بسم الله الرحمن الرحيم

Sudan university of Science and Technology

College of Graduate Studies

Classification of the Thyroid Goiters from Radionuclide thyroid scans at AlNelain Diagnostic Center

تصنيف مرض الدراق من خلال صور الطب النووي في مركز النيلين التشخيصي

Thesis Submitted for Partial Fulfillment of the Award of M.Sc. Degree in Nuclear Medicine Technology

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بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

تصنيف مرض الدراق من خلال صور الطب النووي في مركز النيلين التشخيصي

الرسالة المقدمة للوفاء الجزئي بجائزة الماجستير. درجة في تكنولوجيا الطب النووي

بواسطة

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مشرف

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الآيـــــــة

قَالَ تَعَالَىٰ:

﴿ قُل لَّوۡ كَانَ ٱلۡبَحۡرُ مِدَادٗا لِّكَلِمَٰتِ رَبِّي لَنَفِدَ ٱلۡبَحۡرُ قَبۡلَ أَن تَنفَدَ كَلِمَٰتُ رَبِّي وَلَوۡ جِئۡنَا بِمِثۡلِهِۦ مَدَدٗا ١٠٩ ﴾

صدق الله العظيم

سوره الكهف (109)

Dedication

To my parents

To my teachers

To my brothers

To my sisters

To my friends

I dedicate this study

Acknowledgement

I would like to express my special thanks and gratitude to my teacher (Dr. Salah Ali Fadlalla) who gave me the golden opportunity to do this humble study and helped me through advices, encouragement and corrections of errors. Deep thanks are extended to my parents and friends who helped me a lot in finalizing this study within the limited time frame. Acknowledgement is due to my friend who did all the statistical works of the study.

Abstract

The main objective of this study was to classify the thyroid goiters from radionuclide thyroid scans performed at the department of nuclear medicine in al-nelain diagnostic center during the period between 2014- 2016. The study included a number of 80 radionuclide scans for female patients (64%) and male patients (16%). The range of age of the patients under study was between (18 – 69 years). The study results showed that a number of 14 patients (18%) was diagnosed as normal , 30 patients (38%) were with multinodular goiter ,25 (31%) with simple diffuse goiter , 8 (10%) with toxic multinodular goiter , 3 (4%) with toxic simple diffuse goiter. 92% of patients with multinodular goiter had an inhomogeneous thyroid scan image and 1% had a homogeneous image , 10 of simple diffuse goiter patients had an inhomogeneous thyroid scan image and 15 were with homogeneous scan . All toxic goiters(11) were shown as inhomogeneous thyroid scans, 8 of them showed toxic multinodular goiter and 3 showed toxic simple diffuse goiter . The study proposed some recommendations including the important of taking diets rich of iodine by all people, especially the population of western Sudan. TFT, ultrasound and radionuclide thyroid scans are recommended as a routine prime investigations in the work-up of the thyroid goiter. I^{123} could be used for thyroid scan to determine the goiter functioning because iodine is organified by the thyroid in contrast to Tc^{99m} standard dose. Proper technique and position should always be adopted in thyroid imaging. Determination of the best method of long-term follow-up of patients with thyroid goiter should be considered. More concern and care should be paid to patients with thyroid goiters in Sudan. Future studies on larger sample and other places may give more reliable results.

مستخلص البحث

وكان الهدف الرئيسي من هذه الدراسة هو تصنيف تضخم الغدة الدرقية من خلال المسح الذري للغده الدرقية الذي اجري في قسم الطب النووي في مركز النيلين التشخيصي خلال الفترة ما بين 2014-2016. وشملت الدراسة عددا من 80 مريض اجري لهم مسح ذري للغده الدرقية وقد كانت النتائج كالاتي ،(64%) من الإناث بينما (16%) من الذكور يعانون من مرض الدراق . و قد كان معدل عمر المرضى قيد الدراسة بين (18 – 69 سنة). وأظهرت نتائج الدراسة أن عدد 14 مريضا (18٪) تم تشخيصهم لا يعانون من هذا المرض ، وكان 30 مريضا (38٪) يعانون من مرض الدراق متعدد الأوعية، 25 (31٪) من مرض الدراق ذو الانتشار البسيط، و 8 (10٪) من مرض الدراق السمي متعدد الاوعية، 3 (4٪) من مرض الدراق السمي ذو الانشار البسيط. 92% من المرضى الذين يعانون من مرض الدراق متعدد الأوعية الدموية لديهم صورة غير متجانسة للمسح الذري للغده الدرقية بينما كان 1% لديهم صورة متجانسه ، وكان عدد 10 من مرضى الدراق ذو الانتشار البسيط لديهم صورة مسح ذري غير متجانسة وعدد 15 كان لديهم صور مسح ذري متجانسة. بينما اوضحت جميع صور مرض الدراق السمي و عددها (11) صور مسح زري غير متجانسة، 8 منهم مرض الدراق السمي متعدد الاوعيه ، بينما 3 منهم مرض الدراق السمي ذو الانتشار البسيط . واقترحت الدراسة بعض التوصيات بما في ذلك أهمية تناول الوجبات الغذائية الغنية باليود ، وخاصة سكان غرب السودان. ينصح اجرا كشف الموجات فوق الصوتية و المسح الذري للغده الدرقيه عبر استخدام عنصر اليود المشع 123 لأن اليود هو عنصر يدخل في وظائف من قبل الغدة الدرقية .كما ايضا وصي باهميه النظر في تحديد أفضل طريقة للمتابعة طويلة الأجل للمرضى الذين يعانون من تضخم الغدة الدرقية. وينبغي ايضا المزيد من الاهتمام والرعاية للمرضى الذين يعانون من غدة الدرقية في السودان و الدراسات المستقبلية على عينة أكبر وغيرها من الأماكن قد تعطي نتائج أكثر موثوقية.

List of tables

List of figures

List of abbreviations

T4	thyroxine
T3	triiodothyronine
FNA	Fine needle aspiration
TSH	thyroid-stimulating hormone
EGF	Epidermal growth factor
FGF	Fibroblast growth factor
IGF	Insulin like growth factor
CT	Computer tomography
MRI	Magnetic resonance imaging
US	Ultrasound
MNG	Multinodular goiter
Kev	kiloelectron-Volt
PMTs	photomultipliers tube
SPECT	Single-photon emission computed tomography
PET	positron emission tomography
TFT	Thyroid function test
T1W1	T1 weighted images

Table of contents

CHAPTER ONE

Introduction

Chapter one

1-1Introduction:

The thyroid gland is a butterfly-shaped gland in the neck, just above the clavicles. It is one of endocrine glands, which make hormones. Thyroid hormones control the rate of many activities in the body. These include how fast the burn calories and how fast the heart beats is. All of these activities in the body metabolism. Diseases of the thyroid cause it to make either too much or too little of the hormone. Depending on how much or how little hormone of the thyroid makesthe body may often feel restless or tired, or may lose or gain weight. Thyroid problems include

Goiter - enlargement of the thyroid gland ,Hyperthyroidism - when the thyroid gland makes more thyroid hormones than the body needs ,Hypothyroidism – when the thyroid gland does not make enough thyroid hormones ,Thyroid cancer ,Thyroid nodules - lumps in the thyroid gland ,Thyroiditis - swelling of the thyroid.

To diagnose thyroid diseases, doctors use a medical history, physical exam, and thyroid tests. They sometimes also use a biopsy or nuclear medicine imaging . Treatment depends on the problem, but may include medicines, radioiodine therapy, or thyroid surgery. (John 2001)

Goiter: A goitre is an enlarged thyroid gland. A goitre can mean that all the thyroid gland is swollen or enlarged, or one or more swellings or lumps develop in a part or parts of the thyroid. The generally accepted normal range for thyroid weight is 20–25 g, and a gland more than 30g is considered enlarged. Goiter may be due to a number of causes such as hereditary deficiency of thyroxin synthesizing enzymes (dyshormonogenetic goiter), inflammatory disorders such as

Hashimoto's thyroiditis and Graves' disease; thyroid tumors or due to nonhereditary,noninflammatory.

the goiter may be simple (nontoxic) or toxic, and although toxic goiters are usually nodular, the simple goiter may be diffuse or multi -nodular. (john 2001)

1-2Problem of the Study:

Thyroid goiters are of various types but these types are not determined or classified properly in Sudan in such a way as to specify the appropriate treatment, to the best of the researchers knowledge .

1-3 Importance of the study:

This research can assist in the differentiation of thyroid goiters and this can facilitate the treatment of such goiters.

1-4 Objectives of the study:

1-4-1: General Objective :

To Classify the thyroid goiters from radionuclide thyroid scans at AlNelain Diagnostic Center

1-4-2 Specific Objectives:

to determine the different types of thyroid goiters forms.

to determine the goiter appearance in nuclear medicine image.

to find out the causes of thyroid goiters and the most prevalent in Sudanese people.

to correlate the type of goiter with the thyroid uptake .

1-5 place and duration of the study:

This study was conducted in the nuclear medicine department at ALnelain Diagnostic Center, during the period from August 2014 to December 2015.

1-6 Overview of the study:

This study is included in five chapters. Chapter one, is an introduction, deals with theoretical frame work of the study. It presents the statement of the study problems and the objectives of the study. Chapter two is divided into two sections, section one deals with theoretical background of the study and section two deals with the previous studies. Chapter three discusses the materials and methods. Chapter four includes the results presentation. Finally chapter five includes the discussions, conclusions, recommendations references and appendices.

CHAPTER TWO

Theoretical background and literature review

Chapter Two

2-1 The thyroid gland anatomy :

is the biggest gland in the neck. It is situated in the anterior (front) neck below the skin and muscle layers. The thyroid gland takes the shape of a butterfly with the two wings being represented by the left and right thyroid lobes which wrap around the trachea. The sole function of the thyroid is to make thyroid hormone. This hormone has an effect on nearly all tissues of the body where it increases cellular activity. .(Mcminn 1990)

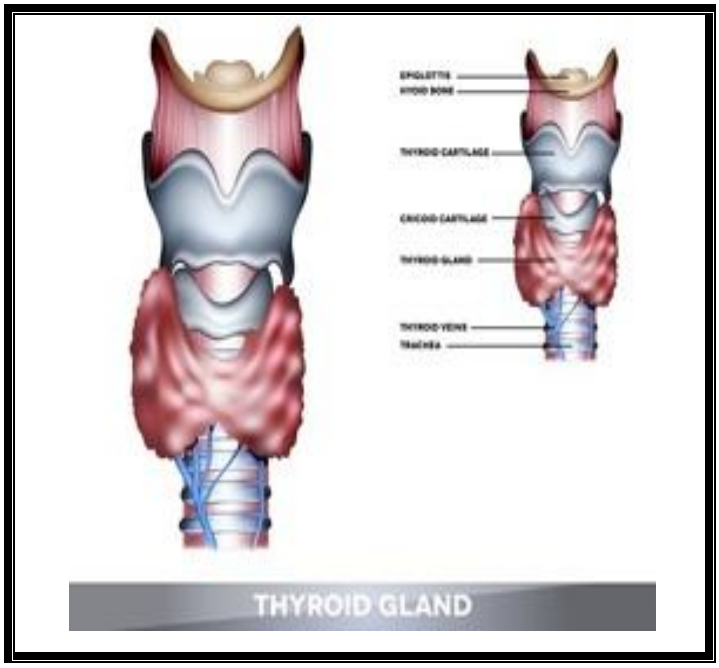


Fig-2.1 shows Thyroid gland

The thyroid gland is a small gland, normally weighing less than one ounce, located in the front of the neck. It is made up of two halves, called lobes, that lie along the windpipe (trachea) and are joined together by a narrow band of thyroid tissue, known as the isthmus. .(Mcminn 1990)

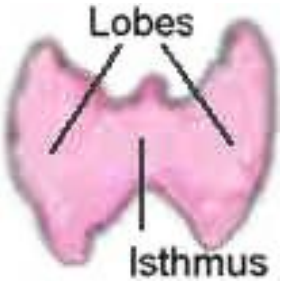


Fig. 2.2 shows thyroid gland lobes and isthmus

The thyroid is situated just below your "Adams apple" or larynx. During development (inside the womb) the thyroid gland originates in the back of the tongue, but it normally migrates to the front of the neck before birth. Sometimes it fails to migrate properly and is located high in the neck or even in the back of the tongue (lingual thyroid). This is very rare. At other times it may migrate too far and ends up in the chest (this is also rare). The thyroid gland consist of Follicular cells (also called thyroid epithelial cells or thyrocytes) are cells in the thyroid gland that are responsible for the production and secretion of thyroid hormones thyroxine (T4) and triiodothyronine (T3). They are simple cuboidal epithelium and are arranged in spherical follicles surrounding colloid. The interiors of one of these follicles is known as the follicular lumen. They have thyrotropin receptors on their surface, which respond to thyroid-stimulating hormone. Calcitonin-producing parafollicular cells (C cells) can be found scattered along the basement membrane of the thyroid epithelium.(Mcminn 1990)

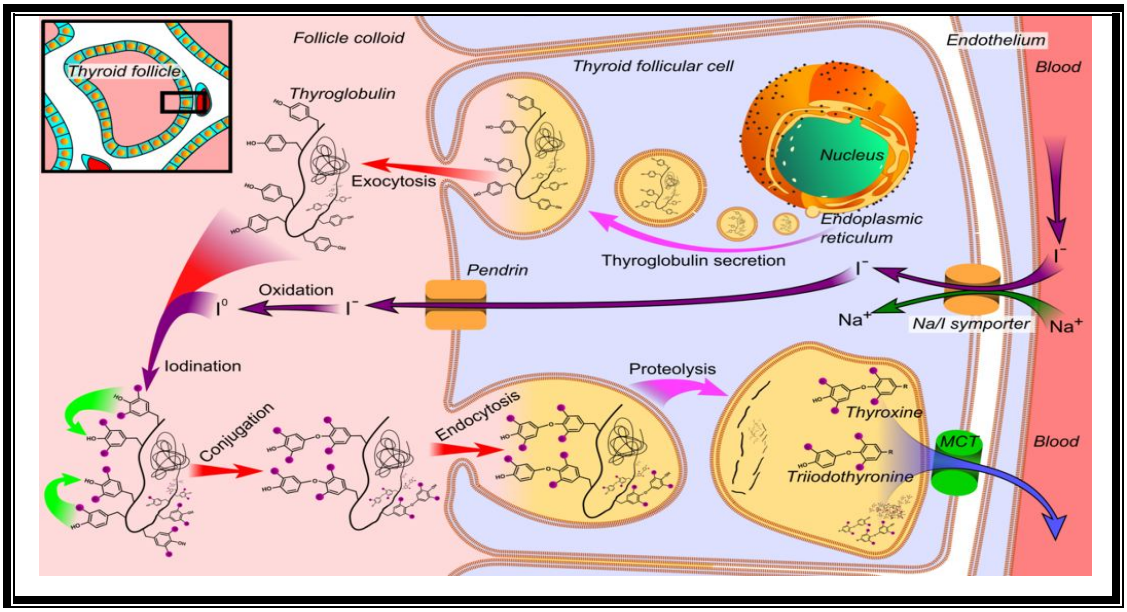


Fig 2-3 shows blood supply of the thyroid gland

2-1-2 Blood supply of the thyroid gland:

Because the thyroid gland is a hormone secreting organ, it is highly vascularized. It receives its blood supply from the superior and inferior thyroid arteries. These arteries lie between the fibrous capsule and the pretracheal layer of deep cervical fascia.The superior thyroid artery is the first branch of the external carotid artery and supplies the top half of the thyroid gland. It divides into anterior and posterior branches supplying respective sides of the thyroid. On the anterior side, the right and left branches anastomose with each other. On the posterior side, the right and left branches anastomose with their respective inferior thyroid arteries. The inferior thyroid artery supplies the lower half of the thyroid and is the major branch of the

thyrocervical trunk, which comes off the subclavian artery. It too divides into several branches, supplying the inferior portion of the thyroid and anastomosing posteriorly with the superior thyroid branches.There are three main veins that drain the venous plexus on the anterior surface of the thyroid. They include the superior, middle, and inferior thyroid veins, and each drains its respective portion of the thyroid. The superior and middle thyroid veins drain into the internal jugular veins, whereas the inferior thyroid vein drains into the brachiocephalic veins, behind the manubrium of the sternum.(Mcminn 1990)

2-1-3Function of the thyroid gland :

The function of the thyroid gland is to take iodine, found in many foods, and convert it into thyroid hormones: thyroxine (T4) and triiodothyronine (T3). Thyroid cells are the only cells in the body which can absorb iodine. These cells combine iodine and the amino acid tyrosine to make T3 and T4. T3 and T4 are then released into the blood stream and are transported throughout the body where they control metabolism (conversion of oxygen and calories to energy).Every cell in the body depends upon thyroid hormones for regulation of their metabolism. The normal thyroid gland produces about 80% T4 and about 20% T3, however, T3 possesses about four times the hormone "strength" as T4 .(Mcminn 1990)

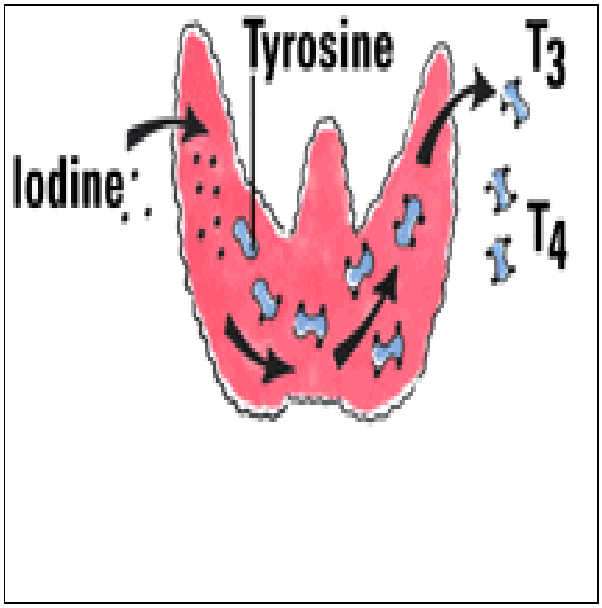


Fig 2-4 shows function of thyroid gland

The thyroid keeps your metabolism under control through the action of thyroid hormone, which it makes by extracting iodine from the blood and incorporating it into thyroid hormones. Thyroid cells are unique in that they are highly specialized to absorb and use iodine. Every other cell depends on the thyroid to manage its metabolism. T3 and T4 travel in your bloodstream to reach almost every cell in the body. The hormones regulate the speed with which the cells/metabolism work. For example, T3 and T4 regulate your heart rate and how fast your intestines process food. So if T3 and T4 levels are low, your heart rate may be slower than normal, and you may have constipation/weight gain. If T3 and T4 levels are high, you may have a rapid heart rate and diarrhea/weight loss. The thyroid's hormones regulate vital body functions, including: Breathing ,heart rate ,central and peripheral nervous systems, body weight ,muscle strength ,menstrual cycles ,body temperature ,cholesterol levels

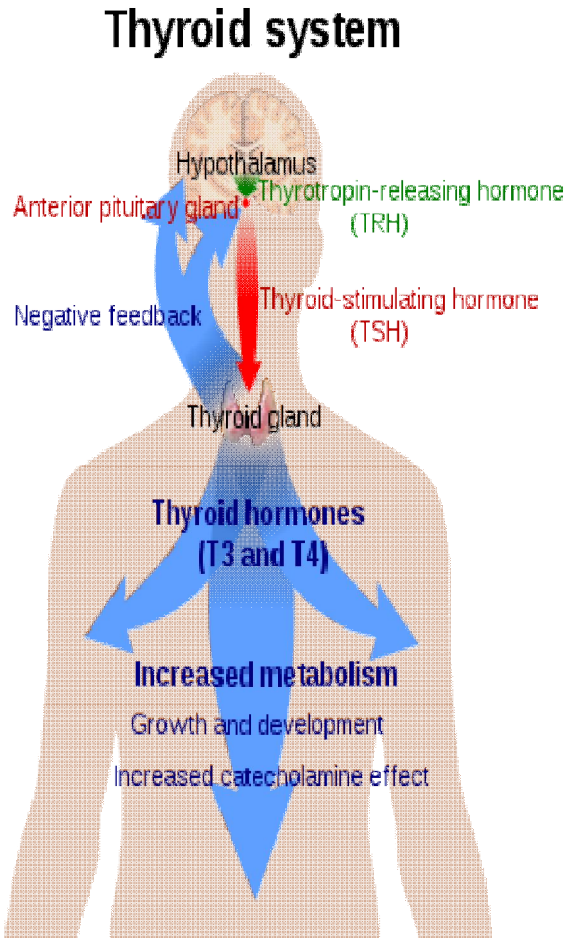


Fig 2-4 thyroid gland system

2-1-4Diseases and Disorders of the thyroid gland:

There are many diseases and disorders associated with the thyroid. They can develop at any age and can result from a variety of causes—injury, disease, or dietary deficiency, for instance. But in most cases, they can be traced to the following problems:

Too much or too little thyroid hormone (hyperthyroidism and hypothyroidism, respectively) ,abnormal thyroid growth ,nodules or lumps within the thyroid thyroid cancer But the most common thyroid diseases are :

Goiters: A goiter is a bulge in the neck. A toxic goiter is associated with hyperthyroidism, and a non-toxic goiter, also known as a simple or endemic goiter, is caused by iodine deficiency.

Hyperthyroidism: Hyperthyroidism is caused by too much thyroid hormone. People with hyperthyroidism are often sensitive to heat, hyperactive, and eat excessively. Goiter is sometimes a side effect of hyperthyroidism. This is due to an over-stimulated thyroid and inflamed tissues, respectively.

Hypothyroidism: Hypothyroidism is a common condition characterized by too little thyroid hormone. In infants, the condition is known as cretinism. Cretinism has very serious side effects, including abnormal bone formation and mental retardation. If you have hypothyroidism as an adult, you may experience sensitivity to cold, little appetite, and an overall sluggishness. Hypothyroidism often goes unnoticed, sometimes for years, before being diagnosed.

Solitary thyroid nodules: Solitary nodules, or lumps, in the thyroid are actually quite common—in fact, it's estimated that more than half the population will have a nodule in their thyroid. The great majority of nodules are benign. Usually a fine needle aspiration biopsy (FNA) will determine if the nodule is cancerous.

Thyroid cancer: Thyroid cancer is fairly common, though the long-term survival rates are excellent. Occasionally, symptoms such as hoarseness, neck pain, and enlarged lymph nodes occur in people with thyroid cancer. Thyroid cancer can affect anyone at any age, though women and people over thirty are most likely to develop the condition.

Thyroiditis: Thyroiditis is an inflammation of the thyroid that may be associated with abnormal thyroid function (particularly hyperthyroidism). Inflammation can cause the thyroid's cells to die, making the thyroid unable to produce enough

hormones to maintain the body's normal metabolism. There are five types of thyroiditis, and the treatment is specific to each.(Larsen PR et al 1998)

2-2 goiter:

A goitre is an enlarged thyroid gland. A goitre can mean that all the thyroid gland is swollen or enlarged, or one or more swellings or lumps develop in a part or parts of the thyroid. The generally accepted normal range for thyroid weight is 20–25 g, and a gland more than 30g is considered enlarged. Goiter may be due to a number of causes such as hereditary deficiency of thyroxin synthesizing enzymes (dyshormonogenetic goiter), inflammatory disorders such as Hashimoto's thyroiditis and Graves' disease; thyroid tumors or due to nonhereditary, noninflammatory.

the goiter may be simple (nontoxic) or toxic, and although toxic goiters are usually nodular, the simple goiter may be diffuse or multinodular.

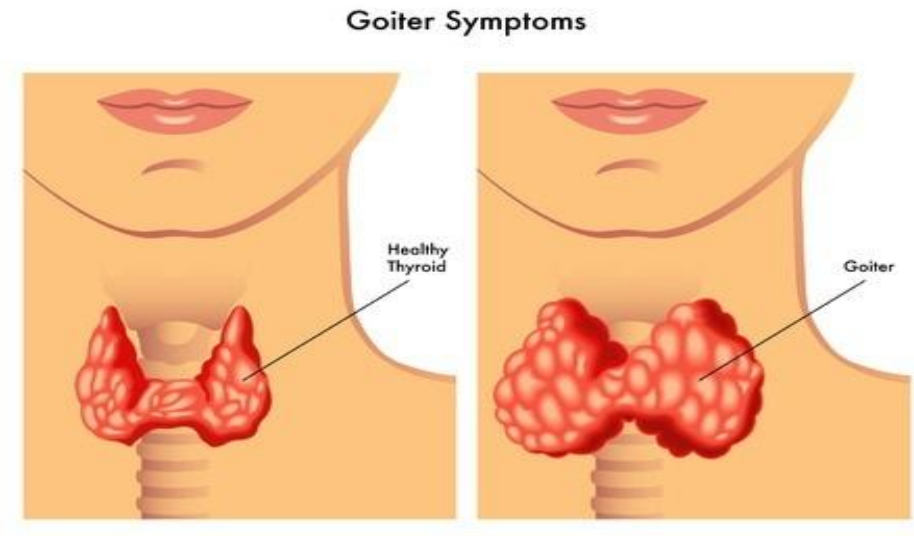


Fig 2-6 shows thyroid goiter

2-2-1Simple (Nontoxic) Diffuse and Multinodular Goiter:

Simple (nontoxic) goiter is defined as diffuse or nodular enlargement of the thyroid gland, which is not associated with thyrotoxicosis and does not result from autoimmune or other inflammatory etiology. Simple goiter is the most common thyroid disorder seen in clinical practice and accounts for most cases of nodular thyroid enlargement. Simple goiter may be endemic or sporadic. The most common cause of simple goiter worldwide is iodine deficiency. In clinical practice a goiter is considered to be endemic if >10% of children ages 6–12 within a population have goiter [1,150]. In both endemic and sporadic goiter multiple factors including relative iodine deficiency, naturally occurring goiterogens and minimal levels of thyroid hormone synthesis enzymes may play a role in goiterogenesis. In many cases of sporadic goiter no definitive cause may be identified.

2-2-1-1 PATHOGENESIS OF SIMPLE GOITER:

All nontoxic goiters in the early phase of goiterogenesis are diffuse; with time they increase in size and also become nodular. This may be followed by auton-omy in thyroid function independent of TSH secretion causing subclinical thyrotoxicosis and eventually overt thyrotoxicosis.

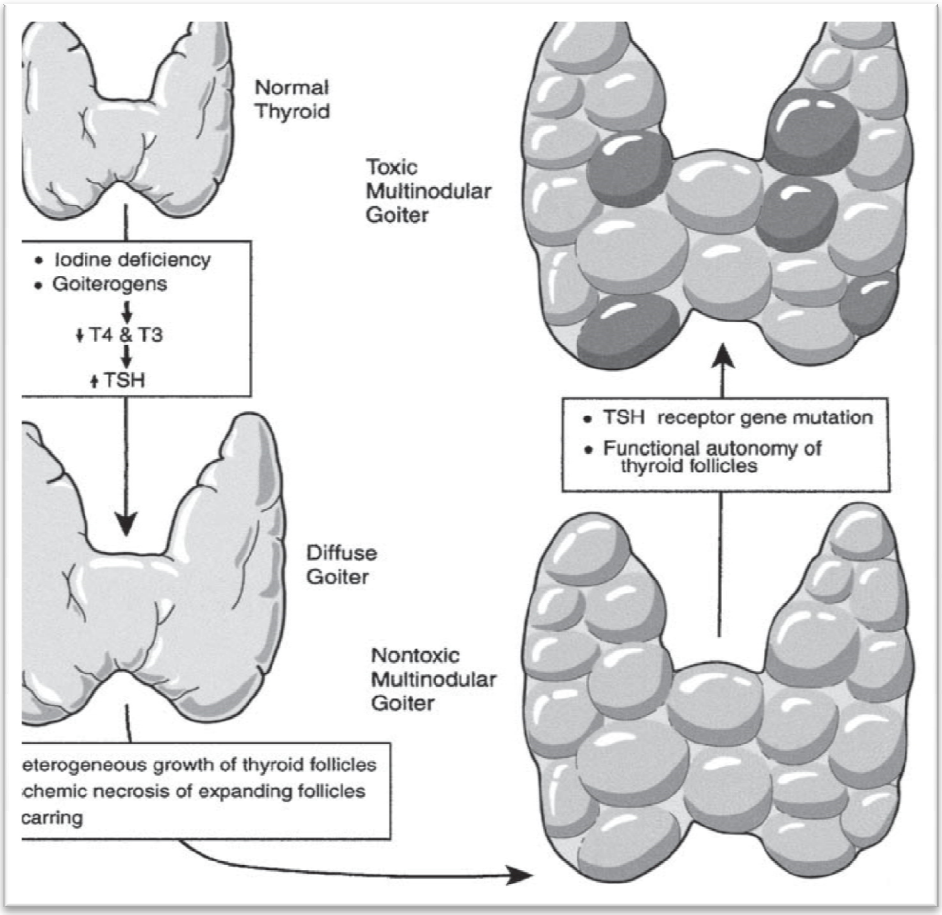


Fig 2-7 shows Pathogenesis of simple goiter

The various stages of goiterogenesis are shown the summary of Pathogenesis of simple goiter these include (1) growth of the thyroid as a result of the stimulatory effect of TSH and growth factors such as epidermal growth factor (EGF), fibroblast growth factor (FGF), and insulin-like growth factor (IGF); (2) nodule formation due to heterogeneous growth of individual thyroid follicles, and ischemic necrosis of expanding thyroid nodules with associated granulation tissue scarring and calcification; (3) increasing functional heterogeneity within the thyroid in which the capacity of thyroid hormone synthesis varies from follicle to follicle; and (4) the development of functional autonomy in which the follicles

within the nodular goiter develop the capacity to synthesize thyroid hormone independent of TSH, leading first to subclinical thyrotoxicosis and finally to overt thyrotoxicosis and toxic multinodular goiter (Rojeski 1985)

2-2-2ENDEMIC GOITER:

The prevalence of endemic goiter is higher in girls than in boys, increases with age during childhood, and peaks at puberty and childbearing age. The prevalence declines in adults and this decline is greater in men than in women .Iodine deficiency in the diet is the most important factor in the development of endemic goiter, which is supported by the finding of decreased prevalence of goiter following iodine supplementation in the diet. However, a significant prevalence of goiter persists after iodine prophylaxis, suggesting that there may additional naturally occurring goiterogens that may play a role in the causation of endemic goiter

2-2-3 SPORADIC GOITER:

This type of simple goiter is 10 times more common in women than in men and it occurs around puberty in both sexes and during pregnancy and lactation in women, suggesting its relationship to physiological demand for iodine . The incidence decreases with age in both sexes and there is significant geographic variation in nonendemic goiter areas for the development of sporadic simple goiter . The cause of sporadic goiter is thought to be relative iodine deficiency. In addition, other factors that play a significant role include the presence of dietary goiterogens mentioned above; certain chemicals that interfere with thyroid hormone synthesis, goiterogens; and certain drugs such as paraminosalicylic acid, sulfonylureas, lithium, and excessive iodine . In a large number of patients no cause can be demonstrated

2-2-4Toxic Multinodular Goiter:

Toxic multinodular goiter (also known as toxic nodular goiter, toxic nodular struma, or Plummer's disease) Toxic nodular goiter involves an enlarged thyroid gland. The gland contains areas that have increased in size and formed nodules. One or more of these nodules produce too much thyroid hormone is a multinodular goiter associated with a hyperthyroidism. It is a common cause of hyperthyroidism in which there is excess production of thyroid hormones from functionally autonomous thyroid nodules, which do not require stimulation from thyroid stimulating hormone (TSH) It is the second most common cause of hyperthyroidism (after Graves' disease) in the developed world. In countries where the population is iodine-deficient i.e. the developing world, iodine deficiency is the most common cause of hypothyroidism. (Decreased iodine leads to decreased thyroid hormone.) However, iodine deficiency can cause goitre (thyroid enlargement); within a goitre, nodules can develop. Risk factors for toxic multinodular goiter include individuals over 60 years of age and female and over 55 years old. Toxic nodular goiter starts from an existing simple goiter Symptoms may include: fatigue ,frequent bowel movements ,heat intolerance increased appetite ,increased sweating ,irregular menstrual period (in women) muscle cramps ,nervousness ,restlessness ,weight loss

2-2-4-1 Sequence of toxic multinodular goiter:

Iodine deficiency leading to decreased T4 production, induction of thyroid cell hyperplasia due to low levels of T4, this accounts for the multinodular goitre appearance ,increased replication predisposes to a risk of mutation in the TSH receptor, if the mutated TSH receptor is constitutively active, it would then become 'toxic' and produces excess T3/T4 leading to hyperthyroidism.(Wilson 1998)

2-2-5 Diagnosis of thyroid goiter:

The doctor may discover an enlarged thyroid gland simply by feeling your neck and having you swallow during a routine physical exam. In some cases, the doctor may also be able to feel the presence of nodules.

2-2-5-1 hormones tests:

Blood tests can determine the amount of hormones produced by yhe thyroid and pituitary glands. If the thyroid is underactive, the level of thyroid hormone will be low. At the same time, the level of thyroid-stimulating hormone (TSH) will be elevated because the pituitary gland tries to stimulate the thyroid gland to produce more thyroid hormone. A goiter associated with an overactive thyroid usually involves a high level of thyroid hormone in the blood and a lower than normal TSH level.(Rojeski, Gharib. 1985)

Table 2-1 summarizes some examples of typical test results and their potential meaning.

TSH	T4	T3	INTERPRETATION
High	Normal	Normal	Mild (subclinical) hypothyroidism
High	Low	Low or normal	Hypothyroidism
Low	Normal	Normal	Mild (subclinical) hyperthyroidism
Low	High or normal	High or normal	Hyperthyroidism
Low	Low or normal	Low or normal	Nonthyroidal illness; pituitary (secondary) hypothyroidism
Normal	High	High	Thyroid hormone resistance syndrome (a mutation in the thyroid hormone receptor decreases thyroid hormone function)

2-2-5-2 Ultrasound imaging:

Ultrasound imaging is based on the same principles involved in the sonar used by bats, ships and fishermen. ultrasound is used to detect changes in appearance, size or contour of thyroid, tissues, and vessels or to detect abnormal masses, such as tumors. Gray scale ultrasound, multiplicity of nodules, bilateral diffuse involvement. Solid nodules are often isochoric with small proportion being hypoechoic 5%. Despite being unencapsulated, nodules are sharply defined with halo(halo composed of adjacent vessels and compressed thyroid). Heterogeneous internal echo pattern with internal debris, septa, solid cystic portions (solid portions with often represents blood clot). Dense shadowing calcification (curvilinear dimorphic, coarse). Nodules with comet tail artifact, highly suggestive of colloid nodule. Cystic component due to hemorrhage or colloid within nodule . background thyroid parenchyma echoes are coarse and heterogeneous(fine bright echoes in normal gland). At the color Doppler Ultrasound peripheral vascularity> intranodular vascularity, septa intranodular solid portions are a vascular (organizing blood, clot).

2-2-5-3Radiographic imaging:

Thoracic inlet x-gray finding , Substernal goiters show, in most cases, a slow-growing enlargement. Chest x-ray findings, if suprasternal ,may be normal or show mild tracheal deviation or harrowing . if substernal, superior medistinal mass with tracheal deviation and narrowing .Chest x-ray finding, if suprasternal , may be normal or show mild tracheal deviation or harrowing .If substernal ,superior medistinal mass with tracheal deviation and narrowing .(Lagalla R et al 1992)

2-2-5-4 Computer tomography :

Neck C.T finding low attenuation areas of degenerative and colloidal cysts. Intermediate attenuation areas of solid adenomaus nodules and fibrosis . High attenuation areas from hemorrhage and calcification (90% amorphous focal ring like).Chest C.T finding thyroid parenchyma replaced with multiple variably sized, heterogeneous solid and cystic masses. diffuse inhomogeneous enhancement.

2-2-5-5 Magnetic Resonance imaging:

T1 W1 finding cystic degeneration ,fibrosis and calcification contribute to hypointense foci . hemorrhage within MNG many yield areas of high T1 signal . Coronal images show(cradling) of inferior margin of substernal MNG by brachiocephalic vessels . T2W2 finding fibrosis and calcification low signal on T2 sequences. Cystic degeneration , hemorrhage seen as high signal foci. T1C+ diffuse markedly inhomogeneous enhancement.(Lagalla R et al 1992)

2-2-5-6 Nuclear medicine imaging:

Although I131 or I 123 may be used for obtaining thyroid uptakes, Tc ^{m99} – pertechnetate and I 123 sodium remain the agents of choice for obtaining maximum morphologic detail of the thyroid gland with the gamma camera . Either radionuclide provides images of excellent quality although the higher energy photons of I^{131} may be preferable for imaging deep ectopic tissue .Even though I^{123} is more expensive than Tc^{m99} , it has the advantage of being able to provide concurrent radioidine uptake and images with relatively low radiation dose. In addition, I123 images reflect both trapping and organification in the gland. **Thyroid scan:** for thyroid scan I^{131} I^{123} and TC^{99m} are used . According to physiology radioactive iodine is appropriate , but considering the physical

characteristics, TC99m O4 is widely used for thyroid scan. **Image acquisition:** image is acquired 10-20minet after intravenous injection of 5-10 mci of $TC^{99m}O^4$ generally , the pinhole collimator is used to change the size of the thyroid on image by changing the distance between thyroid and collimator. Therefore, size marker is used together 100,000 to 300,000 counts or (5minutes) with patient supine and neck extended.

The indications for scintigraphic thyroid imaging include: to relate the general structure of the gland to function , particularly in differentiatiog Graves, disease from toxic nodular goiter. This distinction is important in determining therapeutic radioiodine dose, to determine function in a specific area, for example, to see if a palpable nodule is functional ,to locate ectopic tissue, such as a lingual thyroid, to assist in evaluation of congenital hypothyroidism or organification defects, to determine the a cervical or mediastinal mass is thyroid tissue, to differentiate among the causes of thyrotoxicosis, that is, Graves, disease from subacute, silent, postpartum, or factitious hyperthyroidism. In the latter entities, there are symptoms of mild hyperthyroidism with elevated serum levels of thyroid hormone, but radioiodine studies reveal that the radioiodine uptake in the gland is low and visualization is poor . (Raven 1997)

Normal findings of the thyroid scan: a normal thyroid scan shows a clear margin of thyroid with definite and even uptake of the radioisotope. The lateral margin of thyroid is linear or slightly convex. In case of concave lateral margin ,the extrthyroid lesion should be considered. The most common artifact of TC^{99m}-pertechnetate studies of the thyroid is produced by activity secreted by the salivary glands and swallowed by the patient . This usually presents as a linear area of esophageal activity in the midline of the image. if this complicates interpretation or

causes confusion with an enlarged pyramidal lobe ,repeat imaging should be performed using oblique images or after clearing the esophagus by drinking water.

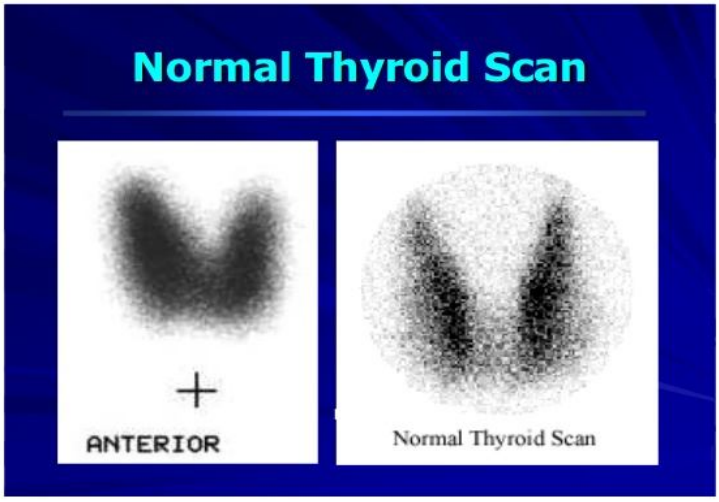


Fig 2.7shows Thyroid scan image

Abnormal finding of thyroid scan:

A. **non-visualized thyroid:** Ectopic thyroid tissue, may occur in the neck, in the base of the tongue (lingual thyroid) in the pelvis (struma ovarii) , or retrosternally in the region of the mediastinum (substernal goiter). When ectopic sites deep within the body are suspected 24-hour imaging with I^{131}-sodium is the method of choice because of interfering salivary gland activity in the neck , attenuation of 140-KeV gamma rays by the sternum or soft tissues, and excessive blood pool activity,TC^{99m}-pertechnetate is generally not as useful. Increase of iodine pool in serum(excess administration of iodine) **,**chronic thyroiditis or primary myxedema, Anti-thyroid treatment ,thyroidectomy state or after ablation of residual thyroid, Congenital thyroid

abnormality become apparent in the first monthe of life. The typical presentation in an infant with low serum thyroid hormone levels and high TSH level.A 24-hour radioiodne scan usually show on activity in the thyroid because without organification , the trapped iodine washes out of the gland and it is not possible to distinguish this from an absent thyroid .A TC^{99m}-pertechnetate,or 2-to 4-hour I123 scan ,on the other hand ,clearly shows the presence of the thyroid because the trapping mechanism of the gland is intact.

B. **B-thyroid nodule:** nodules are classified at imaging with respect to the relative amount of activity present. Cold nodules demonstrate an essential absence of activity, whereas hot nodules are identified by focally increased activity compared with the normal thyroid parenchyma. Nodules that are neither hot nor cold but contain activity comparable to that of the surrounding gland are frequently termed warm nodules.

C. **Cold nodule:** refers to the nodule with a low uptake of radioisotope rather than the normal thyroid. Cold nodule could be found in case of cyst, malignant tumor, benign tumor, thyroiditis , fibrosis, calcification. **Warm nodule and hot nodule:** hot nodule refers to the nodule with higher uptake of radioisotope rather than normal thyroid. Warm nodule show similar uptake as normal thyroid. Some hot nodules have autonomy. Most of the toxic autonomously functioning nodules are benign tumors. some patients with toxic autonomously functioning nodules could have hyperthyroidism due to excess secretion thyroid hormone from nodule.

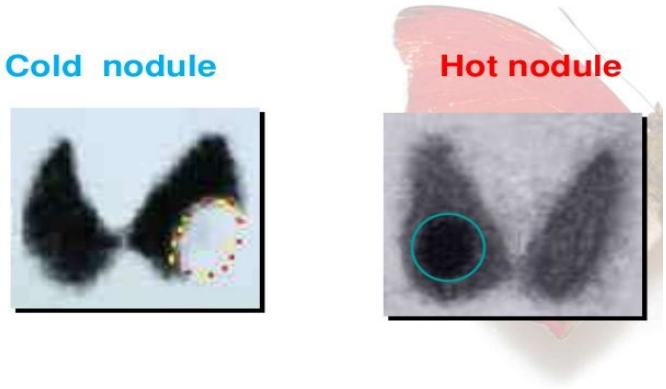


Fig 2.8 shows Thyroid nodules (1)

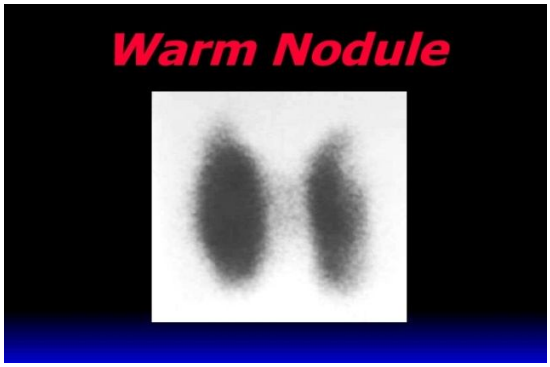


Fig 2.9 shows thyroid nodules (2)

C-Multinodular gland: multinodular goiter typically presents as an enlarged gland with multiple cold, warm, and hot areas, which give the glan a coarsely patchy appearance. These nodules generally constitute a spectrum of thyroid adenomas ranging from hyper functioning to cystic or degeneration lesions. In adults, the cold lesions identified in a multinodular goiter are significantly less likely to represent carcinoma than are solitary cold nodules. Occasionally , multinodular goiter may be mimicked by thyroiditis with multifocal involvement of the gland. However , differentiation on clinical and laboratory grounds is usually possible. (Raven 1997)

Fig 2.10 shows Multi nodular goiter

D-Thyroiditis: chronic thyroiditis (Hashimoto,s thyroiditis) is the most common form of inflammatory disease of the thyroid. The disease is thought to be autoimmune in origin and is much more common in female pations. Occasionally symptoms of mild hyperthyroidism or hypothyroidism may be present, depending on the stage and severity of the disease. Chronic thyroiditis is clinically common and most of them are Hashimoto,s thyroiditis. It typically shows enlarged thyroid with uneven uptake on thyroid scan. In some cases, it shows like thyroid aplasia. Thyroid function test is normal or decreased.

E- Diffuse Toxic Goiter (Graves, disease): diffuse toxic goiter is thought to be of autoimmune origin. It usually presents with varying degrees of thyromegaly. In diagnosis or Graves disease, thyroid scan is not mandatory. However , thyroid scan is performed accompanying thyroid nodule or adenoma. Graves, disease shows evenly increased uptake in thyroid scan.(Raven 1997).

2-3 gamma camera :

A gamma camera, also called a scintillation camera or Anger camera, is a device used to image gamma radiation emitting radioisotopes, a technique known as scintigraphy. The applications of scintigraphy include early drug development and nuclear medical imaging to view and analyse images of the human body or the distribution of medically injected, inhaled, or ingested radionuclides emitting gamma rays. A gamma camera consists of one or more flat crystal planes (or detectors) optically coupled to an array of photomultiplier tubes in an assembly known as a "head", mounted on a gantry. The gantry is connected to a computer system that both controls the operation of the camera and acquires and stores images. The construction of a gamma camera is sometimes known as a compartmental radiation construction. The system accumulates events, or counts, of gamma photons that are absorbed by the crystal in the camera. Usually a large flat crystal of sodium iodide with thallium doping in a light-sealed housing is used. The highly efficient capture method of this combination for detecting gamma rays was discovered in 1944 by Sir Samuel Curran whilst he was working on the Manhattan Project at the University of California at Berkeley. Nobel prize-winning physicist Robert Hofstadter also worked on the technique in 1948. The crystal scintillates in response to incident gamma radiation. When a gamma photon leaves the patient (who has been injected with a radioactive pharmaceutical), it knocks an electron loose from an iodine atom in the crystal, and a faint flash of light is produced when the dislocated electron again finds a minimal energy state. The initial phenomenon of the excited electron is similar to the photoelectric effect and (particularly with gamma rays) the Compton effect. After the flash of light is produced, it is detected. Photomultiplier tubes (PMTs) behind the crystal detect the fluorescent flashes (events) and a computer sums the counts. The computer

reconstructs and displays a two dimensional image of the relative spatial count density on a monitor. This reconstructed image reflects the distribution and relative concentration of radioactive tracer elements present in the organs and tissues imaged. Imaging techniques using gamma cameras Scintigraphy ("scint") is the use of gamma cameras to capture emitted radiation from internal radioisotopes to create two-dimensional[1] images. SPECT (single photon emission computed tomography) imaging, as used in nuclear cardiac stress testing, is performed using gamma cameras. Usually one, two or three detectors or heads, are slowly rotated around the patient's torso. Multi-headed gamma cameras can also be used for Positron emission tomography scanning, provided that their hardware and software can be configured to detect "coincidences" (near simultaneous events on 2 different heads). Gamma camera PET is markedly inferior to PET imaging with a purpose designed PET scanner, as the scintillator crystal has poor sensitivity for the high-energy annihilation photons, and the detector area is significantly smaller. However, given the low cost of a gamma camera and its additional flexibility compared to a dedicated PET scanner, this technique is useful where the expense and resource implications of a PET scanner cannot be justified. (Raven 1997).

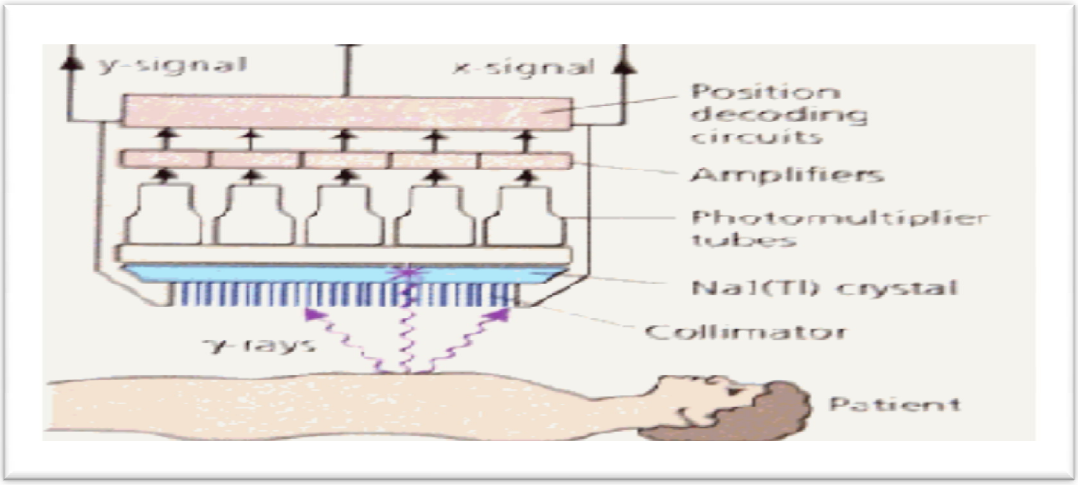


Fig 3.1 shows gamma camera components

2-4 Previous Studies:

In the realm of evaluating and diagnoses of the type of thyroid goiter by using the nuclear medicine imaging technique a numbers of researchers have studied the behavior. A research team, which included investigators from the University of Pennsylvania and Temple University examined data on 111000 patients from the National Inpatient sample years 2000- 2010 . In this group 5525 patients were diagnosed with a substernal goiter. These patients were sudstantially more likely to be older, male, black, Hispanic or to have Medicare insurance.While the vast majority of goiter occur among women, men were significantly more likely to present with substernal goiter

Compared to patients with typical-sized goiters, researchers found that patients with substernal goiter had higher comorbidity (such as hypertension, diabetes, and obesity), were more likely to be admitted to a hospital on an emergency basis, and to have postoperative complications including hemorrhage, lung collapse, and pulmonary embolism. Furthermore, substernal patients were 73 percent more likely to die during hospital admission.

Neki (2006) published review article on thyroid goiter and their conclusion was thyroid goiter are common in females 90% . 25 of them are benign in nature combined use of FNAC, thyroid scan and Ultrasonography can detect them with 85% accuracy.

Kazal HL at el suggested that the evaluation of thyroid goiter is done by taking a detailed medical history , general physical examination, metabolic profile (thyroid function test), imaging and invasive procedures , including FNAC. So, for evaluation, three questions must be taken care of . Is the goiter toxic or not , is the

goiter causing pressure symptoms on the adjoining structures of the neck, is the goiter secreting excess of thyroid hormones. They suggested the points which favored benign pathology as family history of hashimoto thyroiditis , symptoms of hypo-or hyperthyroidism, pain or tenderness associated with the goiter , surface of goiter being soft ,smooth and mobile, multinodulae goiter without a dominant nodule, female sex and points in favor of malignancy as young patients < 20 years age or old > 70 years age, male sex history of external neck radiation during childhood or adolescence , recent change in voice (hoarseness or dysphonia), difficulty in swallowing (dysphagia) , past or family history of thyroid carcinoma, on physical examination, firm consistency of nodule, its irregular shape , its fixation to underlying or overlying tissues , and suspicious regional lymphadenopathy .they also suggested that childhood nodule need special attention due to high incidence of malignancies i.e. 15-25% as compared to adults. Kambal 1968 has chosen endemic goiter as subject because it was a common condition in the Sudan.The records of goiter admission of the University Department of surgery, Khartoum hospital during thr three years 1965-1946 showed that no less than 9.5% of the non-urgent admissions were due to thyroid diseases, mostly simple goiter. The same records indicated that a large proportion of these patients were derived from Darfur especially those with large goiters.The objectives of kambal's study was to determine the incidence of goiter in various parts of Darfure province and to map out the etiological factors underlying the state of endemicity and to out line the most suitable method by means of which goiter can be controlled.

Result of kambal's study : Kambel reported that in the province of Darfur the prevalence of goiter was 58% and that of large goiter 19% , Kambel reported that goiter in all its clinical types constituted an incidence of 12.2% at Khartoum region

Kambel reported one malignant thyroid nodule among a series of 76 patients 1.3% .Kambel considered Khartoum to be an endemic area according to the WHO committee which regarded any area in which the frequency of goiter exceeding 10% to be considered as an endemic area .Kambal belived that endemic goiter in Darfur is due to iodine deficiency.Kambal pointed that salt iodization is the only rational method for goiter control.

CHAPTER THREE

Material and Method

Chapter Three

Materials and Methods

3-1 Materials:

3-1-1 Study sample:

The sample size consisted of 80 thyroid goiter images of patients selected from the gamma camera department at alNelain diagnostic Center during the period . The demographic details of the patient like age, gender and family history were noted for each patient. All the patients included in the study underwent thyroid scan and uptake using Tc^{99m} .

3-1-2 Equipment :

- In this study Thyroid uptake and imaging were carried out using gamma camera single head (MIE, type orbital Digi 37WB) SN 2008/43at AlNilain diagnostic Center
- Tc^{99m}- pertechnetate as a radiopharmaceutical elute from MO^{99}/TC^{99m} generator (Mon.Tek Eczacibasi pharmaceuticals activity 30 GBq) .

3-2 Methods:

3-2-1Technique:

In this study TC^{99m}- pertechnetate was used to do Thyroid uptake and imaging , thyroid was imaged 20 minutes after the intravenous administration of 5 mCi of TC99m- pertechnetate and imaging was carried out using gamma camera single head at nuclear medicine department of AlNilain Diagnostic Center.

3-2-2Methods of data collection:

The information were obtained from books, internet websites ,previous studies thyroid scan images for thyroid goiters patients who had not taken any thyroid medication or radiotherapy.

3-2-3 Methods of data analysis:

The collected data will be analyzed with IBM SPSS statistics version 23' date editor virgin 2, personal computer.

3-3 Inclusion Criteria:

- Patients with thyroid goiters who were referred to alnillen diagnostic center
- Both genders and different ages were included.

3-4 Exclusion Criteria:

- Patients who had therapeutic radiation dose of iodine within 20 days from thyroid scan
- Patients who did not stop thyroid medication within 10 days for thyroxine and 15 days for newmercazole before thyroid scan
- Patients of other thyroid disorders.

CHAPTER FOUR

Result

Chapter four
Results

The present study dealt with investigation of thyroid goiter using thyroid scintigraphy

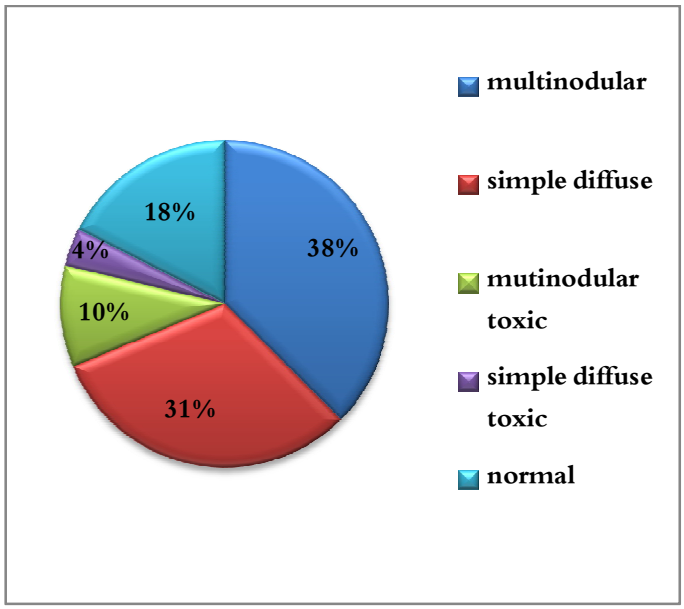
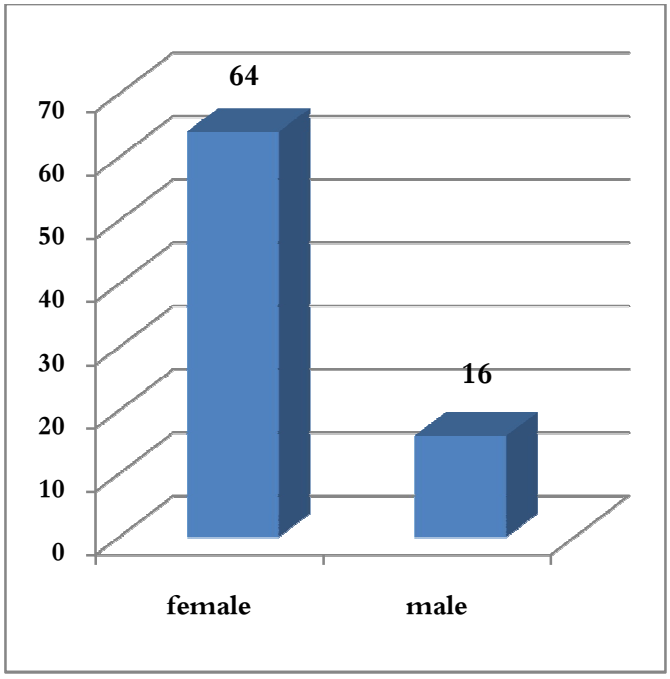


fig 4-1: shows Goiter incidence of patients with thyroid goiter

Table 4-1: shows Goiter incidence of patients with thyroid goiter

Type	Percent	Frequency
multinodular	38%	30
simple diffuse	31%	25
mutinodular toxic	10%	8
simple diffuse toxic	4%	3
normal	18%	14
Total		80



Bar fig 4-2 Gender incidence of patients with thyroid goiter

Table4-2: shows Gender incidence of patients with thyroid goiter

gender	Frequency
female	64
male	16
Total	80

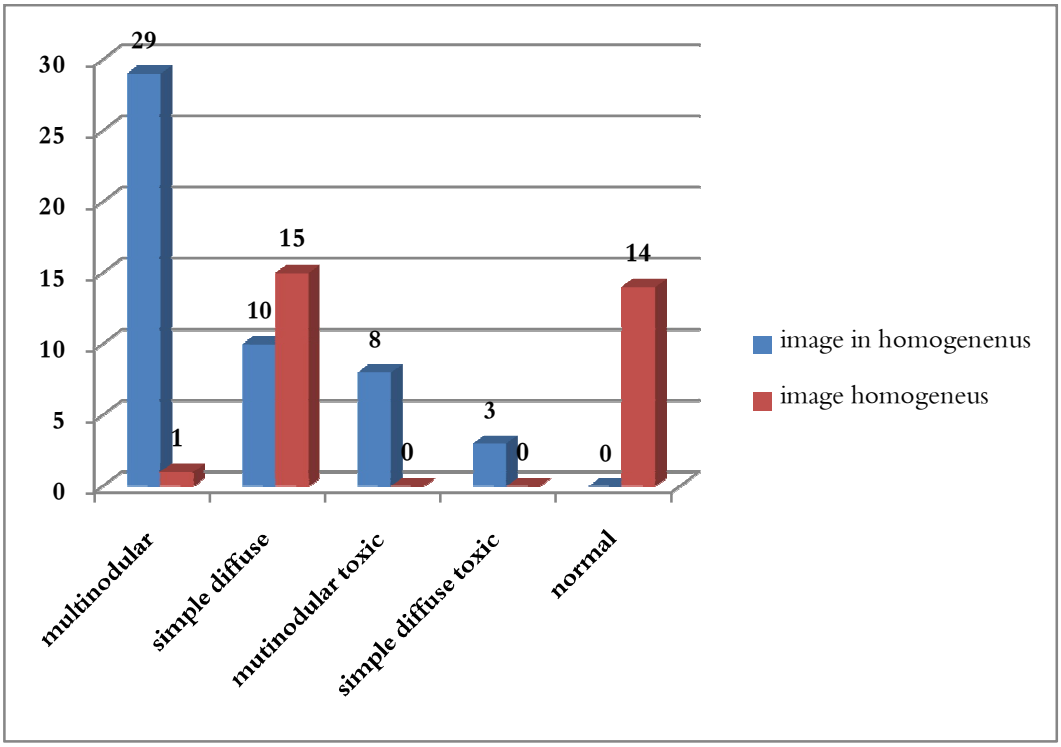


Fig 4-3: shows Image uptake for each goiter of thyroid scan

type	Image		Total
	in homogenenus	homogeneus	
multinodular	29	1	30
simple diffuse	10	15	25
mutinodular toxic	8	0	8
simple diffuse toxic	3	0	3
normal	0	14	14
Total	50	30	80

Tab4-3:Image uptake for each goiter of thyroid scan

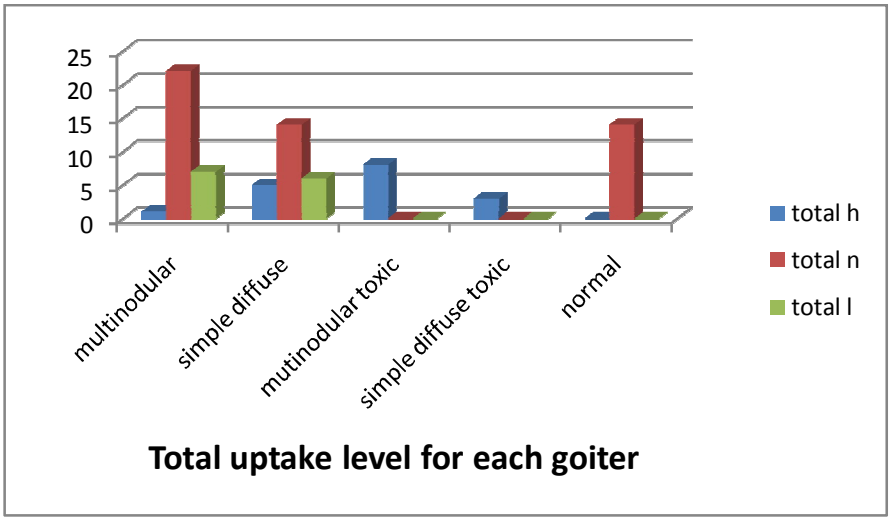


Fig4-4 shows: Total uptake level for each goiter

(normal total uptake 0.5 – 4.0%)

Tab 4-4 show: Total uptake level for each goiter

type	Total			Total
	H	N	L	
multinodular	1	22	7	30
simple diffuse	5	14	6	25
mutinodular toxic	8	0	0	8
simple diffuse toxic	3	0	0	3
normal	0	14	0	14
Total	17	50	13	80

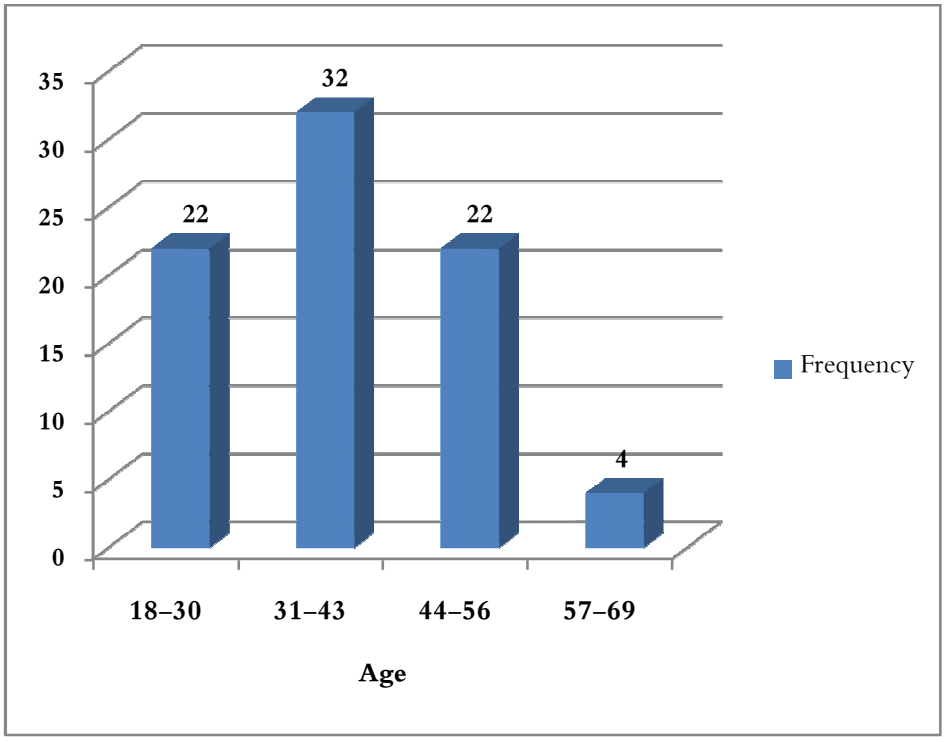


Fig 4-5 Age distribution of patients with thyroid goiter

Table 4-5: Age distribution of patients with thyroid goiter

Age	Frequency
18-30	22
31-43	32
44-56	22
57-69	4

CHAPTER FIVE

Discussion, Conclusion, Recommendation, References and Appendix

Chapter five

Discussion

Thyroid scintigraphy plays an important role in diagnosis of thyroid goiter. Nature of disease , experience and understanding of certain limitation determine its diagnostic utility. This study dealt with thyroid scintigraphy preformed for 80 patients.

The range of age of the patients under study was between (18 – 69 years) .The majority of patients who had thyroid goiter was at the range of age between 31-43 years as shown at table 4-5 which represented age distribution of patient with thyroid goiter and thyroid goiter disease was more prevalent among women , with females to male ratio being 4:1 , female 64% and male 16% and that agrees with the fact that females are more effected by thyroid goiter than male(Rojeski MT 1985) . Enlargement of thyroid gland according to this study took two shapes:, simple diffused goiter whose ratio was 31% multinodular goiter whose ratio was 38% . A goiter can develop in conditions with overproduction of thyroid hormone called toxic goiter and the ratio of toxic multinodular goiter was10% and toxic simple diffuse goiter was 4% as shown on table 4-1 which represented goiter incidence of patients with thyroid goiter.

Multinodular goiter image in this study was represented as an enlarged gland with multiple cold , warm , and hot areas which give the gland inhomogeneous gland appearance ; 92% of multinodular goiter patients had a inhomogeneous thyroid scan image and 1% was a homogeneous image. Simple diffuse goiter shown relatively homogeneous gland appearance ;10% of simple diffuse goiter patients had inhomogeneous thyroid scan image and 15% was homogeneous. A toxic

gland was presented as overproduction of thyroid hormones which it led to increase activity at the gland and that is why it showed as inhomogeneous gland appearance.

The aim of measuring thyroid function is to measure how much radioactive is taken up by the thyroid gland .In this study toxic goiter patients took up too much activity due to overproduction of thyroid hormones that is why it always have a high thyroid uptake level whereas multinodular and simple diffuse goiter showed different level of total thyroid uptake between high, normal, and low depending on the amount of activity taken by the thyroid as shown at table 4-4 which represented total uptake level for each goiter.

Conclusion

- Thyroid goiters are common in 7% to 10% of the population and affect women more commonly than men(Rojeski 1985). The man cusses of thyroid goiter is hyperthyroidism - when the thyroid gland makes more thyroid hormones than a body needs ,hypothyroidism – when the thyroid gland does not make enough thyroid hormones, thyroid cancer thyroid nodules - lumps in the thyroid gland ,thyroiditis.
- In this study thyroid scan was performed in 80 cases with goiter in the department of nuclear medicine in the Al-nelin Diagnostic Center . The range of age of the patients under study was between (18 – 69 years), 64% were females and 16% were males . According to the diagnosis, 14 (18%) was normal , 30 (38%) was multinodular goiter ,25 (31%) was simple diffuse goiter , 8 (10%) was toxic multinodular goiter , 3 (4%) was toxic simple diffuse goiter. 92% of multinodular goiter patients had inhomogeneous thyroid scan image and 1% was homogeneous image , 10% of simple diffuse goiter patients had inhomogeneous thyroid scan image and 15% was homogeneous. All toxic goiters showed as inhomogeneous thyroid scan image 8% for toxic multinodular goiter and 3% for toxic simple diffuse goiter. From the above percentages, it could be concluded that multinodular goiter was more prevalent than other types of goiters , whereas toxic simple diffuse goiter represented the least percentage.

Recommendations

Diet with rich iodine should be taken by all people especially people of west Sudan. TFT, ultrasound and Thyroid scan are recommended as a routine prime investigation in the work-up of the thyroid goiter .

I^{123} could be used for thyroid scan to determine the goiter functioning because iodine is organified by the thyroid in contrast to Tc^{99m}.

Standard dose, technique and position should always be adopted in thyroid imaging .

Determination of the best method of long-term follow-up of patients with thyroid goiter.

More concern and care should be paid to patients with thyroid goiters in Sudan

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Appendix1

Table(5-6) : represent the 80 patient with thyroid goiter (master table) :

NO	gender	Age	Goiter	Image	Total uptake	Uptake
1	female	18	multinodular	homogeneus	1.87	N
2	female	18	normal	homogeneus	1.63	N
3	female	19	normal	homogeneus	2.20	N
4	female	20	normal	in homogenenus	.50	N
5	female	22	multinodular	in homogenenus	.25	L
6	female	22	simple diffuse	homogeneus	.45	L
7	female	22	simple diffuse	homogeneus	.04	L
8	female	23	simple diffuse	homogeneus	2.50	N
9	female	23	simple diffuse	in homogenenus	1.29	N
10	female	26	multinodular	homogeneus	.51	N
11	male	26	multinodular	homogeneus	.87	N
12	female	26	normal	in homogenenus	.89	N
13	female	27	multinodular	homogeneus	1.11	N
14	female	27	simple diffuse	homogeneus	1.18	N
15	female	27	normal	homogeneus	1.50	N
16	male	28	normal	homogeneus	.90	N
17	male	29	simple diffuse	in homogenenus	.93	N
18	male	29	multinodular	in homogenenus	.07	L

19	female	30	multinodular	in homogenenus	1.40	N
20	female	30	multinodular	in homogenenus	1.41	N
21	female	30	multinodular	homogeneus	1.85	N
22	female	30	normal	in homogenenus	1.47	N
23	female	31	simple diffuse	in homogenenus	.70	L
24	female	31	multinodular	in homogenenus	1.12	N
25	female	31	multinodular	in homogenenus	2.10	N
26	female	31	simple diffuse	in homogenenus	1.26	N
27	female	31	simple diffuse toxic	in homogenenus	14.20	H
28	female	32	multinodular	in homogenenus	.77	N
29	male	32	multinodular	in homogenenus	1.48	N
30	female	32	multinodular	in homogenenus	1.56	N
31	female	33	multinodular	homogeneus	.46	L
32	female	33	simple diffuse	in homogenenus	.40	L
33	female	33	multinodular	homogeneus	2.10	N
34	male	33	normal	homogeneus	.81	N
35	male	35	normal	homogeneus	1.70	N
36	male	35	normal	in homogenenus	1.90	N
37	female	35	multinodular	in homogenenus	.28	L
38	female	35	mutinodular toxic	homogeneus	5.80	H
39	female	36	simple diffuse	homogeneus	1.12	N
40	female	36	simple diffuse	homogeneus	1.23	N

41	male	36	simple diffuse	homogeneus	4.90	H
42	male	36	normal	homogeneus	.96	N
43	male	36	normal	homogeneus	.13	N
44	male	37	normal	in homogenenus	2.47	N
45	male	39	simple diffuse	homogeneus	.33	L
46	female	39	simple diffuse	homogeneus	.51	N
47	male	40	normal	in homogenenus	.61	N
48	female	40	simple diffuse	in homogenenus	5.80	H
49	female	40	multinodular	in homogenenus	1.67	N
50	female	41	mutinodular toxic	in homogenenus	5.00	H
51	female	41	simple diffuse toxic	in homogenenus	9.00	H
52	female	43	multinodular	homogeneus	1.17	N
53	female	43	simple diffuse	in homogenenus	1.11	N
54	female	43	simple diffuse toxic	in homogenenus	10.50	H
55	male	45	multinodular	homogeneus	2.10	H
56	female	45	simple diffuse	homogeneus	1.77	N
57	female	45	simple diffuse	in homogenenus	1.30	N
58	female	45	simple diffuse	in homogenenus	1.47	N
59	female	45	mutinodular toxic	in homogenenus	12.40	H
60	female	45	multinodular	homogeneus	.40	L
61	female	46	simple diffuse	in homogenenus	.42	L
62	female	46	mutinodular toxic	in homogenenus	18.50	H

63	female	47	mutinodular toxic	in homogenenus	11.00	H
64	female	48	mutinodular toxic	in homogenenus	7.70	H
65	female	49	multinodular	in homogenenus	.89	N
66	female	49	simple diffuse	in homogenenus	16.40	H
67	female	49	multinodular	homogeneus	1.11	N
68	female	50	simple diffuse	in homogenenus	.91	N
69	male	50	multinodular	in homogenenus	.52	N
70	female	50	multinodular	in homogenenus	.43	N
71	female	50	simple diffuse	in homogenenus	.91	N
72	female	50	multinodular	in homogenenus	.36	L
73	female	53	simple diffuse	in homogenenus	3.50	H
74	female	55	multinodular	in homogenenus	.30	L
75	female	55	simple diffuse	in homogenenus	4.30	H
76	female	56	mutinodular toxic	in homogenenus	36.40	H
77	female	57	multinodular	in homogenenus	.71	N
78	female	60	mutinodular toxic	in homogenenus	20.50	H
79	female	63	multinodular	in homogenenus	.60	N
80	female	68	multinodular	homogeneus	1.40	N

Appendix 2

Fid 5-1: show MO^{99}/TC^{99m} generator

Fig 5-2: show dose celebratre

Fig 5-3: show gamma camera single head 1

Fig 5-4: show gamma camera single head 2