بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduates Studies

Estimation of reference value of Thyroid Uptake and its Correlation to Thyroid Function Test in Sudanese

تقدير القيمة المرجعية لأمتصاص الغدة الدرقية وارتباطها بوظيفة الغدة الدرقية لدي السودانيين

A Thesis Submitted in partial fulfillment of the requirement for the M.Sc. Degree in nuclear medicine technology

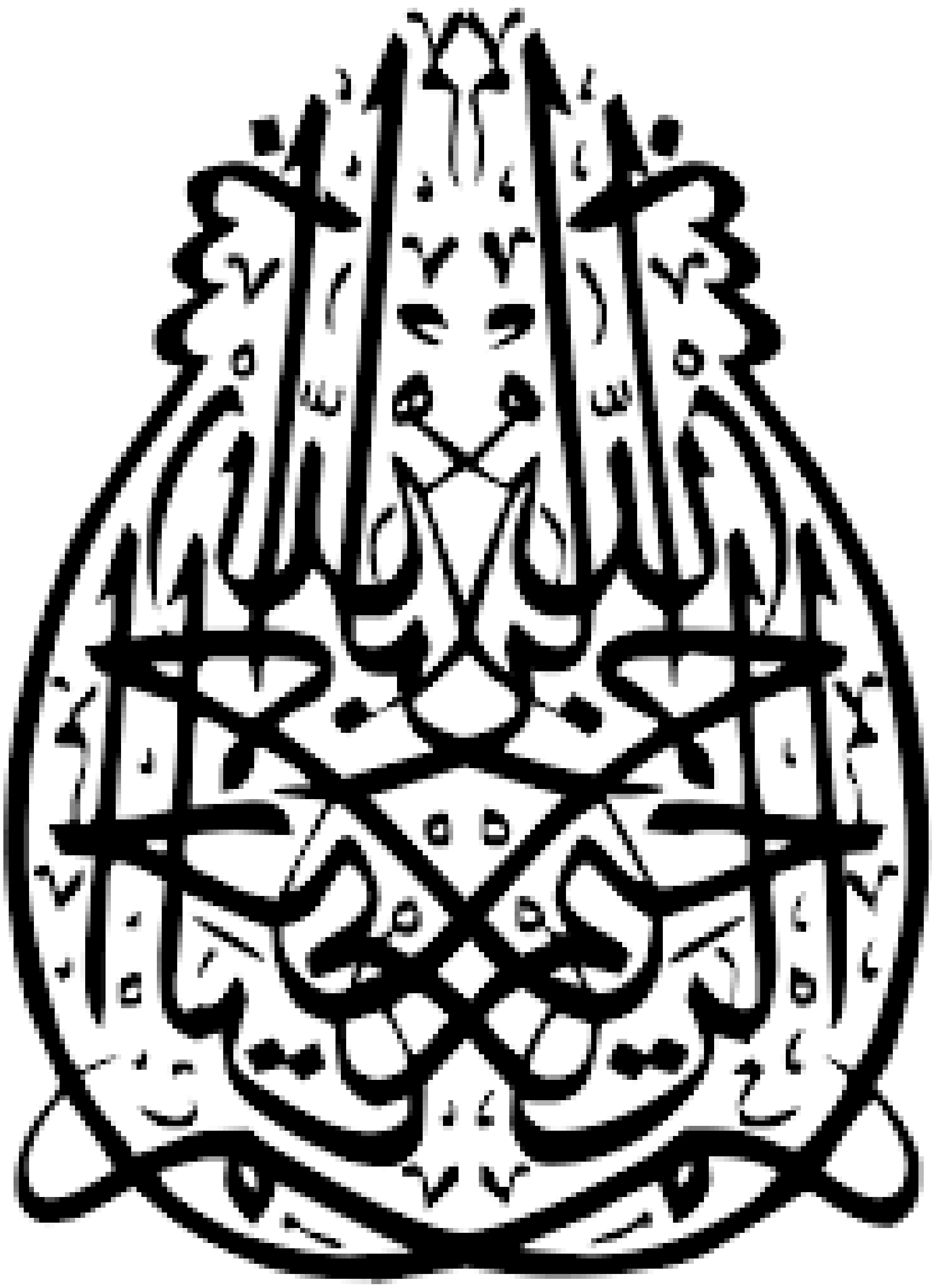
By:

Sarah Rahamtallah Gadeen Medani

Supervisor:

Prof . Mohammed Alfadil Mohammed Jaralnabi

March - 2021



الآيـة

بسم الله الرحمن الرحيم

(قُل لَّئِنِ اجْتَمَعَتِ الْإِنسُ وَالْجِنُّ عَلَىٰ أَن يَأْتُوا بِمِثْلِ هَٰذَا الْقُرْآنِ لَا يَأْتُونَ بِمِثْلِهِ وَلَوْ كَانَ بَعْضُهُمْ لِبَعْضٍ ظَهِيرًا)

{ سورة الاسراء: الآية 88}

صدق الله العظيم

DEDICATION

I dedicate this thesis to my parents for their endless love, support and encouragement. And especially my mother for her greet effort to make me always on the top.

ACKNOWLEDGMENTS

First and foremost, I have to thank my parents for their love and support throughout my life. Thank you both for giving me strength to reach for the stars and chase my dreams. My lovely sister deserves my wholehearted thanks as well for her continuous support.

I would like to sincerely thank my supervisor prf. Mohammed alfadil Mohammed , for his guidance and support throughout this study and especially for his continuous collaboration and trusting in me.

ABSTRACT

The aim of this study is to describe the thyroid uptake in Sudanese population by scintigraphy and to correlate this uptake with their clinical results of Thyroid Function Test (TFT). Thyroid uptake and their TFT clinical results were recorded in a sample of 99 patients and presented with clinically suspected thyroid gland diseases given the presence of anxiety, irritability, nervousness, trouble sleeping, losing weight and an enlarged thyroid gland symptom. The average thyroid uptake was (11.07 ± 2.8) for the total dataset; it was higher in hyperthyroidism (19.68 ± 5.27) than in normal (1.924 ± 0.61). In the statistical analysis, thyroid uptake was correlated with all TFT measures, it was found that T3, T4 have a positive correlation with the uptake while TSH has a negative correlation with it. A predictive model for uptake values inspection was created using multiple linear regression. Therefore, a specific reference values of thyroid uptake as a function of clinical TFT results in Sudanese population, could be used for evaluating thyroid uptake in clinical practice.

المستخلص

هذه دراسه تحليلة وصفيه الهدف منها هو وصف امتصاص الغدة الدرقية لدي السكان السودانين عن طريق التصوير الوميضي وربط هذا الامتصاص بالنتائج السريرية لاختبار وظائف الغدة الدرقية. تم تسجيل امتصاص الغدة الدرقية ونتائجها السريرية في عينة من 99 مريضاً وتم تقديمهم مع امراض الغدة الدرقية المشتبه بها سريريا نظرا لوجود القلق والتهيج والعصبية وصعوبة النوم وفقدان الوزن وتضخم واضح في الغدة الدرقية . كان متوسط امتصاص الغدة الدرقية (11.07 ± 2.8) لاجمالي مجموعة البيانات .

كان اعلي فرط في نشاط الغدة الدرقية (19.68 ± 5.27) من المعدل الطبيعي (0.61 ± 1.924) .في التحليل الاحصائي ارتبط امتصاص بجميع مقاييس وظائف الغدة الدرقية , ووجد ان ثلاثي الايوديين الثايروكسين لهما علاقة ايجابية مع الامتصاص بينما TSH له علاقة عكسية معه . تم انشاء نموذج تنبؤي لفحص قيم الامتصاص باستخدام الانحدار الخطي المتعدد . لذلك يمكن استخدام قيم مرجعية محددة لامتصاص الغدة الدرقية كدالة لنتائج TFTالسريرية في السكان السودانيين ,لتقييم امتصاص الغدة الدرقية في الممارسة العملية السريرية .

ABBREVIATIONS

Abb	Name
RICK	Radiation & Isotope Center Khartoum
TFT	Thyroid Function Test
T3	Tri iodothyronine
T4	Thyroxin
TSH	Thyroid stimulating Hormone
RIA	Radio Active Iodine
NM	Nuclear medicine
TG	Thymoglobulin
TPO	Thyroid Peroxides
GD	Graves' Disease
PTU	Propylene Thiouracil
TU	Thyroid Uptake
BG	Back Ground
SPECT	Single Photon Emission Computer tomography
ROI	Region of Interest

Contents

List of Figures

List of Tables

CHAPTER ONE

CHAPTER ONE

INTRODUCTION

1.1 Introduction:

Thyroid gland is one of the important glands in human bodies that by playing great role in hormone function by producing thyroxin and tri-iodothyronin (T3 & T4).

The iodine trapping by thyroid is known in the nuclear medicine investigation by Thyroid Uptake (Brucer, 1989). Concerning the high incidence of thyroid disease, the normal range for thyroid hormones level and thyroid uptake have not been established yet for the Sudanese population.

Estimation of the thyroid gland volume is generally considered to be an important in several pathologic situations such as iodine deficiency, Goiter, thyroiditis, multinodular goiter and others (Zimmermann et al., 2001).

The thyroid gland function depends on the presence of iodine content in the blood, which is a form of minerals and like other chemicals content of the soil is affected by the climate and location. The main supply of the iodine for the thyroid gland is the food (fish as main) and water which is ultimately depend on the iodine content of the soil and water as the soil component and composition vary from area to another (Brucer, 1989).

Nowadays thyroid disorder is one of the most common health problems all over the world; about 200 million people in the world have some form of thyroid disease, thus the accurate and rapid diagnosis and treatment of thyroid diseases is a critical issue depending on the efficiency and rapidity of tools been used to conduct the diagnosis of thyroid disorders.

Radioimmunoassay, enzyme linked immunosorbent assay (ELISA) and imunoradiometric assay (IRMA) constitute the main tools for biochemical evaluation of thyroid functions. Thyroid radioactive $^{99m}TcO_4$ uptake study is a simple and cost-effective method to investigate thyroid function and retains a confirmatory and clarifying status when the results of other tests are ambiguous or contradictory. $^{99m}TcO_4$ uptake by thyroid is also performed for calculation of therapeutic dose of iodine-131 in thyrotoxicosis. This study is trying to find out the correlation between thyroid uptake of $^{99m}TcO_4$ and thyroid hormone levels obtained by radioimmunoassay (RIA) (John 2003).

1.2 Problem of the study:

There is no thyroid uptake references value for Sudanese population hence the a thinity and life style differences may effect on this value.

1.3 Research Objectives:

1.3.1 General objectives:

The main objective of this research is to standardize a simple and fast methodology for performing Thyroid Uptake and to determine the normal values for 99mTc-pertechnetate uptake in Sudanese.

1.3.2 Specific objectives:

- To determine the normal range of the thyroid uptake & Area
- To measure the thyroid Area, right lobe and left lobe Area for patients with homogenous distribution of radiotracer & normal thyroid function test (T.F.T)
- To correlate between the thyroid uptake to age, gender, body mass index (MBI) and thyroid area

- To correlate between the thyroid area to age and weight.

1.4 Significance of the study:

This study will determine how much the thyroid uptake and function are correlated to each other, reflecting the sensitivity of the thyroid uptake scan to indicate the levels of thyroid hormones in patient's blood. This will make thyroid studies more accurate and reliable.

1.5 Thesis Outlines

This study falls into five chapters, Chapter one which is an introduction, It presents the statement of the study problems, objectives and the overview of the study. Chapter two contains the background material. Specifically, it discusses the anatomy and physiology as well as pathology of the thyroid gland. This chapter also includes a summary of previous work performed in this field. Chapter three describes the materials and a method used. Chapter four deals with the results and finally chapter five shows the discussion, conclusion and recommendations and references list.

CHAPTER TWO

Chapter Two

Literature Review

2.1 Theoretical Background:

2.1.1 Anatomy of the thyroid gland:

The Thyroid gland is one of the important glands in human bodies that by playing great role in hormone function by producing thyroxin (T3) and tri-iodothyronin (T4). It is the largest of the endocrine glands (20-25 g). In humans, it has a "butterfly" shape, with two lateral lobes that are connected by a narrow section called the isthmus. It is located in the neck just below your Adam's apple, in close approximation to the first part of the trachea. Most animals, however, have two separate glands on either side of the trachea. Thyroid glands are brownish-red in color.

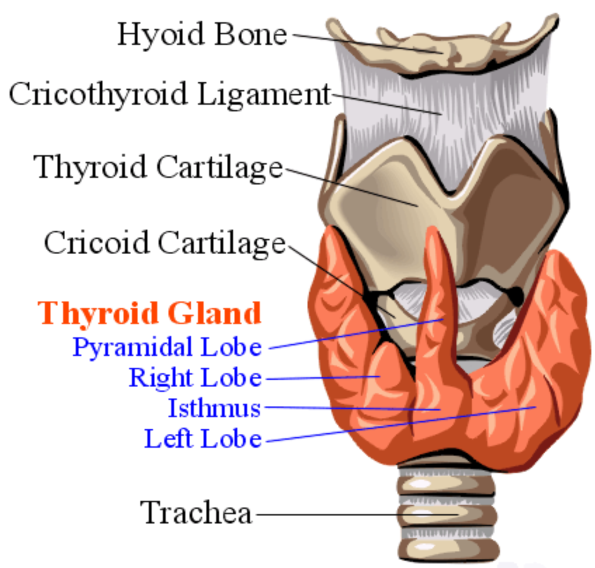


Figure 2.1: Human Thyroid

2.1.2 Anatomical Variations

Hypoglossal Duct Cyst Hypoglossal duct fails to involute completely.

A thyroid Absence of Thyroid gland:

1. Pyramidal Lobe

2. Absence of Isthmus

3. Ectopic Gland

The average gland is 40 to 60 mm in length and 13 to 18 mm thick with the isthmus approximately 4 to 6 mm thick. A pyramidal lobe is present in 10% to 40% of it is a finger-like lobe of tissue which extends superiorly from the isthmus and is of variable height. The normal thyroid gland has a wide range of sizes. Normal variations in size occur with age, gender and nutrition: the gland is larger in youth, the well-nourished and in women - especially during menstruation and pregnancy.

2.1.3Thyroid tissue:

The microscopic structure of the thyroid is quite distinctive. Thyroid epithelial cells - the cells responsible for synthesis of thyroid hormones - are arranged in spheres called thyroid follicles. Follicles are filled with colloid, a proteinaceous depot of thyroid hormone precursor.

In addition to thyroid epithelial cells, the thyroid gland houses one other important endocrine cell. Nestled in spaces between thyroid follicles are Para follicular or C cells, which secrete the hormone calcitonin. The structure of a parathyroid gland is distinctly different from a thyroid gland. The cells that synthesize and secrete parathyroid hormone are arranged in rather dense cords or nests around abundant capillaries. (Chwajink, 1995)

2.2 Physiology of the thyroid gland:

The thyroid gland located immediately below the larynx on each lobe of and anterior to the trachea, is one of the largest endocrine glands, normally weighting 15 to 20 grams in adults. The thyroid secrete two major hormones, thyroxin and tri iodothyroxine, commonly called T4 and T 3, respectively (Stathatos, 2012).both of these hormones profoundly increase the metabolic rate of the body. complete lack of thyroid secretion usually causes the basic metabolic rate to fall 40 to 50 per cent below normal, and extreme excesses of thyroid secretion can increase the basal metabolic rate to 60 to 100 per cent above normal. Thyroid secretion is controlled primarily by thyroid -stimulating hormone (TSH) secreted by the anterior thyroid pituitary gland. The thyroid gland also secretes calcitonin, an important hormone for calcium metabolism (Stathatos, 2012).

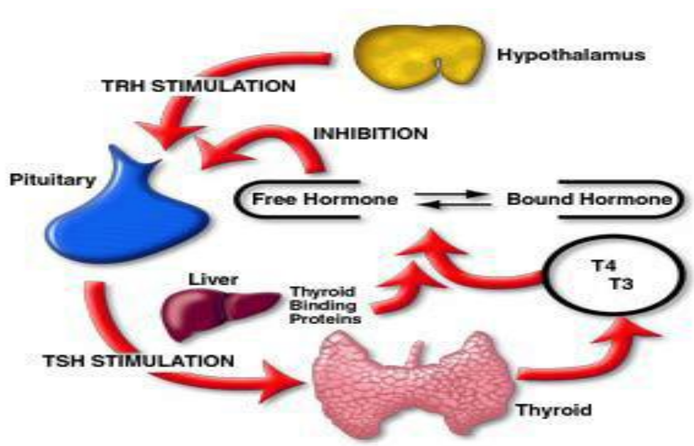


Figure 2.2 Thyroid Function

Synthesis and Secretion of the Thyroid Metabolic Hormone About 93 percent of the metabolically active hormones secreted by the thyroid gland is thyroxin, and 7 percent triiodothyroxine. However, almost all the thyroxin is eventually converted to triiodothyronine in the tissue, so that both are functionally important.

The functions of these two hormones are qualitatively the same, but they differ in rapidity and intensity of action. Triode threonine is about four times as potent as thyroxin, but it’s present in the blood in much smaller quantities and persists for much shorter time than thyroxin (Moleti et al., 2014).

Iodide Trapping is the first stage in the formation of thyroid hormone, it transport of iodides from the blood into the thyroid glandular cells and follicles. The basal membrane of the thyroid cell has the specific ability to pump the iodide actively to the anterior of the cell. This is called iodide trapping. In normal gland, the iodide pump concentrates the iodide to about 30 times its concentration in the blood. When the thyroid gland becomes maximally active, this concentration ratio can rise to as high as 250 times. The rate of iodide trapping by the thyroid is influenced by several factors, the most important being the concentration of TSH (Moleti et al., 2014).

Oxidation of the iodide ion is the first essential step in the formation of the thyroid hormone is conversion of the iodide ions to oxidized form iodine, either nascent iodine (10) or (13). That is then capable of combining directly with the amino acid tryosine. This oxidation of iodine is promoted by the enzyme peroxidase and its accompanying hydrogen peroxide, which provide potent system capable of oxidizing iodides. The peroxidase is either located in the apical membrane of the cell or attached to it, thus providing the oxidized iodine at exactly the point in the cell where the thyroglobulin molecule issues forth from the Golgi apparatus and through the cell membrane into the stored thyroid gland colloid (Moleti et al., 2014).

The binding of iodine with the thyroglobulin molecule is called organification of the thyrogloulin. Oxidized iodine even in the molecular form will bind directly but very slowly with the amino acid tyrosine. In the thyroid cell, however, the oxidized iodine is associated with an iodinase (Moleti et al., 2014).

Enzyme the process to occur within seconds or minute. Therefore, almost as rapidly as the thyroglobulin molecule is released from the golgi apparatus or as it is secreted through the apical cell membrane into the follicle, iodine binds with about one sixth of the tyrosine amino acids within the thyroglobulin molecule, the stage of iodination of tyrosine and final formation of the two important thyroid hormones, thyroxine and triiodothyronine (Mariotti and Beck-Peccoz, 2000).

Release of thyroxine and triiodothyronine from the thyroid Gland: Throglobulin itself is not released into the circulating blood in measurable amounts, instead, thyroxine and triiodothyronine must first be cleaved from the thyroglobulin molecule, and then these free hormones are released.

Daily Rate of Secretion of Thyroxine and Triiodothyronine about 93 per cent of thyroid hormone released from the thyroid gland is normally thyroxine and only 7 percent is triiodothyronine, about 35 micrograms of triiodothyronine per day.

The general effect of thyroid hormone is to activate nuclear transcription of large numbers of genes therefore, in virtually all cells of the body, great numbers of protein enzymes, the new result is generalized increase in functional activity throughout the body (Mariotti and Beck-Peccoz, 2000).

Thyroid hormones increase the number and activity of Mitochondria, when thyroxine or triiodothyronine is given to an animal, the mitochondria in most cells of the animals body increase in size as well as number. Furthermore, the total membrane surface area of the mitochondria increases almost directly in proportion of the increased metabolic rate of the whole animal. Therefore, one the principal functions of the thyroxine might be increases the rate of formation of adenosine triphosphate (ATP) to energize cellular function. However, the increase in the number and activity of the cell as well as the cause of the increase (Mariotti and Beck-Peccoz, 2000).

2.3 Thyroid Problems:

The suboptimum level of thyroid dysfunction could lead to some diseases or other pathological states in the human bodies such as (hyperthyroidism, hypothyroidism, thyrotoxicosis, thyroiditis ….. etc) (Brucer, 1989).

The thyroid gland is prone to several very distinct problems, some of which are extremely common. These problems can be broken down into:

• Those concerning the production of hormone (too much, or too little).

• Those due to increased growth of the thyroid causing compression of

important neck structures or simply appearing as a mass in the neck.

• The formation of nodules or lumps within the thyroid which are worrisome for the presence of thyroid cancer and Those which are cancerous.

2.4 Pathology of the thyroid:

2.4.1 Goiter:

Any form of thyroid enlargement is called a goiter. The increase in volume is gradual and may be associated with normal thyroid function (euthyroid), decreased function (hypothyroidism) or increased hormonal production (hyperthyroidism). Euthyroid goiter is the most common and iodine deficiency is usually the cause (Cignini et al., 2012).

2.4.2 Nodules:

Many thyroid diseases can present with one or more thyroid nodules. Benign thyroid nodules outnumber malignant thyroid nodules approximately 500 to 1.

2.4.2.1 Solitary thyroid nodules:

There are several characteristics of solitary nodules of the thyroid which make them suspicious for malignancy. Although as many as 50% of the population will have a nodule somewhere in their thyroid, the overwhelming majority of these are benign. Occasionally, thyroid nodules can take on characteristics of malignancy and require either a needle biopsy or surgical excision.

2.4.3 Diffuse Colloid (Simple) Goiter:

Zones of glandular hyperplasia result in dilated follicles filled with colloid. These dilated follicles appear as cold nodules. They can undergo hemorrhage and necrosis. Colloid nodules are the most common type of thyroid nodule but thyroid function is normal.

Sonographic ally ; the gland is symmetrically enlarged with normal echogenicity.

2.4.4 Adenomatous or Multinodular Goiters (MNG):

Sometimes hyperplasia and dilatation of follicles with colloid does not affect the thyroid uniformly and results in a multinodular goiter. Thyroid function is usually normal. The patient presents with an enlarged gland and pressure symptoms related to the trachea and esophagus. Multiple cold nodules are demonstrated on NM scans. MNG’s can grow to enormous sizes and are often asymmetrical due to nodule masses of various sizes (Cignini et al., 2012).

2.4.5 Hyperthyrodism:

Hyperthyroidism means too much thyroid hormone. Current methods used for treating a hyperthyroid patient are radioactive iodine, anti-thyroid drugs, or surgery. Each method has advantages and disadvantages and is selected for individual patients. Many times the situation will suggest that all three methods are appropriate, while other circumstances will dictate a single best therapeutic option. Surgery is the least common treatment selected for hyperthyroidism. There are different causes of hyperthyroidism but the most common underlying cause of hyperthyroidism is Graves' disease.

There are actually three distinct parts of Graves' disease:

● Over activity of the thyroid gland (hyperthyroidism)

● Inflammation of the tissues around the eyes causing swelling, and

● Thickening of the skin over the lower legs (pretibial myxedema)

2.4.5.1 Characteristics of Graves' Disease:

Graves' Disease effects women much more often than men (about 8.1 ratio, thus 8 women get Graves' Disease for every man that gets it. Graves' Disease is often called diffuse toxic goiter because the entire thyroid gland is enlarged, usually moderately enlarged, and sometimes quite big. Graves' Disease is uncommon over the age of 50 (more common in the 30's and 40's). Graves' Disease tends to run in families.

2.4.6 Hypothyrodism:

Hypothyroidism means too little thyroid hormone and is a common problem. In fact, hypothyroidism is often present for a number of years before it is recognized and treated. There are two fairly common causes of hypothyroidism:

The first is a result of previous (or currently ongoing) inflammation of the thyroid gland which leaves a large percentage of the cells of the thyroid damaged (or dead) and incapable of producing sufficient hormone. The most common cause of thyroid gland failure is called autoimmune thyroiditis (also called Hashimoto's thyroiditis), a form of thyroid inflammation caused by the patient's own immune system.

The second major cause is the broad category of medical treatments.

Hypothyroidism can even be associated with pregnancy. Treatment for all types of hypothyroidism is usually straightforward.

2.4.6.1 Symptoms of Hypothyroidism:

They are many symptoms of hypothyroidism: Fatigue, weakness, weight gain or increased difficulty losing weight, coarse, dry hair, dry, rough pale skin, hair loss, cold intolearance (can't tolerate the cold like those around you), muscle cramps and frequent muscle eaches, constipation, depression, irritability, memory loss, abnormal menstrual cycles and decreased libido.

2.4.6.2 Potential dangers of hypothyroidism:

Because the body is expecting a certain amount of thyroid hormone the pituitary will make additional thyroid stimulating hormone (TSH) in an attempt to entice the thyroid to produce more hormones. This constant bombardment with high levels of TSH may cause the thyroid gland to become enlarged and form a goiter (termed as "compensatory goiter"). The symptoms of hypothyroidism will usually progress. Rarely, complications can result in severe life-threatening depression, heart failure or coma.

2.4.7 Thyroiditis:

Thyroiditis is an inflammatory process ongoing within the thyroid gland. Thyroiditis can present with a number of symptoms such as fever and pain, but it can also present as subtle findings of hypo or hyper-thyroidism. There are a number of causes, some more common than others. Thyroiditis is an inflammation (not an infection) of the thyroid gland. Several types of thyroiditis exits and the treatment is different for each.

2.4.7.1 Hashimoto's thyroiditis:

Hashimoto's Thyroiditis (also called autoimmune or chronic lymphocytic thyroiditis) is the most common type of thyroiditis. It is named after the Japanese physician, Hakaru Hashimoto that first described it in 1912. The thyroid gland is always enlarged, although only one side may be enlarged enough to feel. During the course of this disease, the cells of the thyroid becomes inefficient in converting iodine into thyroid hormone and "compensates" by enlarging the radioactive iodine uptake may be paradoxically high while the patient is hypothyroid because the gland retains the ability to take-up or "trap" iodine even after it has lost its ability to produce thyroid hormone. As the disease progresses, the TSH increases since the pituitary is trying to induce the thyroid to make more hormone, the T4 falls since the thyroid can't make it, and the patient becomes hypothyroid. The sequence of events can occur over a relatively short span of a few weeks or may take several years.

It is more common in young and middle aged women. NM studies show little or no uptake of isotope.

2.4.7.2 Silent Thyroiditis:

Silent thyroiditis is the third and least common type of thyroiditis. It was not recognized until the 1970's although it probably existed and was treated as Graves' disease before that. This type of thyroiditis resembles in part Hashimoto's Thyroiditis and in part De Quatrain's Thyroiditis. The blood thyroid test are high and the radioactive iodine uptake is low (like De Quatrain's Thyroiditis), but there is no pain and needle biopsy resembles Hashimoto's Thyroiditis. The majority of patients have been young women following pregnancy. The disease usually needs no treatment and 80% of patients show complete recovery and return of thee thyroid gland to normal after three months. Symptoms are similar to Graves' Disease except milder. The thyroid gland is only slightly enlarged and expophthalamoses' (development of "bug eyes") does not occur. Treatment is usually bed rest with beta blockers to control palpitations (drugs to prevent rapid heart rates).

Radioactive iodine, surgery, or anti thyroid medication is never needed. A few patients have become permanently hypothyroid and needed to be placed on thyroid hormone (Chwajink, 1995).

2.4.8 Thyroid cancer:

Thyroid cancer is a fairly common malignancy; however, the vast majorities have excellent long term survival.

2.5 Thyroid function tests

2.5.1 Definition:

Thyroid function tests are blood tests used to evaluate how effectively the thyroid gland is working . The thyroid gland function depend on the presence of iodine content Is the most popular test .Because thyroid is the only organ in the body that takes up and uses iodine These tests include the thyroid-stimulating hormone test

(TSH), the thyroxine test (T4), the triiodothyronine test (T3), the thyroxine-binding globulin test (TBG), the triiodothyronine resin uptake test (T3RU), and the longacting thyroid stimulator test (LATS).

2.5.2 Purpose:

Thyroid function tests are used to:

• help in diagnose an underactive thyroid(hypothyroidism) and an overactive thyroid (hyperthyroidism).

• evaluate thyroid gland activity

• monitor response to thyroid therapy

2.5.3 Precautions

• Thyroid treatment must be stopped one month before blood is drawn for a thyroxine (T4) test.

• Steroids, propranolol (Inderal), cholestyramine (Questran), and other medications that may influence thyroid activity are usually stopped before a triiodothyronine (T3) test.

• Estrogens, anabolic steroids, phenytoin, and thyroid medications may be discontinued prior to a thyroxine-binding globulin (TBG) test. The laboratory analyzing the blood sample must be told if the patient cannot stop taking any of these medications. Some patients will be told to take these medications as usual so that the doctor can determine how they affect thyroxine-binding globulin.

• Patients are asked not to take estrogens, androgens, phenytoin (Dilantin), salicylates, and thyroid medications before having a triiodothyronine resin uptake (T3RU) test.

• Prior to taking a long-acting thyroid stimulant (LATS) test, the patient will probably be told to stop taking all drugs that could affect test results.

2.6 Other test used to diagnose thyroid gland:

2.6.1 Measurement of Serum Thyroid Hormones T4 by RIA: T4 by RIA (radioimmunoassay)

is the most used thyroid test of all. It is frequently referred to as a T7 which means that a resin T3 uptake (RT3u) has been done to correct for certain medications such as birth control pills, other hormones, seizure medication, cardiac drugs, or even aspirin that may alter the routine T4 test. The T4 reflects the amount of thyroxin in the blood. If the patient does not take any type of thyroid medication, this test is usually a good measure of thyroid function.

2.6.2 Measurement of Serum Thyroid Hormones T3 by RIA:

As stated on our thyroid hormone production page, thyroxin (T4) represents 80% of the thyroid hormone produced by the normal gland and generally represents the overall function of the gland. The other 20% is triiodothyronine measured as T3 by RIA. Sometimes the diseased thyroid gland will start producing very high levels of T3 but still produce normal levels of T4. Therefore, measurement of both hormones provides an even more accurate evaluation of thyroid function

2.6.3 Thyroid Binding Globulin:

Most of the thyroid hormones in the blood are attached to a protein called thyroid binding globulin (TBG). If there is an excess or deficiency of this protein it alters the T4 or T3 measurement but does not affect the action of the hormone. If a patient appears to have normal thyroid function, but an unexplained high or low T4, or T3, it may be due to an increase or decrease of TBG. Direct measurement of

TBG can be done and will explain the abnormal value. Excess TBG or low levels of TBG are found in some families as in hereditary trait. It causes no problem except falsely elevating or lowering the T4 level. These people are frequently misdiagnosed as being hyperthyroid or hypothyroid, but they have no thyroid problem and need no treatment.

2.6.4 Measurement of Pituitary Production of TSH:

Pituitary production of TSH is measured by a method referred to as IRMA (immunoradiometric assay). Normally, low levels (less than 5 units) of TSH are sufficient to keep the normal thyroid gland functioning properly. when the thyroid gland becomes inefficient such as in early hypothyroidism, the TSH becomes elevated even though the T4 and T3 may still be within the "normal" range. This rise in TSH represents the pituitary gland's response to a drop in circulating thyroid hormone; it is usually the first indication of thyroid gland failure. Since TSH is normally low when the thyroid gland is functioning properly, the failure of TSH to rise when circulating thyroid hormones are low is an indication of impaired pituitary function. The new "sensitive" TSH test will show very low levels of TSH when the thyroid is overactive (as a normal response of the pituitary to try to decrease thyroid stimulation). interpretations of the TSH level depends upon the level of thyroid hormone; therefore, the TSH is usually used in combination with other thyroid tests such as the T4 RIA and T3 RIA.

2.6.4 TRH Test:

In normal people TSH secretion from the pituitary can be increased by giving a shot containing TSH Releasing Hormone (TRH...the hormone released by the hypothalamus which tells the pituitary to produce TSH). A baseline TSH of 5 or less usually goes up to 10-20 after giving an injection of TRH. Patients with too much thyroid hormone (thyroxin or triiodothyronine) will not show a rise in TSH when given TRH. This "TRH test" is presently the most sensitive test in detecting early hyperthyroidism. Patients who show too much response to TRH (TSH rises greater than 40) may be hypothyroid. This test is also used in cancer patients who are taking thyroid replacement to see if they are on sufficient medication. It is sometimes used to measure if the pituitary gland is functioning. The new "sensitive" TSH test (above) has eliminated the necessity of performing a TRH test in most clinical situations.

Table 2.1: shows the normal value of thyroid lab investigation. Test Abbreviation Typical Ranges

Test	**Abbreviation**	**Typical ranges**
free thyroxin fraction	FT4F	0.03-0.005%
Free Thyroxin	FT4	0.7-1.9 ng/dl
Thyroid hormone binding ratio	THBR	0.9-1.1
Free Thyroxin index	FT4I	4-11
Serum Triiodothyronine	T3	80-180 ng/dl
Serum thyroxin	T4	4.6-12 ug/dl
Serum thyrotropin	TSH	0.5-6 uU/ml
Free Triiodothyronine 1	FT3	230-619 pg/d
Free T3 Index	FT3I	80-180
Serum thyroglobulin 1	Tg	0-30 ng/m
Thyroxin-binding globulin	TBG	12-20 ug/dl T4 +1.8 ugm
TRH stimulation test Peak	TSH	9-30 uIU/ml at 20-30 min
Radioactive iodine uptake	RAIU	10-30%

2.6.5 Thyroid Uptake Test:

A means of measuring thyroid function is to measure how much iodine is taken up by the thyroid gland (RAI uptake). Remember, cells of the thyroid normally absorb iodine from our blood stream (obtained from foods we eat) and use it to make thyroid hormone (described on our thyroid function page). Hypothyroid patients usually take up too little iodine and hyperthyroid patients take up too much iodine. The test is performed by giving a dose of radioactive iodine on an empty stomach. The iodine is concentrated in the thyroid gland or excreted in the urine over the next few hours. The amount of iodine that goes into the thyroid gland can be measured by a "Thyroid Uptake". Of course, patients who are taking thyroid medication will not take up as much iodine in their thyroid gland because their own thyroid gland is turned off and is not functioning. At other times the gland will concentrate iodine normally but will be unable to convert the iodine into thyroid hormone; therefore, interpretation of the iodine uptake is usually done in conjunction with blood tests.

2.6.6 Thyroid Scan:

Taking a "picture" of how well the thyroid gland is functioning requires giving a radioisotope to the patient and letting the thyroid gland concentrate the isotope (just like the iodine uptake scan above). Therefore, it is usually done at the same time that the iodine uptake test is performed. Although other isotopes, such as technetium, will be concentrated by the thyroid gland; these isotopes will not measure iodine uptake which is what we really want to know because the production of thyroid hormone is dependent upon absorbing iodine. It has also been found that thyroid nodules that concentrate iodine are rarely cancerous; this is not true if the scan is done with technetium. Therefore, all scans are now done with radioactive iodine. Both of the scans above show normal sized thyroid glands, but the one on the left has a "HOT" nodule in the lower aspect of the right lobe, while the scan on the right has a "COLD" nodule in the lower aspect of the left lobe (outlined in red and yellow).

Pregnant women should not have thyroid scans performed because the iodine can cause development troubles within the baby's thyroid gland .two types of thyroid scans are available. A camera scan is performed most commonly which uses a gamma camera operating in a fixed position viewing the entire thyroid gland at once. This type of scan takes only five to ten minutes. In the 1990's, a new scanner called a Computerized Rectilinear Thyroid (CRT) scanner was introduced. The CRT scanner utilizes computer technology to improve the clarity of thyroid scans and enhance thyroid nodules. It measures both thyroid function and thyroid size. A life-sized 1:1 color scan of the thyroid is obtained giving the size in square centimeters and the weight in grams. The precise size and activity of nodules in relation to the rest of the gland is also measured. CTS of the normal thyroid gland In addition to making thyroid diagnosis more accurate, the CRT scanner improves the results of thyroid biopsy. The accurate sizing of the thyroid gland aids in the follow-up of nodules to see if they are growing or getting smaller in size. Knowing the weight of the thyroid gland allows more accurate radioactive treatment in patients who have Graves' disease. Specifically thyroid Scans are used for the following reasons:

• Identifying Nodules and Determining If They Are "Hot" Or "Cold".

• Measuring the size of the goiter prior to treatment.

• Follow-up of thyroid cancer patients after surgery.

• Locating thyroid tissue outside the neck, i.e. base of the tongue or in the chest.

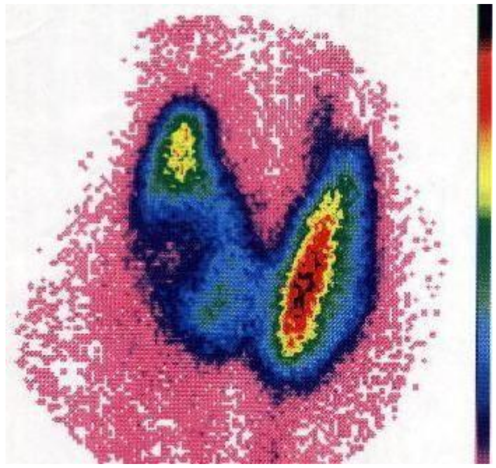


Figure 2-3 Thyroid scan

2.6.7 Thyroid Ultrasound scans:

Thyroid ultrasound refers to the use of high frequency sound waves to obtain an image of the thyroid gland and identify nodules. It tells if a nodule is "solid" or a fluid-filled cyst, but it will not tell if a nodule is benign or malignant. Ultrasound allows accurate measurement of a nodule's size and can determine if a nodule is getting smaller or is growing larger during treatment.

Ultrasound aids in performing thyroid needle biopsy by improving accuracy if the nodule cannot be felt easily on examination.

2.6.8 Thyroid Antibodies:

The body normally produces antibodies to foreign substances such as bacteria; however, some people are found to have antibodies against their own thyroid tissue. A condition known as Hashimoto's Thyroiditis is associated with a high level of these thyroid antibodies in the blood. Whether the antibodies cause the disease or whether the disease causes the antibodies is not known; however, the finding of a high level of thyroid antibodies is strong evidence of this disease. Occasionally, low levels of thyroid antibodies are found with other types of thyroid disease. When Hashimoto's thyroiditis presents as a thyroid nodule rather than a diffuse goiter, the thyroid antibodies may not be present.

2.6.9 Thyroid Needle Biopsy:

This has become the most reliable test to differentiate the "cold" nodule that is cancer from the "cold" nodule that is benign ("hot" nodules are rarely cancerous). It provides information that no other thyroid test will provide. While not perfect, it will provide definitive information in 75% of the nodules biopsied. Thyroid nodules increase with age and are present in almost ten percent of the adult population. Autopsy studies reveal the presence of thyroid nodules in 50 percent of the population, so they are fairly common. Ninety-five percent of solitary thyroid nodules are benign, and therefore, only five percent of thyroid nodules are malignant. Common types of the benign thyroid nodules are adenomas (overgrowths of "normal" thyroid tissue), thyroid cysts, and Hashimoto's thyroiditis. Uncommon types of benign thyroid nodules are due to sub-acute thyroiditis, painless thyroiditis, unilateral lobe agenesis, or Riedel's struma. As noted on previous pages, those few nodules which are cancerous are usually due to the most common types of thyroid cancers which are the differentiated" thyroid cancers. Papillary carcinoma accounts for 60 percent, follicular carcinoma accounts for 12 percent, and the follicular variant of papillary carcinoma accounting for six percent. These well differentiated thyroid cancers are usually curable, but they must be found first. Fine needle biopsy is a safe, effective, and easy way to determine if a nodule is cancerous.

Thyroid cancers typically present as a dominant solitary thyroid nodule which can be felt by the patient or even seen as a lump in the neck by his/her family and friends. This is illustrated in the picture above. As pointed out on our page introducing thyroid nodules, we must differentiate benign nodules from cancerous solitary thyroid nodules. While history, examination by a physician, laboratory tests, ultrasound, and thyroid scans (shown in the picture below) can all provide information regarding a solitary thyroid nodule, the only test which can differentiate benign from cancerous thyroid nodules is a biopsy (the term biopsy means to obtain a sample of the tissue and examine it under the microscope to see if the cells have taken on the characteristics of cancer cells). Thyroid cancer is no different in this situation from all other tissues of the body...the only way to see if something is cancerous is to biopsy it. However, thyroid tissues are easily accessible to needles, so rather than operating to remove a chunk of tissue with a knife, we can stick a very small needle into it and remove cells for microscopic examination. This method of biopsy is called a fine needle aspiration biopsy, or "FNA". Cold nodule: Thyroid cells absorb iodine so they can make thyroid hormone out of it. When radioactive iodine is given, a butterfly image will be obtained on x-ray film showing the outline of the thyroid. If a nodule is composed of cells which do not make thyroid hormone (don't absorb iodine) then it will appear "cold" on the x-ray film. A nodule which is producing too much hormone will show up darker and is called "hot". The evaluation of a solitary thyroid nodule should always include history and examination by a physician. Certain aspects of the history and physical exam will suggest a benign or malignant condition. Remember, a biopsy of some sort is the only way to tell for sure.

2.6.10Thyroid fine needle aspiration (FNA) biopsy:

is the only non-surgical method which can differentiate malignant and benign nodules in most, but not all, cases. The needle is placed into the nodule several times and cells are aspirated into a syringe. The cells are placed on a microscope slide, stained, and examined by a pathologist. The nodule is then classified as no diagnostic, benign, suspicious or malignant.

No diagnostic indicates that there are an insufficient number of thyroid cells in the aspirate and no diagnosis is possible. A no diagnostic aspirate should be repeated, as a diagnostic aspirate will be obtained approximately 50 percent of the time when the aspirate is repeated. Overall, five to 10 percent of biopsies are no diagnostic, and the patient should then undergo either an ultrasound or a thyroid scan for further evaluation.

Benign thyroid aspirations are the most common (as we would suspect since most nodules are benign) and consist of benign follicular epithelium with a variable amount of thyroid hormone protein (colloid).

2.7 Malignant thyroid aspirations can diagnose the following thyroid cancer types:

papillary, follicular variant of papillary, medullary, anaplastic, thyroid lymphoma, and metastases to the thyroid. Follicular carcinoma and Hurthle cell carcinoma cannot be diagnosed by FNA biopsy. This is an important point. Since benign follicular adenomas cannot be differentiated from follicular cancer (~12% of all thyroid cancers) these patients often end up needing a formal surgical biopsy, which usually entails removal of the thyroid lobe which harbors the nodule. Suspicious cytology’s make up approximately 10 percent of FNA's. The thyroid cells on these aspirates are neither clearly benign nor malignant. Twenty-five percent of suspicious lesions are found to be malignant when these patients undergo thyroid surgery. These are usually follicular or Hurthle cell cancers. Therefore, surgery is recommended for the treatment of thyroid nodules from which a suspicious aspiration has been obtained. FNA is the first, and in the vast majority of cases, the only test required for the evaluation of a solitary thyroid nodule. (A TSH value should also be obtained to evaluate thyroid function.) Thyroid ultrasound and thyroid scans are usually not required for evaluation of a solitary thyroid nodule. FNA has reduced the cost for evaluation and treatment of thyroid nodules, and has improved yield of cancer found at thyroid surgery.

Although a solitary thyroid nodule can enlarge or shrink over time, the natural history of solitary nodules reveals that most nodules change little with it.

2.8 Previous studies

-October(2010) Shimaa Hamid Mohammed worked out a method to assess the thyroid abnormalities by using 99mTc and RIA (comparative study) ,and found that there is higher incidence of thyroid abnormalities in females than males 4:1,while 50% of patients their age range from 21-40 with the mean age of 41.8-+15 .the shape of thyroid (i.e. regular and irregular) and homogeneity of radiotracer (i.e. homogenous and in homogenous) has no effects on the T3 ,T4,TSH and uptake between the two of each group . but these quantities were affected by the age factor in a linear fashion; inversely with the TSH and uptake, and directly with T3and T4. As well the thyroid uptake was linearly associated with T3and T4 inversely, while with TSH was directly.

-November (2010) DafallaEltayebHussien worked out a method to assess the thyroid hormones level in thyroid patients by using Radio Immune Assay(RIA) and found that subjects aged between 20-40 years old are the most commonly affected by one of the thyroid abnormalities (hyperthyroidism and hypothyroidism) the subjects of (20-30) years old were approximately referred for investigation 1.5 times as those aged between (20-40) years old .also found that females were approximately four times as the number of males patients referred for thyroid investigation . A further conclusion is that the majority of the thyroid referred subject was complaining of hyperactivity of the thyroid gland.

-(2009) Wadah Mohammed Ali worked out a method to evaluate the relationship between thyroid uptake and thyroid function test (T.F.T) and found that there is strong and significant correlation between thyroid uptake and T3 and T4 but insignificant between the uptake and TSH. The normal range for thyroid uptake in this study was ranged from 5.78 to 6.12%. The linear relationship between thyroid uptake and T3 showed a coefficient equal to 0.65 uptake%/(nmol\L) and a constant equal to 2.6 as shown in the following equation: uptake% = 0.647 T3 + 2.6859.

In case of T4 the coefficient equal to 0.04 uptake%/(nmol\L) with a constant equal to 3.6 as shown by the following equation: uptake% = 0.0365 T4nmol\L + 3.5861. This study indicates that thyroid uptake can be use only to show thyroid disorder because it can give indication about the level of hormones if it low, normal, or elevated

-(2008) Kamal Faisal Yusuf worked out a method to estimate the normal thyroid Uptake by using technisium-99m and found that the uptake of the thyroid gland For patients with normal thyroid function test (T.F.T) and homogenous distribution of the radiotracer in the range of (0.4% to 4.5%). by measuring the thyroid volume in this study for patient that with homogenous distribution of the radiotracer and normal thyroid function test (T.F.T) (mean of normal range of these patients T3 0.8-3.0n mol/L, T4 60-160 n mo/L and TSH 0.7-5.0 mu/L) in RICK.

CHAPTER THREE

Chapter Three

Material and Methods

3.1 Materials:

3.1.1 Machine used:

The material used to collect the data were categorized into, nuclear medicine an instrument which is dual head SPECT and whole-body gamma camera, NUCINE Spirit (DHV), manufactured by MEDISO company Hungary at 2005. Collimator used low energy general purpose (LEGP), window: 20% and the radiopharmaceutical used the Tc-99m injected intravenously, dose: 5mci (185Mbq) (+,- depending on extremes of body weight).

3.1.2 Radiopharmaceutical uses:

Thyroid gland function and structure can be evaluated using uptake and Scintigraphy studies.

Technetium-99m, in the chemical form of pertechnetate (99m TcO4-), is also used for thyroid Scintigraphy and uptake the similarity of volume and charge between the iodide and pertechnetate ions is the explanation for the uptake of 99m Tc-pertechnetate by the thyroid gland. 99mTc-pertechnetate has been used worldwide to study the thyroid function because of a number of advantage, such as a short half-life (6 hours), short retention in the gland, and no ß- radiation, thus providing low dosimetry to the thyroid gland (10,000 times less than that of ^{131}I-iodide) , as well as to the body as a whole. its gamma photon of 140 kev is ideal for imaging using scintillation cameras and in addition it has low cost and is readily available.

There is an international consensus that the radiopharmaceuticals of choice for thyroid gland imaging are 99m Tc-pertechnetate or ^{123}I-iodide. Although the thyroid does not organify 99mTc- pertechnetate, in the majority of cases the uptake and imaging data provide all the information needed for accurate diagnosis.

35

in rare instances, ^{123}I-iodide can subsequently be used for assessment of organification defects.

Despite these recommendations, most nuclear medicine laboratories in Brazil choose the radiopharmaceutical ^{131}I-iodide to study the thyroid gland. This practice can in part be explained by the fact that there is a lack of standard values for 99mTc- pertechnetate uptake by the thyroid gland. This study had the aim of standardizing a simple and fast method for performing thyroid uptake and Scintigraphy and defining the 99mTc- pertechnetate uptake values in normal individual (IAEA, 1995).

3.2 Method:

3.2.1 Design of the study:

This is a descriptive study where the data collected prospectively

3.2.2 Population of the study

Adult Sudanese male and female with normal thyroid that showed no sign of abnormality T.F.T in RICK their age ranged from 13 to 60 years old. The sample of this study were consisted of 58 patients with thyroid problem referred to RICK from different hospitals and private clinics in Sudan. The sample includes different tribes and ethnic groups because RICK is the biggest central hospital in Sudan. All the investigations was done in radiation and isotopes center of Khartoum (RICK) including T.F.T and thyroid uptake in the period from December 2016 to May 2017.

Exclusion criteria: All subjects with anterior neck swelling or if there is any clinical evidence of thyroid disease, high or low uptake, non-homogenous of shape or T.F.T abnormal.

3.2.3 Sample size and type

The sample of this study were consisted of 58 patients (54 female and 4 male) their age ranged from 13 to 60 years old with thyroid problem referred to RICK from different hospitals and private clinics in Sudan. The sample includes different tribes and ethnic groups because RICK is the biggest central hospital in Sudan.

3.2 .4 Method of data collection:

3.2.4.1 Technique and methods of thyroid uptake:

3.2.4.1.1 Patient preparations:

The patient was prepared according to the following points: patient should stop thyroid media, patient also should stop taking any food contain iodine. If the patient is female, will be inspected if she is pregnancy, the patient will return to their physicians. In case of breast feeding, the patient will be asked to stop feeding for a while until the radioactive substance been execrated from the body. The history of the patient should be taking into account, and the clinical condition should be noted. The related study must be available, which is help full in diagnosis.

3.2.4.1.2 Technique of uptake:

Before the injection of the radioactive dose it must be measure accurately in the dose calibrator, and take a 60 seconds image of the full syringe in the gamma camera. Then inject the dose of 5.0 mci of 99mTcO4 – for adult patient. The dose can be minimizing in case of children or low weight patient using different calculation methods. (it is also can be used to maximize the dose in case of high weight patients). After the injection, 60 seconds image for the empty syringe was taken.The patient waits for 15 minutes, for maximum concentration of sodium pertecnetate.

Firstly 330 K. counts image AP was taken in supine position with pillow under the shoulder and chin hyper extended for good visualizations of thyroid gland; this image is used in calculation of thyroid uptake.

If there an enlarged in the thyroid gland marker with point source 99mTc or 57Co will be used in the supra-sternal notch (S.S.N) to determine the extension of the gland.

If there is suspicious of any disorder in the first image, additional images (RAO, LAO) will be done, or by using the marker in the location of abnormality.

Lastly ROI was drawn around full syringe, empty syringe and AP patient image, the computer program will automatically measure the actual activity injected to the patient by subtract the empty activity from the full, after that it can measure the thyroid uptake using special nuclear medicine program.

The method for the calculation of thyroid uptake, based on images of the gland and syringe counts before and after radiopharmaceutical injection, was previously described by simplified for routine use. The number of counts present in the thyroid (T) was determined by an automatic region of interest (ROI) draw around the borders of the gland. Another ROI was drawn by the same process just below the gland for background subtraction (BG). The counts in the syringe before and after radiopharmaceutical injection were obtained directly from the images. All counts were corrected for the acquisition time and decay of technetium-9m. the thyroid uptake (TU) was calculated automatically by subtraction before & after injection of the radioactive isotopes & background of surround tissues according to the software of the machine in a form of percentage. Berman, M (1988).

3.2.4.2 Variable of data collection:

The data in in this study were collected using the following variable: Age, gender, height, weight, BMI, thyroid uptake, thyroid weight, area of lobes measurement; and thyroid area as well as isthmus.

Table 3.1: Simple Example of Master Data Sheet **Age Gender Height Weight BMI Th. Uptake Th. area Th. weight A of Rt. lo A of Lt. lo**

3.2.5 Method of data analysis:

Data will be analyzed by using of Excels Microsoft program, SPSS version 21.0 under windows and Qlik view program, where the mean dimension of each lobe was measured and significant differences between male and female as well as sample was made including the difference between the area of thyroid and BMI. Also correlation and linear relationship between thyroid measurements and body characteristics were investigated.

3.3 Ethical approval:

The study has been approved by college research board and participant were verbally agreed to participate in the study.

CHAPTER FOUR

CHAPTER FOUR
RESULTS AND DISCUSSION

This section describes and discusses the results that obtained from the applying of all the steps which illustrated before on the previous section. The sequence of all steps of the methodology was obviously discussed.

4.1 Results and discussion:

In this retrospective study, a total of 99 patients were examined via Thyroid scintigraphy and presented with clinically suspected thyroid gland diseases given the presence of anxiety, irritability, nervousness, trouble sleeping, losing weight and an enlarged thyroid gland symptom.

The common clinical features detected in these patients that were related to their complains were as follows: i) anxiety (n = 60; 60.6%); ii) nervousness (n = 15; 15.1%); iii) trouble sleeping (n = 70; 69.3%); iv) losing weight (n = 40; 39.6%); and v) an enlarged thyroid gland symptoms (n = 30; 30.3%).

The data were pre-diagnosed depending on the uptake into two datasets (Normal or Hyperthyroidism). The clinical results of the Thyroid Function Test (TFT) for all the patients were collected, then a statistical analysis is performed into this data by using statistical analysis Toolbox in MATLAB version R2018a, to find the correlation between the clinical results and the uptake value.

The relationships between each of the TFT clinical results (T3, T4, and TSH) and the thyroid uptake of the same patient are shown in figure 4.1(a, b and c) respectively, in which the X-axis represents one of the TFT values, and the Y-axis represents the values of the uptake for all the dataset.

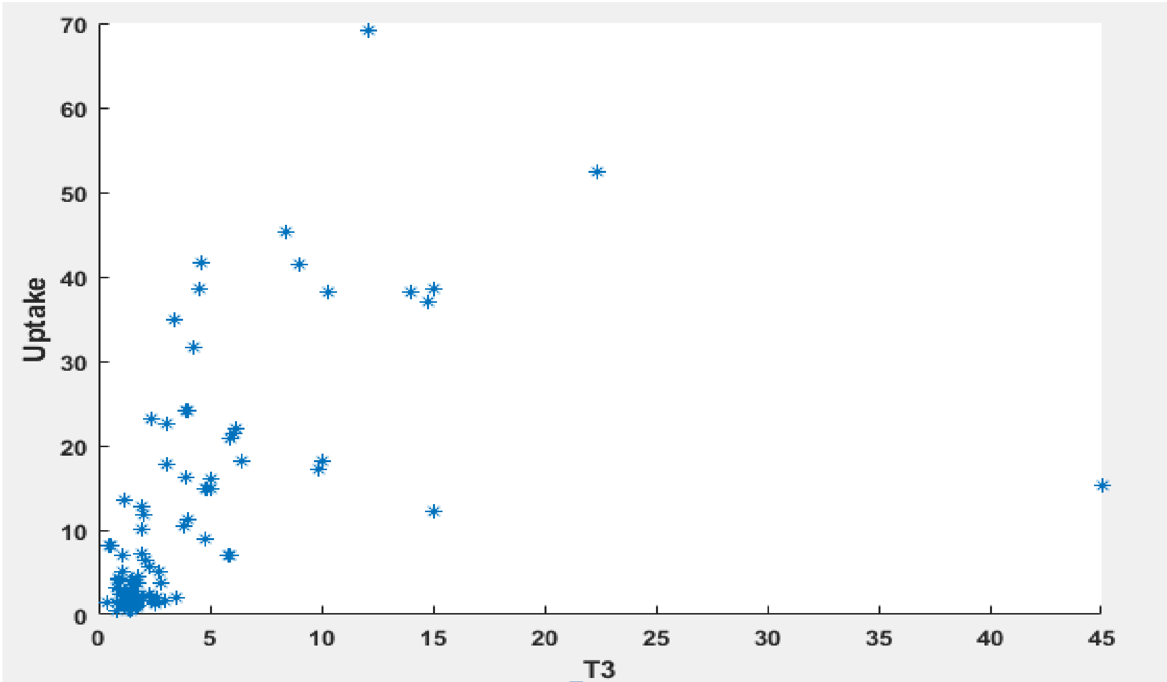


Figure 4.1.a: Scatter plot of T3 values and uptake

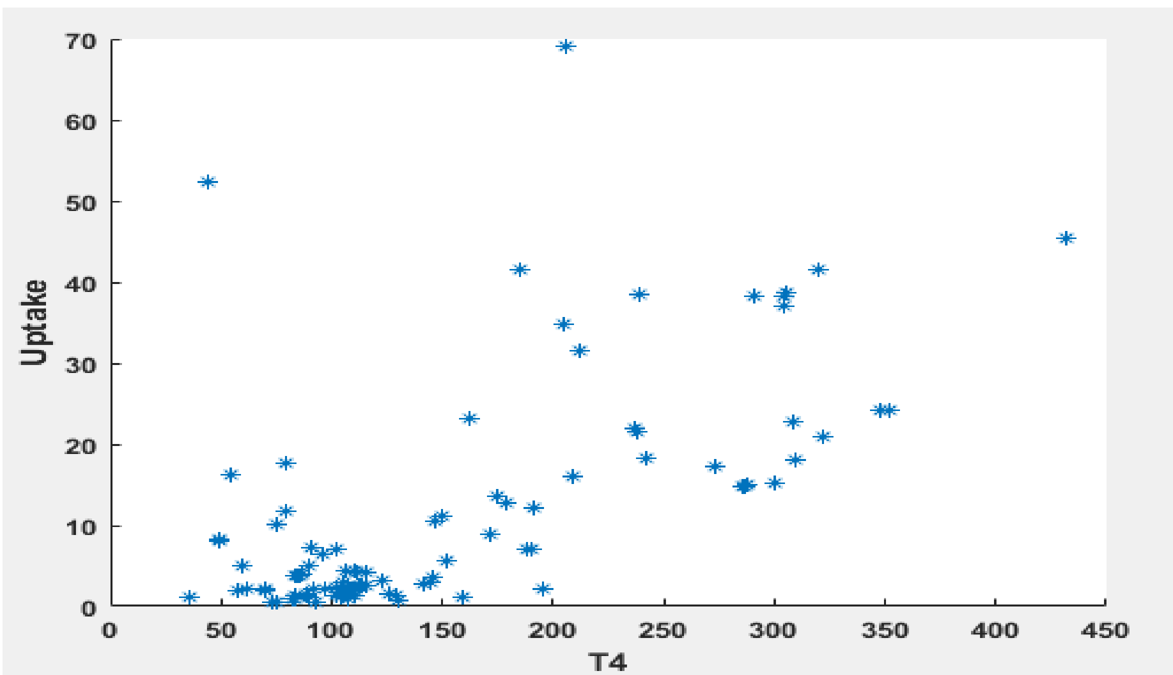


Figure 4.1.b: Scatter plot of T4 values and uptake

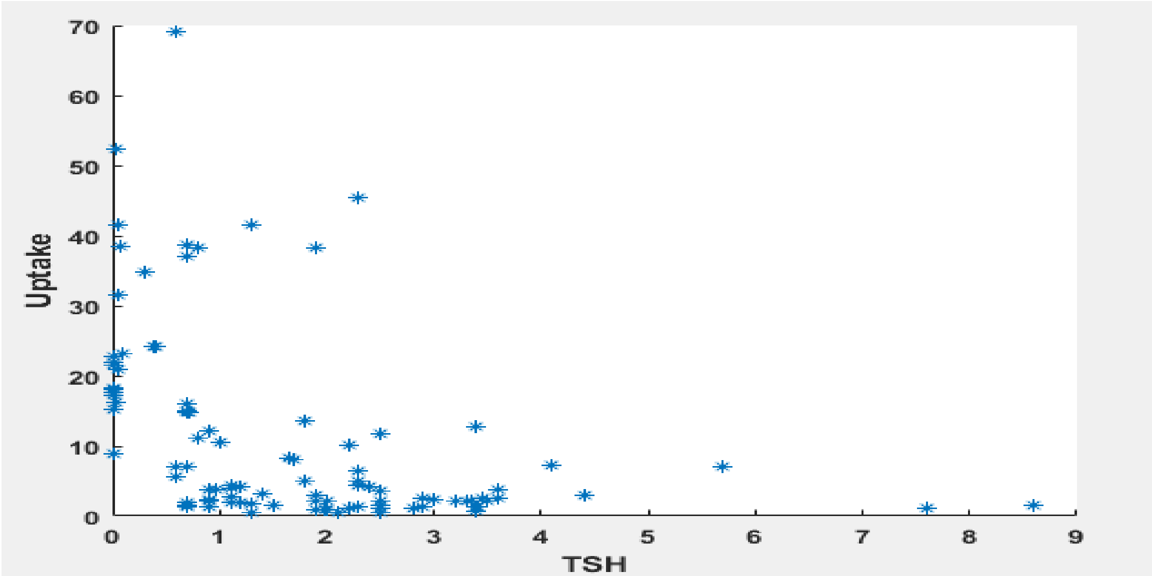


Figure 4.1.c: Scatter plot of TSH values and uptake

Then the statistics of each plot was obtained using the figure's data statistic option, these statistics are displayed in table 4.1. While the mean of each scatter plot in figure 4.1 was superimposed to the figure and plotted in figure 4.2 (a, b and c). Uptake has a mean of 11.07, while T3, T4 and TSH have the means of (3.979, 150 and 1.7) respectively.

Table 4.1: Statistics for all dataset.

	T3	T4	TSH	Uptake
Min	0.4	36	0.005	0.43
Max	45	432	8.6	69.04
Mean	3.979	150	1.7	11.07
Median	1.98	110	1.3	4.23
Mode	1.5	110	0.7	0.95
Std	5.645	86.51	1.533	13.72
Range	44.6	396	8.595	68.61

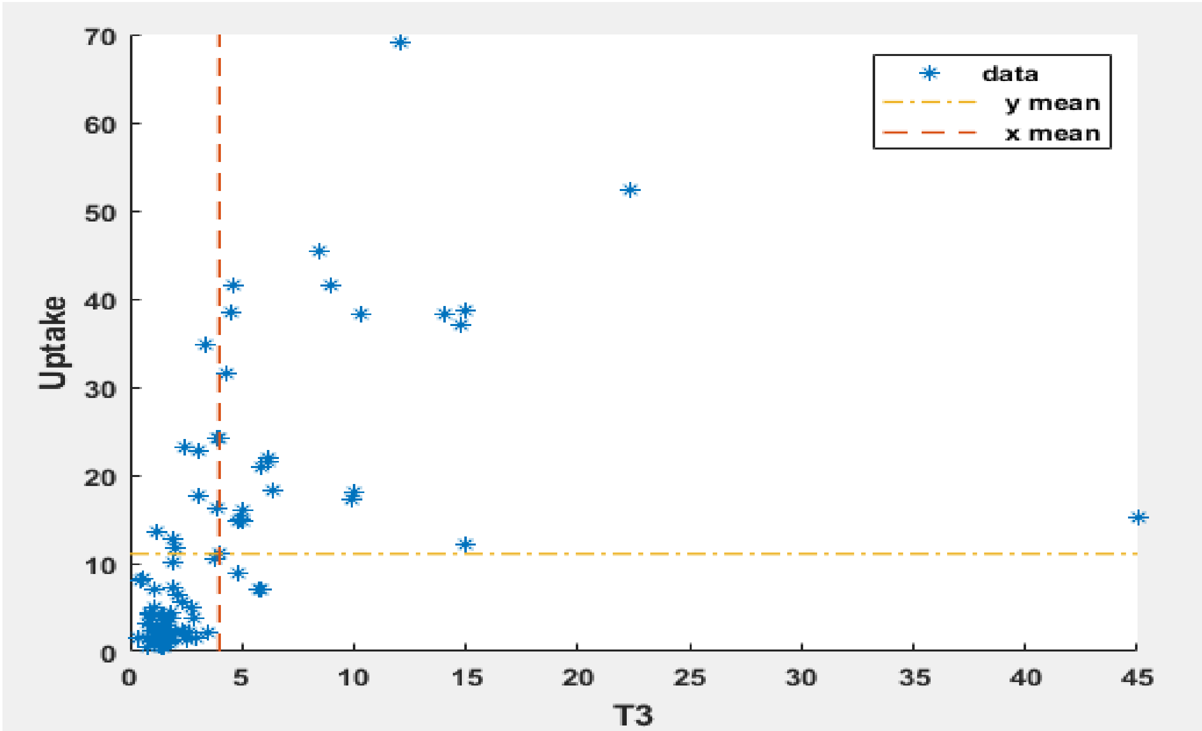


Figure 4.2.a: Scatter plot of T3 values and uptake with statistical mean

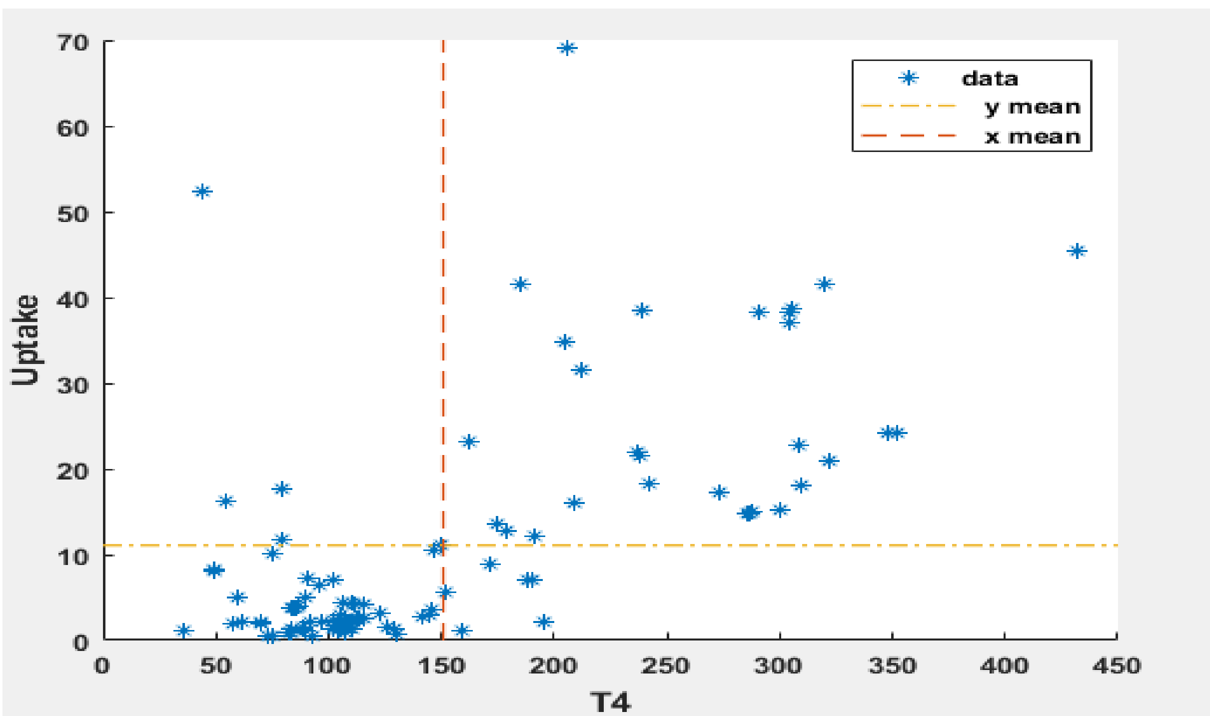


Figure 4.2.b: Scatter plot of T4 values and uptake with statistical mean

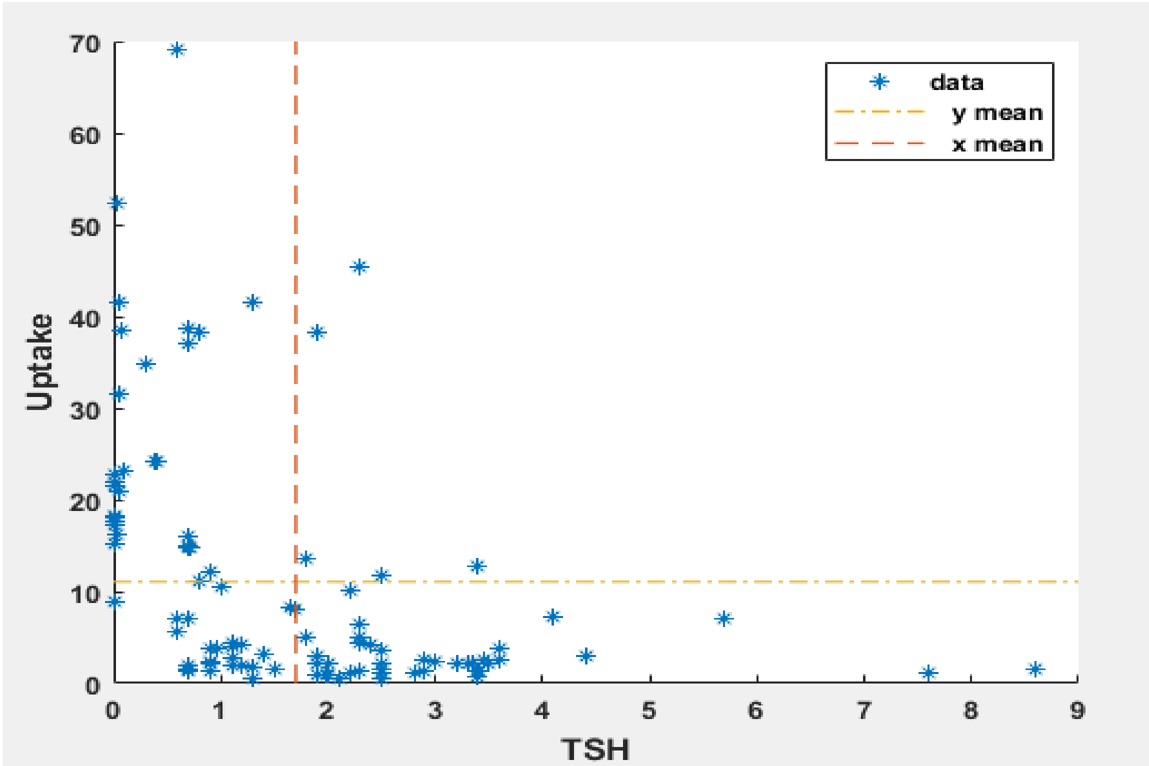


Figure 4.2.c: Scatter plot of TSH values and uptake with statistical mean

Figure 4.3 (a, b and c) shows the correlation of uptake with each TFT clinical results (T3, T4, and TSH) and the thyroid uptake, but here the scatter grouping option of the statistical toolbox of MATLAB was used to give more detailed statistical representative graphs, the grouping was done depending on the diagnosis of each case either its normal or having hyperthyroidism. The normal data marked in red, while the hyperthyroidism ones marked in blue, and it is clearly seen that the normal data have low uptake and low values of T3 and T4 level as well, while TSH has a relatively raised value (uptake has a mean of 1.924, while T3, T4 and TSH have the means of (1.626, 102.4 and 2.15) respectively). To make the plots more clear and statistically representative, the statistical means superimposed to the figure, which have been taken from table 4.2, in which all the statistics data for normal dataset are shown.

Table 4.2 Statistics for Normal data.

	T3	T4	TSH	Uptake
Min	0.4	36	0.7	0.43
Max	3.5	195	8.6	3.97
Mean	1.626	102.4	2.387	1.924
Median	1.5	104	2.15	1.86
Mode	1.4	83	2.5	0.95
Std	0.6022	27.33	1.57	0.9031
Range	3.1	159	7.9	3.54

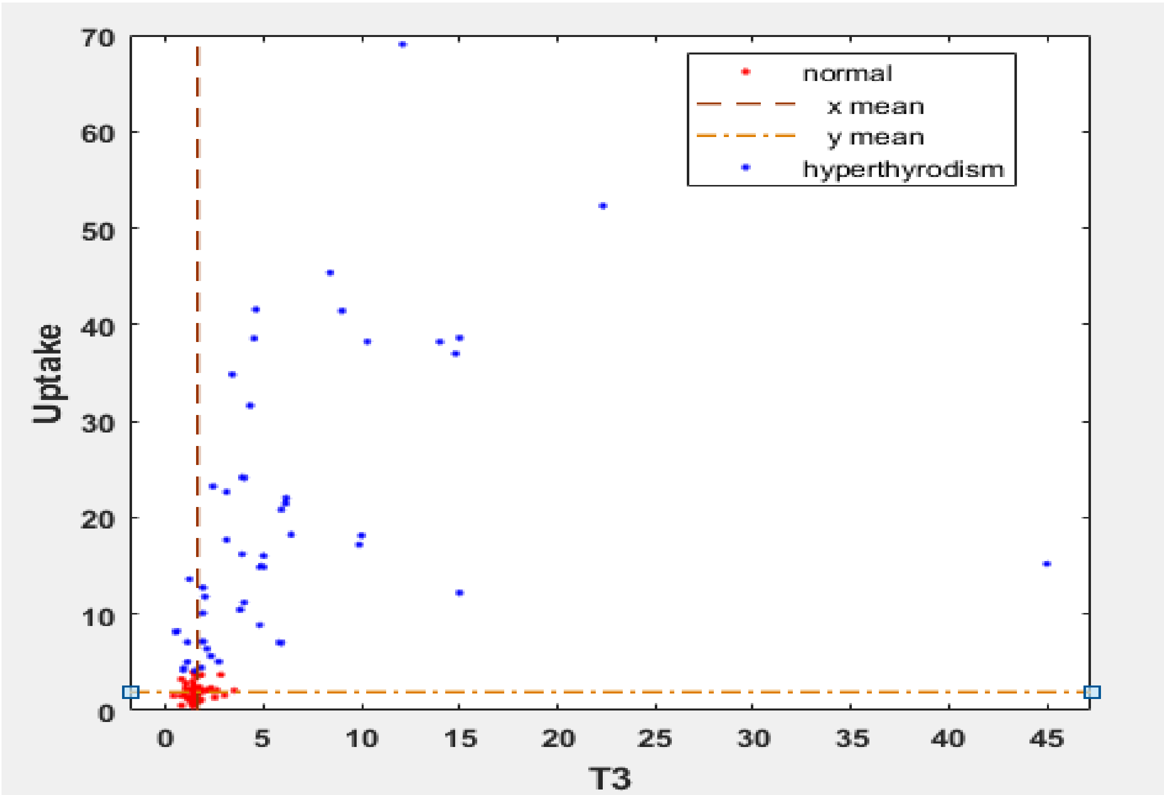


Figure 4.2.a: Correlation of uptake with T3 for normal dataset.

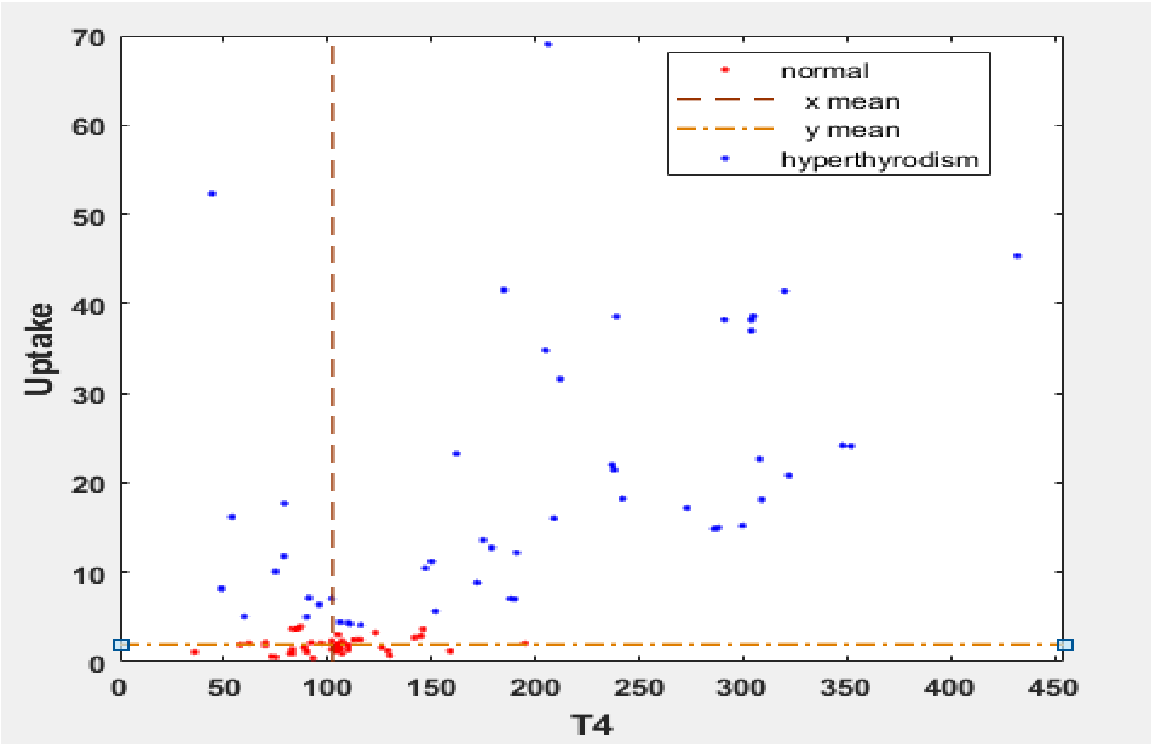


Figure 4.2.b: Correlation of uptake with T4 for normal dataset.

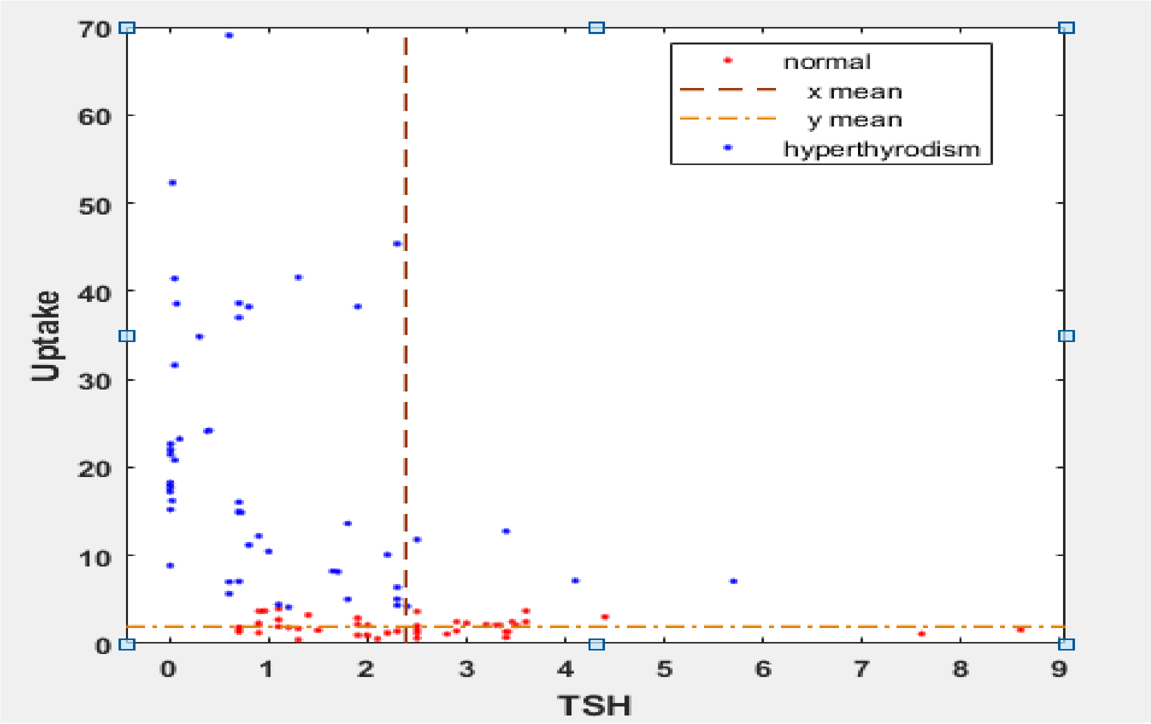


Figure 4.2.c: Correlation of uptake with TSH for normal dataset.

In contrary, in the case of hyperthyroidism the values of uptake T3 and T4 levels are high, while TSH has low level compered to its normal level (uptake has a mean of 19.68, while T3, T4 and TSH have the means of (6.195, 196.5 and 1.053) respectively). This is illustrated in better way by displaying their statistics in table 4.3, and plotting this in figure 4.4 (a, b and c).

Table 4.3 Statistics for Hyperthyroidism data:

	T3	T4	TSH	Uptake
Min	0.5	44.5	0.005	4.12
Max	45	432	5.7	69.04
Mean	6.195	196.5	1.053	19.68
Median	4.3	190	0.7	15.2
Mode	1.9	49	0.7	4.12
Std	7.196	97.94	1.187	14.56
Range	44.5	387.5	5.695	64.92

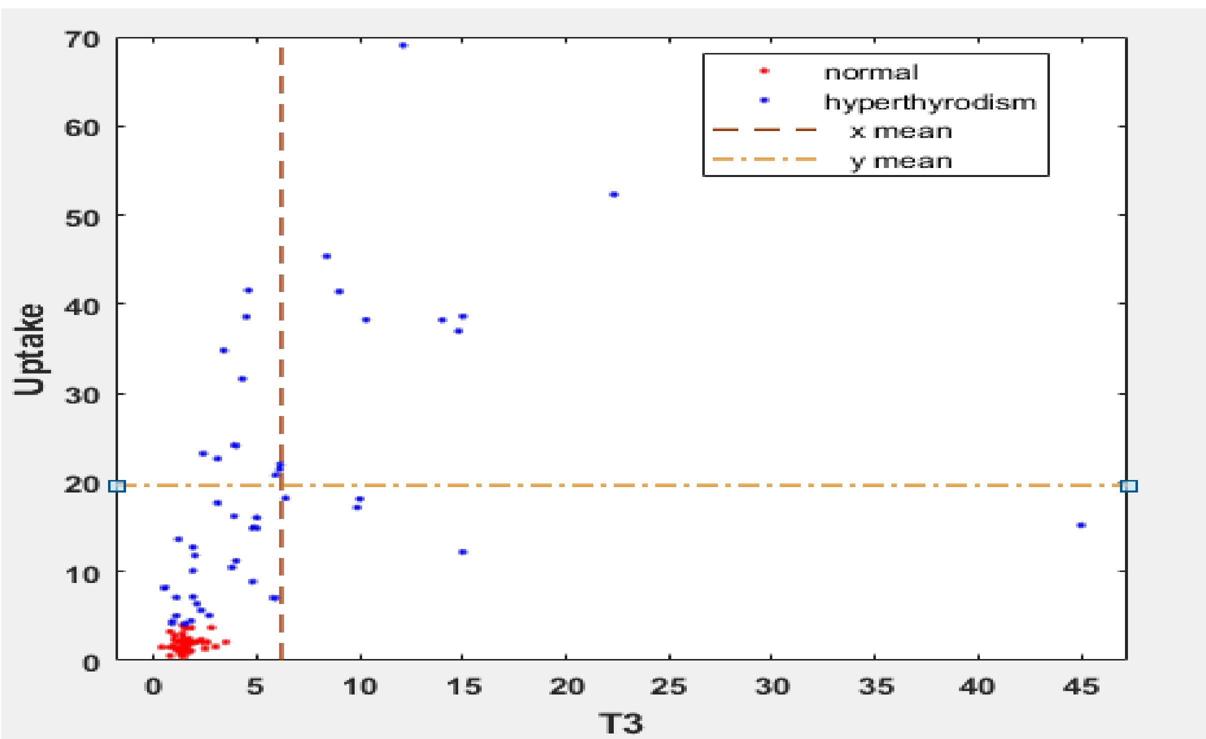


Figure 4.3.a: Correlation of uptake with T3 for hyperthyroidism dataset.

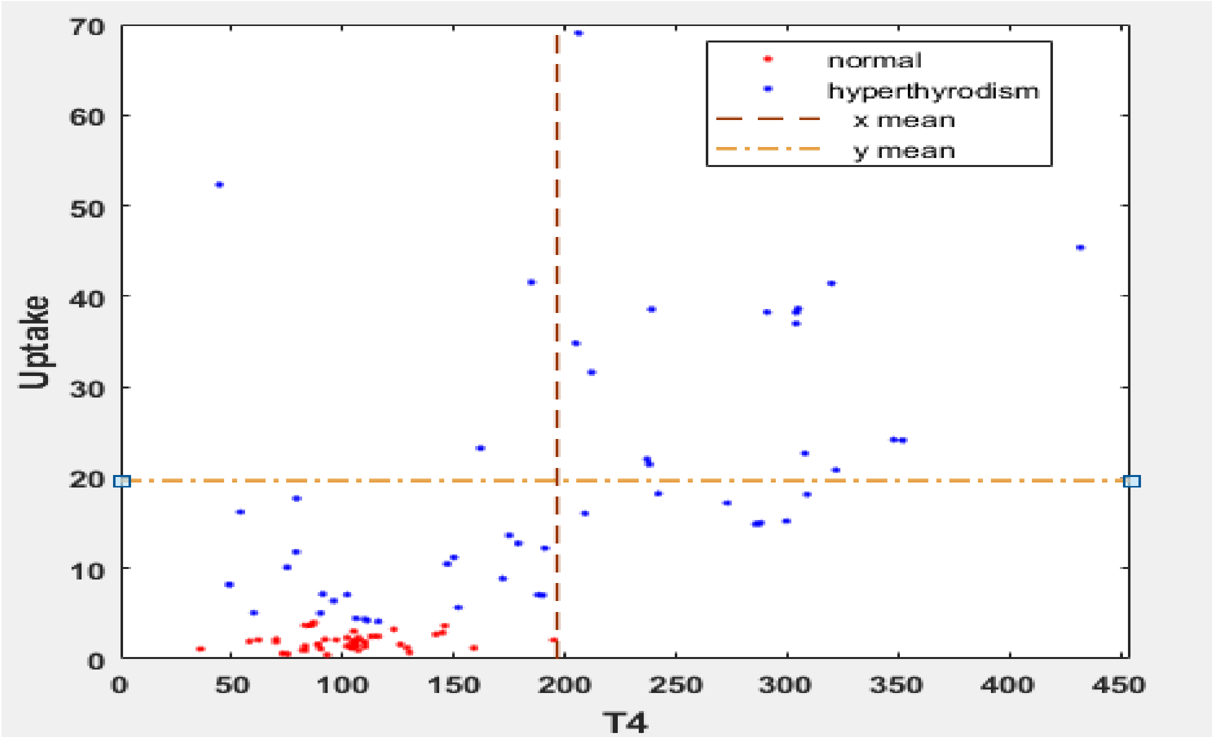


Figure 4.3.b: Correlation of uptake with T4 for hyperthyroidism dataset.

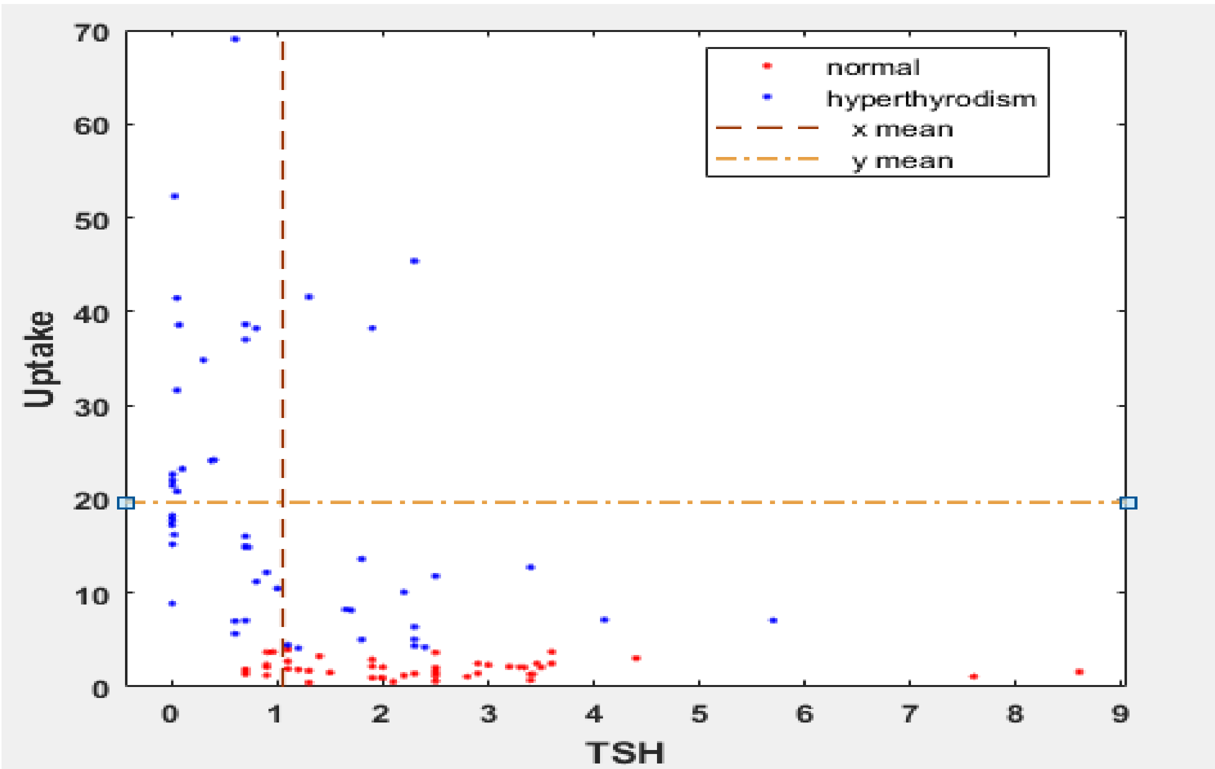


Figure 4.3.c: Correlation of uptake with TSH for hyperthyroidism dataset.

The last step was to create a predictive model to specify reference values of thyroid uptake as a function of TFT result. This is done using the multiple linear regression function associated in the Excel data analysis Tool Pak. The predictive values (P-values) of each independent variable should be less than 0.15, any P-value which is greater than or equal to 0.15 should be excluded from the model. Predictive values of 0.15 or greater indicate that the P-value of that particular independent variable is such that it really does not matter in predicting the model outcomes it is not of significance. In this model all P-values of the independent variable are less than 0.15 that is why they all included.

Table 4.4: Regression Statistics

Multiple R	0.703662
R Square	0.495141
Adjusted R Square	0.479198
Standard Error	9.899471
Observations	99

Table 4.5: Analysis of Variance (ANOVA)

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	9130.731	3043.577	31.05706	4.43E-14
Residual	95	9309.954	97.99952		
Total	98	18440.69			

Table 4.6: Predictive values and Coefficients:

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.11674	2.887102	-0.04044	0.967831	-5.84836	5.614883	-5.84836	5.614883
T3	0.64446	0.206333	3.123403	0.00237	0.234838	1.054083	0.234838	1.054083
T4	0.071619	0.014071	5.089717	1.81E-06	0.043684	0.099554	0.043684	0.099554
TSH	-1.28305	0.732826	-1.75083	0.083204	-2.73789	0.171793	-2.73789	0.171793

The model is assumed to be linear (the independent variables have a linear relationship to the dependent variable) so it will obey the straight-line equation for multiple independent variables:

$$\boldsymbol{Y = Constant + B1(X1) + B2(X2) + \cdots + Bn(Xn)}$$

In this model there are three independent variables (T3, T4, and TSH) and one dependent variable which is Uptake, for thus:

n = 3. Y ≡ Uptake. X1 ≡ T3. X2 ≡ T4. X3 ≡ TSH.

Constant ≡ Coefficient of Intercept.

B1 ≡ Coefficient of T3. B2 ≡ Coefficients T4. B3 ≡ Coefficients TSH.

Therefore, when these values are taken from table 4.6 the predictive model equation of this study will be as follows:

$$\boldsymbol{Uptake} = -0.11674 + 0.64446(\boldsymbol{T3}) + 0.071619(\boldsymbol{T4}) - 1.28305(\boldsymbol{TSH})$$

CHAPTER FIVE

CHAPTER FIVE

Conclusion and Recommendations

5.1 Conclusion:

Based on the measurements conducted in 99 controls from a case-control study carried out in a general population, predicting thyroid uptake. Thyroid uptake increased with increasing of T3 and T4 in case of hyperthyroidism and have low values in normal cases, in contrary TSH has an inverse proportional to thyroid uptake where TSH has a relatively high values in normal cases and low values in hyperthyroidism cases. Therefore, it is concluded that thyroid uptake has a positive correlation with T3 and T4 while it has a negative correlation with TSH, and this is obvious in the predictive model formula in which the minus sign of TSH coefficient denotes that TSH is negatively correlated to thyroid uptake.

This study has some drawbacks, including the relatively small number (n = 99) of individuals, and the homogeneity of the sample diagnosis (hypothyroidism cases is not included). On the other hand, the fact that a specific reference values of thyroid uptake as a function of TFT clinical results could be used for the evaluation of thyroid uptake in clinical practice is an advantage.

5.2 Recommendations:

1. Increase the sample size to be representative for all the Sudanese population.
2. Model validation.
3. Model should be enhanced after validation.
4. Model implementation.

References

Arthur C. G uyton ,M.D (2003) Anatomy and Physiology ,smnderscollecge.
58

A manual of radioactivity procedures. NCRP Report No. 28. national bureau of standards handbook 80, U.S. department of commerce, washington, d.c.,1961

Alexander, w. d., harden, r. Mcg., and shimmins, j.,1966, lancet, 2, 1041.

Atkins, h. l., and richards, p., 1968, j. nucl, med., 9, 7.degrossi, o., gotta, h., olivari, a., pecorini, v., and chwojnik, a., 1995, nud.-med., 4, 383.

Andros, g., harper, p. v., lathrop, k. a., and mc-cardle, r. j., 1965, J. din. endocr. metab., 25, 1067.

Brucer,m. June, 1989. : thyroid radioiodine uptake measurement. a standard system for universal intercalibration. U.S. AEC Report orins-19

-Berman, m., hoff, e., barandes,m., becker, d. v.,sonenbero, m., benua, r. and kotaras, d. a. : iodine kinetics in man--a model. i. clin. endocrinol. 28:1, 1988.

Crespo g .g.andVettrer ,h. 1996, the calibration and standardization of thyroid radioiodine measurements. intern.i appl. radiation isotopes 17:53.

Cameron, j. r .and bi.l, d. b. 1992, thyroid uptake studies with 131I in very small doses. radiology 79:452.

Hine, g. j. and leovinger r 1997,, application and radiation dose of radioisotopes in medicine in instrumentation in nuclear medicine, Academic Press, New York, p. 626.

J.F.LAMBB , G.G.INGRAM , I.A>JOHNSTON , R.M.PITMAN (2004) Essential of physiology third edition . London Edinburgh *bostonMelbourgneparis berlin Vienna* .

Nishi I, Ichihara K, Takeoka , Miyai K , Amino N 1996. Intra-individual and seasonal variation of thyroid function tests in healthy subject.

Clin.chem.47,1353-1363

59

Report of consultants of the International Atomic Energy Agency.The calibration and standardization of thyroid radioiodine uptake measurements.

Phys. Med. Biol. 6:533

Sucker et.al.concice of human physiology , 2nd edition chapter six page 212-301 .

W.M.Ali 2010 correlation of thyroid uptake and function test. Sudan university for science and technology