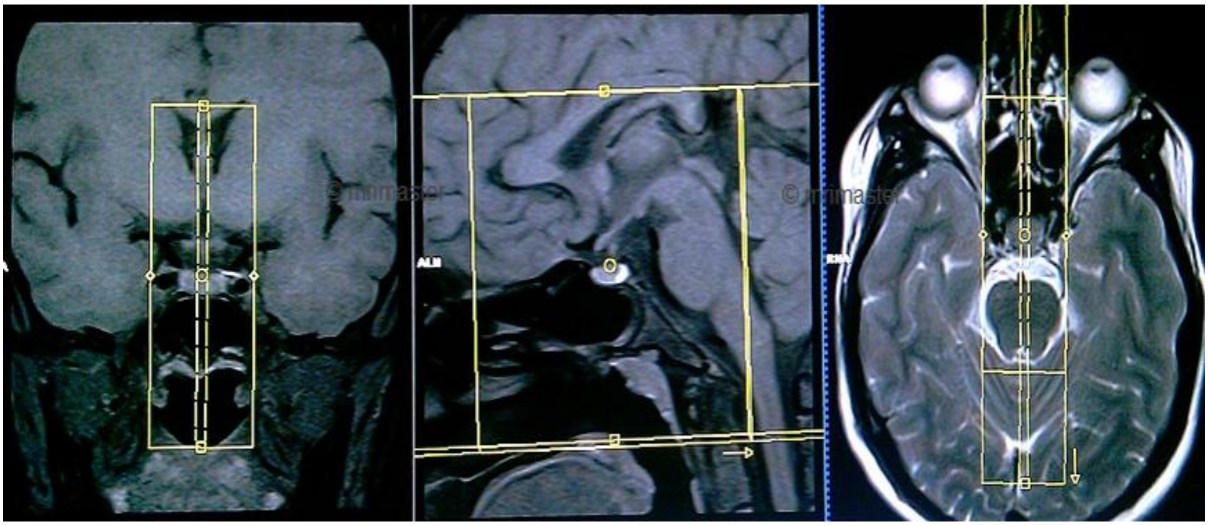

Fig (3.1) Shows: the technique of pituitary gland in sagittal plane

3.2.2 Method of measuring pituitary gland:

The standard measurement technique was used. Using PACS measurements feature, guide lines were drawn superior and inferior to the pituitary gland in the midsagittal plane determined by measuring the greatest distance between the base and the top of the gland (Figure 3.1A). Also in the midsagittal plane, similar method was used to measure the distance between anterior and posterior margins, referred to as width of the gland (Figure 3.1B).

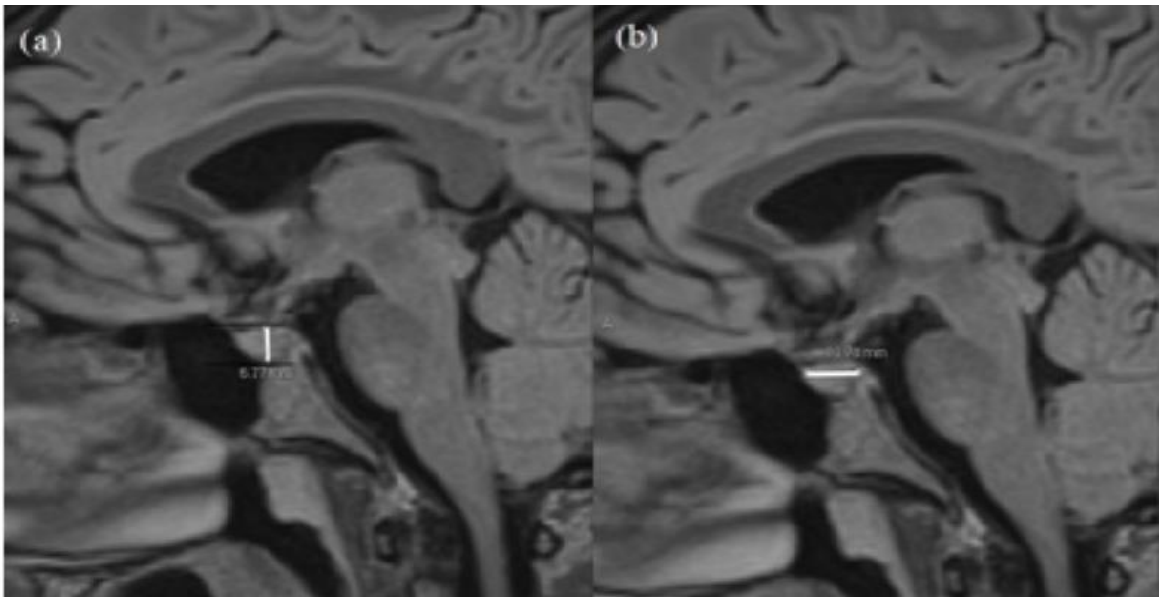

Fig (3.2) Shows: measurement of pituitary gland sagittal (a,b) . (a) Shows length measuring the greatest distance between the base and top of the pituitary gland, (b) Shows width measuring the greatest distance between anterior and posterior of the pituitary gland.

3.2.3 Data analysis:

Descriptive statistics will used to describe the study variables, using the Statistical Package Software (SPSS) to analyze variables.

Chapter four

Results

Table (4.1) Frequency distribution of age

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
male	41	40.6	40.6	40.6
female	60	59.4	59.4	100.0
Total	101	100.0	100.0	

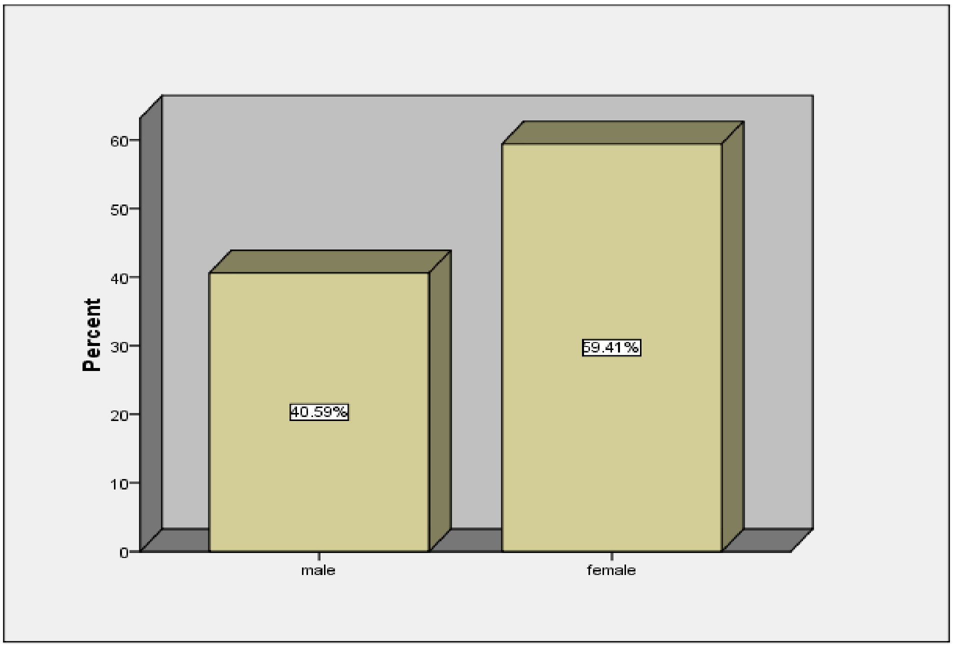

Fig (4.1) Frequency distribution of age

Table (4.2) Frequency distribution of gender

Age / years	Frequency	Percent	Valid Percent	Cumulative Percent
7-17	7	6.9	6.9	6.9
18-28	24	23.8	23.8	30.7
29-39	20	19.8	19.8	50.5
40-50	14	13.9	13.9	64.4
51-61	9	8.9	8.9	73.3
62-72	20	19.8	19.8	93.1
73-83	6	5.9	5.9	99.0
84-95	1	1.0	1.0	100.0
Total	101	100.0	100.0	

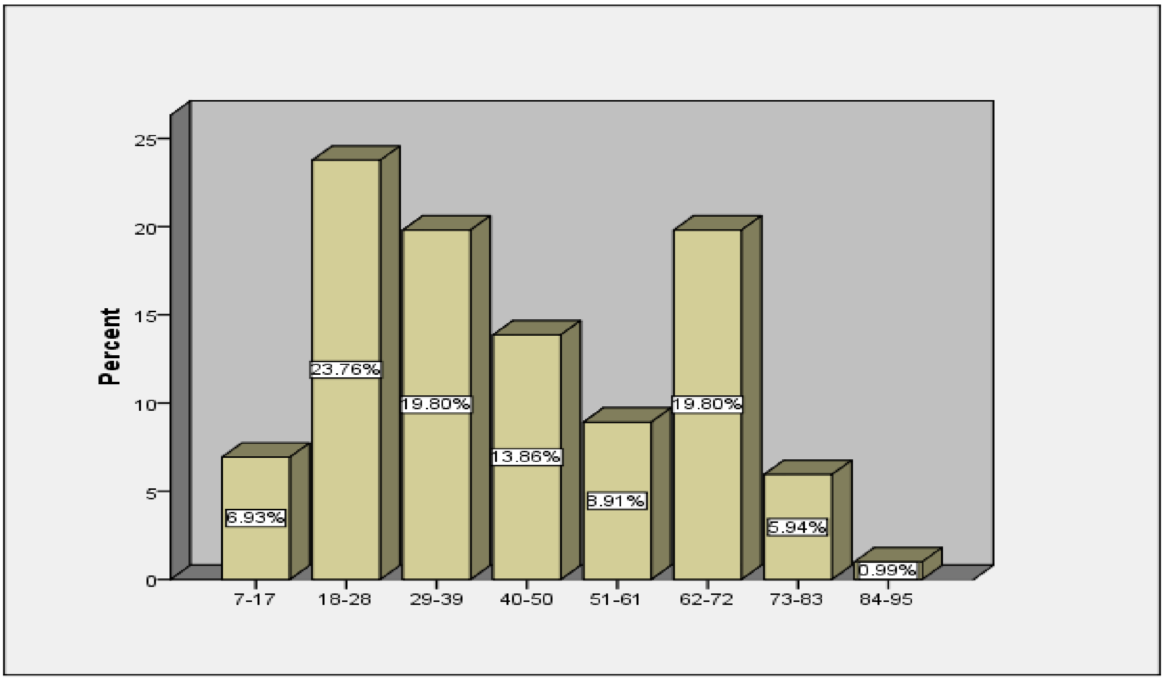

Fig (4.2) Frequency distribution of gender

Table (4.3) descriptive statistic for age and measurement (min, max, mean± Std. Deviation)

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	101	7.0	95.0	43.525	20.3104
Length	101	5.4	13.7	8.915	1.6557
Width	101	4	11	6.80	1.428
Valid N (listwise)	101				

Table (4.4) compare mean measurement in different age

Age		Width	Length
7-17	Mean	8.657	6.529
	Std. Deviation	2.3501	1.1056
18-28	Mean	8.279	6.521
	Std. Deviation	1.4506	.8516
29-39	Mean	8.880	6.750
	Std. Deviation	1.7118	1.5909
40-50	Mean	9.136	7.129
	Std. Deviation	1.7212	1.3436
51-61	Mean	8.433	5.989
	Std. Deviation	1.7685	1.2927
62-72	Mean	9.425	6.920
	Std. Deviation	1.3202	1.5807
73-83	Mean	10.117	8.533
	Std. Deviation	1.4798	1.9623
84-95	Mean	10.500	6.700
Total	Mean	8.915	6.804
	Std. Deviation	1.6557	1.4278
P value		0.147	0.048

Table (4.5) compare mean measurement in different gender

a. Mean

Gender	N	Mean	Std. Deviation	Std. Error Mean
male	41	41.439	19.6126	3.0630
female	60	44.950	20.8159	2.6873
male	41	8.629	1.4622	.2284
female	60	9.110	1.7611	.2274
male	41	6.673	1.2359	.1930
female	60	6.893	1.5491	.2000

a. t-test for comparing mean (independent)

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Age	-.852	99	.396	-3.5110	4.1210	-11.6880	4.6661
	-.862	89.378	.391	-3.5110	4.0747	-11.6069	4.5850
Width	-1.441	99	.153	-.4807	.3337	-1.1429	.1814
	-1.492	95.191	.139	-.4807	.3222	-1.1205	.1590
Length	-.759	99	.449	-.2202	.2899	-.7954	.3551
	-.792	96.545	.430	-.2202	.2779	-.7718	.3315

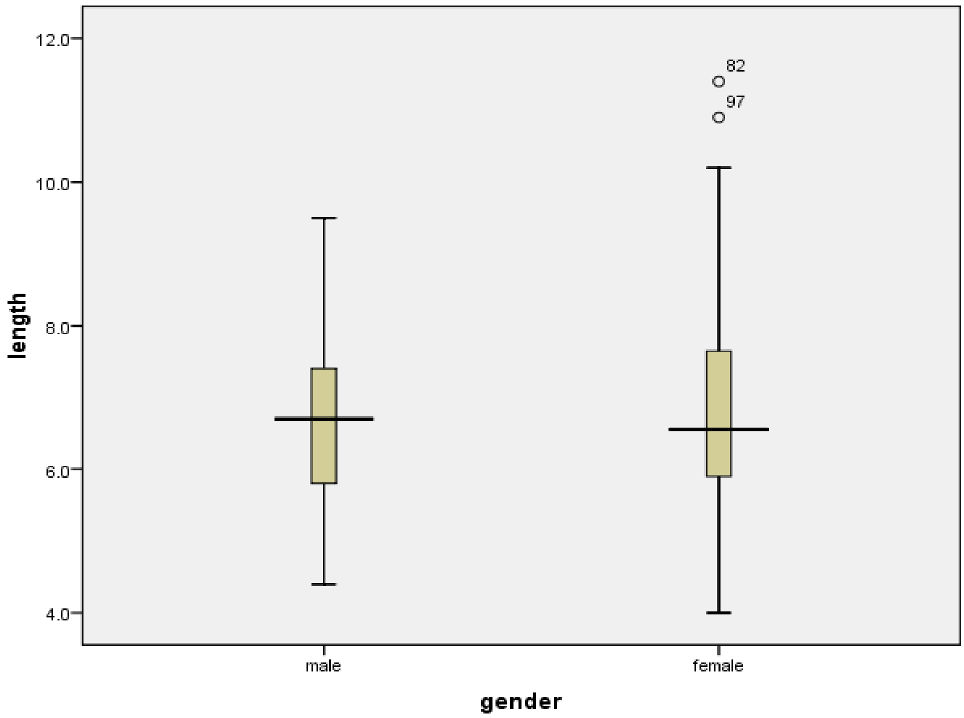

Fig (4.3) plot box shows mean measurement of length in both gender

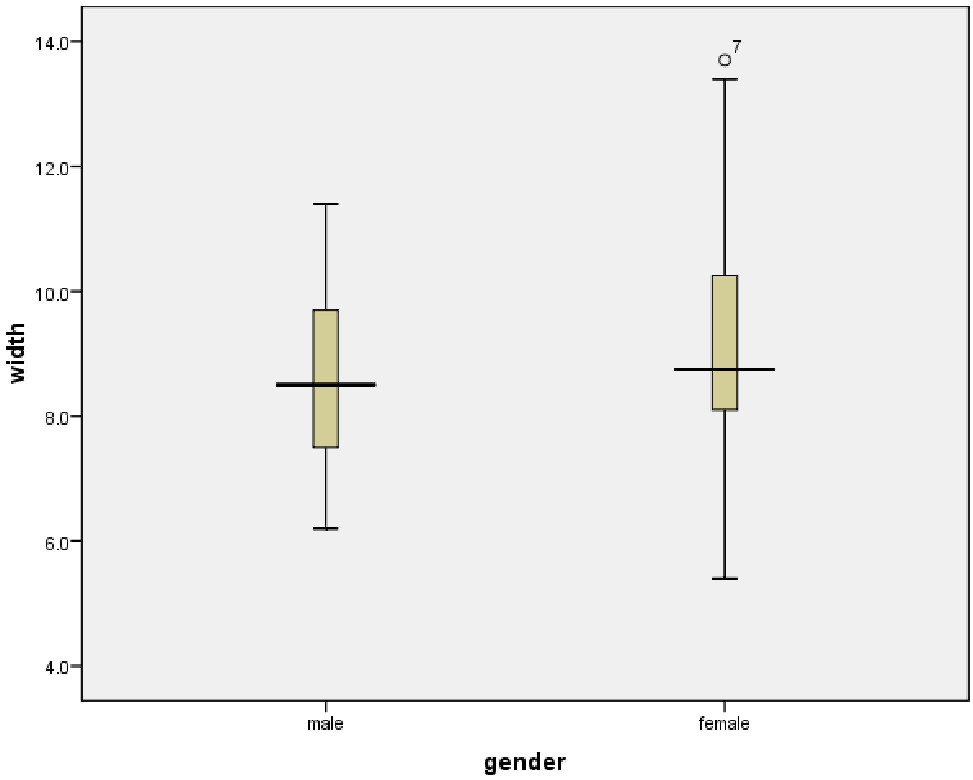

Fig (4.4) plot box shows mean measurement of width in both gender

Table (4.6) correlation between age and measurements

		AGE	Width	Length
Age	Pearson Correlation	1	.283**	.179
	Sig. (2-tailed)		.004	.074
	N	101	101	101
Width	Pearson Correlation	.283**	1	.322**
	Sig. (2-tailed)	.004		.001
	N	101	101	101
Length	Pearson Correlation	.179	.322**	1
	Sig. (2-tailed)	.074	.001	
	N	101	101	101
**. Correlation is significant at the 0.01 level (2-tailed).				

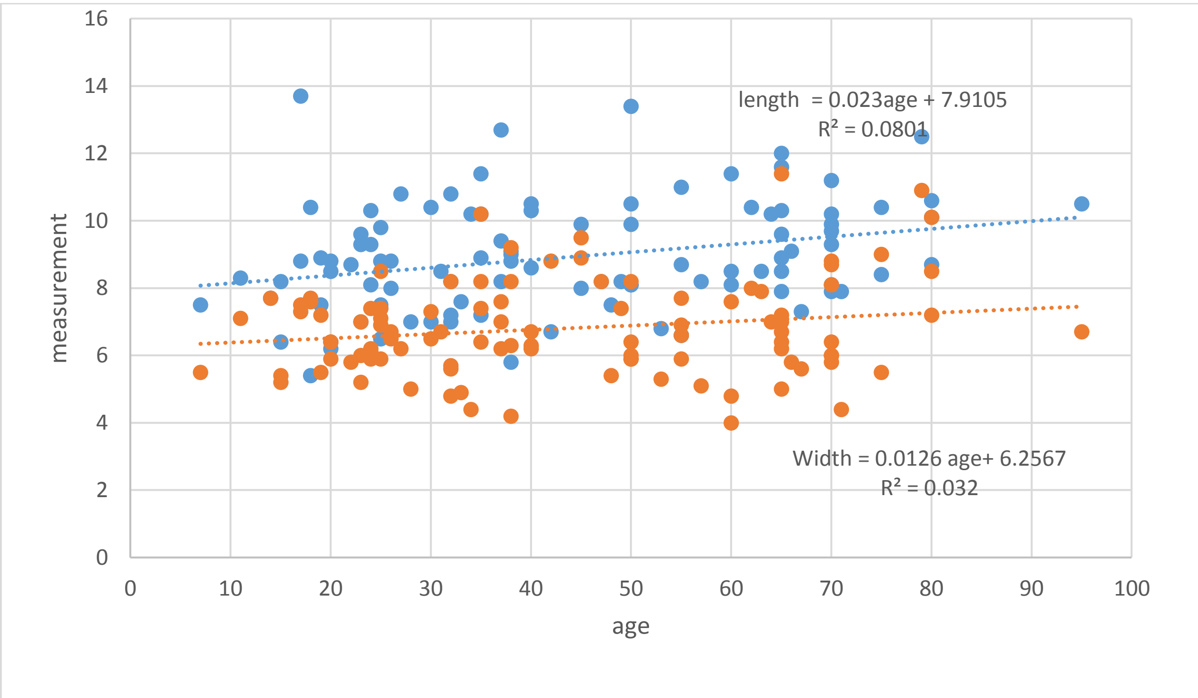

Fig (4.5) scatter plot shows relationship between age and measurements

Chapter five

Discussion, conclusion and recommendations

5.1 Discussion

The study was interesting to evaluate the pituitary dimension in normal Sudanese people in different age use magnetic resonance imaging.

The study had done over both gender male and female with percentage (40.6%, 59.4%) respectively. table (4.1). with mean age of 43.52±20.3 year .table (4.3).their age were classified with an interval 10 of year as descriptive graph showed in figure (4.2).

The variables were the mean of length measured (8.91 mm ± 1.7mm), the width measured (6.80mm ±1.4m). Table (4.3). These were the standard measures of Sudanese normal pituitary found by this study.

Also this study had explained:

There is no significant between age and measurement of length of the pituitary, more than 0.01 significant level. And there is a weak positive correlation between them. Table (4.6).

There is significant between age and measurement of width of the pituitary, more than 0.01 significant level. And there is a weak positive correlation between them. Table (4.6).

In general measurement of the mean of the width of the pituitary according to the age increased with age. Table (4.4).

In general measurement of the mean of the length of the pituitary according to the age increased in age 7- 40 and 70 - 80 but decrease in middle age 40 -70 .table (4.4).This result was similar to the study done by **Muhammad F (2008)** said 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) and decreased gradually thereafter.

This result was not similar to the studies done by **C.Cem DENK (1999)** who said the pituitary gland gradually increased from the age of 11 to 20 years and gradually decreased after 21 years in both sexes, then increased at the age of 51-60. And also **Suzuki M (1990)** said the minimum mean observed in the age of 0_9 and the maximum mean in age 10_19 the height gradually decreased with increasing age after age 20 years.

In general measurement of the mean of the width and length of the pituitary more in females than in male's .table (4.5), this result were similar to the studies by **C.Cem DENK et al (2020)**

5.2 Conclusion

1. There is no significant between age and measurement of length of the pituitary. And there is a weak positive correlation between them.

2. There is significant between age and measurement of width of the pituitary. And there is a weak positive correlation between them.

3. Increased measurement of pituitary gland width with age

4. Increased measurement of pituitary gland length with age 7 to 40 years and from 70 to 80 years but decreased in middle age 40 to 70.

5. Measurement of the pituitary gland width and length more in females than in males.

6. MRI is considered as excellent method to determine normal pituitary gland dimension.

7. A thorough knowledge of the normal anatomy of the pituitary gland and the anomalies that affect it are important for interpreting radiographs, as it improves the quality of the results and allows development of a new diagnostic criterion.

5.3 Recommendation

1. Further studies of the normal Pituitary gland in specific age groups using Dynamic pituitary MRI protocol is recommended.

2. Further studies of the Pituitary gland size and shape is recommended.

3. Further study use compared between CT and MRI to assessment of Pituitary gland anatomy in the Sella Tercica is recommended.

4. Further studies of the Pituitary gland dimensions with increase number of samples size in different Sudanese tribe using MRI is recommended.

5. Further studies of the normal Pituitary gland using Volumetric MRI is recommended.

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Appendices

Appendix (A)

Data collection sheet

No	Gender	Age	Width	Length