

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Sudan University of Science and Technology

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Classification of Thyroid Nodules Among Patients in Gezira State

تصنيف عقيدات الغدة الدرقية لدى المرضى بولاية الجزيرة

A thesis Submitted for Partial Fulfillment of M. Sc. Degree in Nuclear
Medicine Technology

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February 2017

الآية

بسم الله الرحمن الرحيم

قال تعالى:

وَقُلْ اَعْمَلُوا فَسَادِي اللَّهِ عَوَّلَكُمْ وَاَنْفُسَكُمْ وَاَنْفُسَكُمْ

صدق الله العظيم

(سورة التوبة : 105)

Dedication

**Every challenging work needs self efforts as well as guidance of
elders especially those who were very close to our heart.**

I dedicate my humble effort to my sweet and loving...

Father & Mother,

**Whose affection, love, encouragement and prayers of day and
night make me able to get such success and honor,**

Also I dedicate this work to my...

Brothers, sisters and friends

For their all continued love and support.

Acknowledgment

I wish to express my sincere thanks to Dr. Salah Ali Fadlalla, for providing me with all the necessary facilities for this research.

Also I would like to thank Mr. Yousif Abdelhammed, NCI, Abdelbagi Omer and everybody who had a role in pushing me forward.

Abstract

Thyroid scintigraphy using Tc-99m pertechnetate is a frequently performed procedure in routine nuclear medicine practice. There is no clear description of thyroid diseases pattern in Sudan using nuclear medicine as a diagnostic tool. The aim of this retrospective study was to classify the pattern of thyroid nodules using the nuclear medicine facilities in National Cancer Institute during a period (2014-2015).

All patients referred to the department of nuclear medicine for thyroid scan from January 2014 to December 2015 were included in this study .Data were analyzed by SPSS software. A total of 1538 subjects were included in this study (142 male, 1396 female with ratio of 1:9, mean age 38.4 ± 15.08 years). All subjects underwent static thyroid scintigraphy after injection of $^{99m}\text{Tc-O}_4$, thyroid uptake and scan were taken as a conclusion of the thyroid report; the thyroid nodules were classified, in addition to other thyroid diseases. The total numbers of thyroid nodules were compared with other thyroid disease. The percentages of each type were calculated and comparison of all types was determined. The percentage of cold nodule was (2%) , hot or toxic nodules was (19%) , simple multi nodular was (31%) and toxic multinodular was (4%) in a total of nodular goiter (56 %). This study concluded that, there was high percentage of nodular goiter among the patients under study.

المستخلص

يعتبر تصوير الغدة الدرقية باستخدام نظير التكنيشيوم المشع من أكثر الاختبارات شيوعاً في الطب النووي لتحديد شكل وحجم ووظيفة الغدة الدرقية. لا يوجد وصف واضح لنمط أمراض الغدة الدرقية في السودان باستخدام الطب النووي كأداة تشخيصية، لذا كان الهدف من هذه الدراسة المرجعية هو تصنيف عقيدات الغدة الدرقية وحساب نسبتها في جميع حالات المرضى الذين تم تصويرهم في قسم الطب النووي في المعهد القومي للسرطان في العامين (2014-2015).

وقد شملت الدراسة جميع المرضى المحولين الى قسم الطب النووي لفحص الغدة الدرقية من يناير 2014 الى ديسمبر 2015. تم تحليل البيانات باستخدام برنامج الحزم الإحصائية للعلوم الاجتماعية SPSS ومن ثم تحديد وجود العقيدات بأشكالها المختلفة. اشتملت الدراسة على عدد الف وخمسمائة ثمانية وثلاثين حالة، كان عدد الذكور (142) وعدد الإناث (1396) بنسبة مطلقة 1:9 وكان متوسط أعمارهم ± 38.4 سنة. وخضعت جميع الحالات لفحص الغدة الدرقية بعد حقنهم بنظير التكنيشيوم وبعد المسح الضوئي تم تجميع وتصنيف وتحليل تقارير صور الغدة الدرقية للفئة المستهدفة؛ وصنفت عقيدات الغدة، بالإضافة إلى أمراض الغدة الدرقية الأخرى. تم حساب النسب المئوية لأي نوع من عقيدات الغدة الدرقية ومقارنتها بأمراض الغدة الدرقية الأخرى. وأظهرت هذه الدراسة أن العقيدات الباردة كانت تمثل (19%) والساخنة (2%)، والمتعددة الباردة (31%)، والمتعددة النشطة (4%) وقد مثلت في مجموعها النسبة الأعلى (56%) من مجموع امراض الغدة الدرقية المختلفة. خلصت هذه الدراسة أن وجود العقيدات بأشكالها المختلفة تمثل النسبة الأعلى لأمراض الغدة الدرقية للمرضى الذين وفدوا إلى القسم في تلك الفترة.

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List of abbreviations

NM - Nuclear Medicine.

CT - Computerized Tomography.

MRI - Magnetic Resonance Imaging.

I¹²³ - Iodine -123.

Tc^{99m} - Technetium-99m.

TSH - Thyroid Stimulating Hormone.

PTU - Propylthiouracil.

T4 - Thyroxine.

T3 - Triiodothyronine.

Tg - Thyroglobulin.

AMP - Adenosine Monophosphate.

TRH - Thyrotropin Releasing Hormone.

SCN - Thiocyanate.

CLO₄ - Perchlorate.

MT - Methimazole.

MIT - Mono- iodo-tyrosine

DIT - Di-iodo-tyrosine.

RAIU - Thyroid Radioactive Iodine Uptake.

FNA - Fine Needle Aspiration Biopsy.

^{99m}TcO₄⁻ - Pertechnetate Ions.

SPECT - Single Photon Emission Computed Tomography.

⁵⁷Co - Isotopes of Cobalt.

DTC - Differentiated Thyroid Cancer.

Gy - Gray.

Rad - Radiation Absorbed Dose.

KeV - Kilo electron Volt.

AFTN - Autonomously Functioning Thyroid Nodules.

rh TSH - Recombinant Human TSH.

CHT - Congenital Hypothyroidism.

USA - United States of America.

MBq - Megabecquerel.

mCi - Millicurie.

RIA - Radioimmunoassay.

SPSS - Statistical Package for the Social Sciences.

NCI - National Cancer Institute.

RICK - Radioisotope Center in Khartoum.

Na^{99m}TcO₄. Sodium Pertechnetate.

SDG - Simple Diffuse Goiter.

SNG - Simple Nodular Goiter.

SMNG - Simple Multinodular Goiter.

TDG - Toxic Diffuse Goiter.

TNG - Toxic Nodular Goiter.

TMNG - Toxic Multinodular Goiter.

ALARA - As Low As Reasonably Achievable.

Chapter One

Introduction

Chapter one

Introduction

1.1. Introduction:

Thyroid disorders affect a wide spectrum of our population. Numerous imaging modalities including nuclear medicine, ultrasonography, computerized tomography (CT) and more recently magnetic resonance imaging MRI have been used in an attempt to provide a pathophysiologically related diagnosis in patients with diseases of the thyroid. (Yousef et. al. 2012)

Nuclear medicine imaging of thyroid provides useful information about the shape, size and site of thyroid tissue, the function of thyroid nodule, and functioning thyroid tissue in patients with thyroid carcinoma. Either iodine -123 (I^{123}) or technetium-99m (Tc^{99m}) may be used. Iodine deficiency continues to be a significant public health problem in many areas of the world. (Yousef et. al. 2012)

A thyroid nodule is a 'discrete lesion within the thyroid gland that is palpably and/or ultrasonographically distinct from the surrounding thyroid parenchyma. Thyroid nodules are extremely common, with 7% of adults having palpable nodules and up to 50% of adults having nodules visible on ultrasound around 5% of thyroid nodules are malignant. (Yousef et. al. 2012)

Thyroid nodules may occur as isolated, often incidental findings, or they may be associated with systemic features of thyrotoxicosis or hypothyroidism.

They may be solitary or may present as a dominant nodule in a multinodular goiter. Solitary nodules have a higher likelihood of being malignant although overall the prevalence of cancer is similar between patients with a solitary nodule and patients with multiple nodules. (Yousef et. al. 2012)

The challenge for the general practitioner is to assess the nodule and determine which patients require referral to a surgeon or endocrinologist for further investigation and management. (Yousef et. al. 2012)

Referral may be required to exclude or confirm malignancy and is also indicated for patients who are symptomatic from benign thyroid nodule. (Yousef et. al. 2012) Thyroid scintigraphy is highly sensitive and specific in detecting thyroid nodules and can be used as sole investigation for deciding management protocol in thyroid nodular goiter. (Yousef et. al. 2012)

Role of thyroid scintigraphy in distinguish thyroid nodule (benign-malignant) and characterized them into appropriate management. (Yousef et. al. 2012)

Technetium 99m, in the chemical form of pertechnetate ($^{99m}\text{TcO}_4^-$), 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. ^{99m}Tc -pertechnetate has been used worldwide to study the thyroid function because of a number of advantages, such as a short half-life (6 hours), short retention in the gland, and no Beta- 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. (Celso et al 2002)

The size and nodularity of the thyroid gland increases over time and the presence of a nodular gland is often first detected either by the patients themselves or by the physician during a routine physical examination or a radiological examination of the neck. (Michel et al 2012)

Most patients with nodular goiters are asymptomatic and the medical concerns essentially revolve around three questions: the presence of thyroid dysfunction, the presence of a malignancy, and the likelihood of a progressive increase in size of the nodule ultimately leading to symptoms. Some patients can present with a rapidly enlarging, and sometimes painful, thyroid mass, which may reflect degeneration and hemorrhage into a previously undetected adenomatous nodule or

cancer, or alternatively may indicate the presence of an aggressive malignancy, particularly anaplastic carcinoma or lymphoma. (Michel et al 2012)

Thyroid nodules are very common in the general population. The prevalence of palpable thyroid nodules is only approximately 4–7%, but the prevalence of ultrasound-detectable nodules is between 19 and 67%. Twenty to forty-eight percent of patients with apparently solitary thyroid nodules palpated on physical exam will have additional sonographically detectable nodules. Thyroid nodules are more common in women than in men by a ratio of about 4 to 1, and increase in frequency with age and with decreasing iodine intake. Thyroid nodules are also more common in patients who have a history of head and neck irradiation, developing at a rate of about 2% per year compared with 0.1% per year in patients without a history of significant radiation exposure. (Dina, 2010)

1.2. Problem of the study:

Isotope scanning is generally used to classify nodules to nonfunctioning (cold), or functioning (warm or hot) nodules.

Thousands of thyroid scans have been done at the department of nuclear medicine – Wad Medani to detect thyroid nodules and for thyroid uptake without being classified to different types of nodules, to the best of the researcher's knowledge.

1.3. Objectives of the study:

1.3.1. General Objective:

To classify the thyroid Nodules among patients referred for thyroid scan at the Department of Nuclear Medicine – National Cancer Institute – during 2014-2015.

1.3.2. Specific Objectives:

- To determine the thyroid nodule/s after thyroid scan.
- To classify the type of nodule/s.
- To determine the prevalence of each type of the nodules.

1.4. Overview of the study:

This study falls into five chapters, chapter one dealt with introduction, chapter two dealt with literature review that included Thyroid Anatomy and Physiology, Nuclear Medicine Examination of thyroid, and previous studies, chapter three dealt with materials and methods, chapter four dealt with the result of the study and chapter five dealt with discussion, conclusion and recommendations.

Chapter Two

Literature Review

Chapter two

Literature Review

2.1 Theoretical Background

2.1.1 Thyroid Anatomy and Physiology:

The normal thyroid gland begins as a primitive diverticulum at the base of the tongue in the third week of gestation and grows caudally toward its ultimate position anterior to the thyroid cartilage. In the adult it forms a butterfly-shaped structure weighing about 20 grams. Some thyroid tissue may remain along the thyroglossal duct to form a pyramidal lobe or a thyroglossal thyroid remnant in post-natal life. In rare cases the thyroid fails to descend and forms at the base of the tongue (lingual thyroid) where it may present as a mass. The thyroid originates near the formation site of the aortic sac, and for this reason accessory thyroid tissue may be found in the mediastinum. (Williams, 2003).

The normal thyroid is made up predominantly of follicular cells whose function is the production, storage and secretion of thyroid hormone. These cells are able to trap iodine and produce thyroxine by about the 11th week of gestation. The follicular cells, possibly under the influence of TSH, arrange themselves to form follicles into which they secrete thyroglobulin. A second population of cells, known as parafollicular or C cells, is derived from the neural crest. These appear about midgestation and are responsible for the secretion of calcitonin. The C cells do not form follicles and their secretory polarity is oriented toward the capillaries.

There are relatively few lymphatics in the thyroid compared to capillaries and these are concentrated in the pericapsular areas. Thyroidal lymphatics drain to nodes on the thyroid, trachea, larynx and in the tracheo-esophageal groove as well as to the deep cervical nodes along the internal jugular vein. Drainage to nodes in the upper mediastinum is also common (Fig. 1). (Williams, 2003)

2.1.2 .Normal Physiology and Metabolism:

The follicular cells reversibly take up iodide ions from the bloodstream against a 30-fold concentration gradient and irreversibly convert them to an organic form, which is secreted into the follicles (Fig. 2.1). The steps of uptake and organification are stimulated by thyroid stimulating hormone (TSH). Uptake is competitively inhibited by large anions such as thiocyanate and perchlorate. Organification is blocked by the thyroid-blocking drugs, propylthiouracil (PTU) and methimazole. Oxidized iodine is secreted into the colloid where synthesis of mono- and diiodotyrosines occurs, going on to the production of thyroxine (T4) and triiodothyronine (T3). These steps are also blocked by anti-thyroid drugs. Within the follicle, thyroid hormones are bound to thyroglobulin (Tg). The storage capacity of the thyroid as an endocrine gland is exceptional: an average gland contains about 3 month's supply of hormone. The amount of iodine contained in a normal gland, subject to an adequate iodine intake, is about 7-10mg. Release of hormone from the follicle is stimulated by TSH and inhibited by iodide and lithium. (Williams, 2003)

Tg is a large protein (660kd) that serves as the matrix for thyroid hormone synthesis in the follicles and also as the storage vehicle. Tg synthesis is stimulated by TSH via the cyclic AMP mechanism. Of the 134 tyrosine residues in the molecule, no more than 15-17 are usually iodinated, including no more than 2-4 molecules of T4 and T3. The release of the hormone seems to result in the destruction of the Tg molecule, seemingly an inefficient process when the energy costs of synthesizing such a large molecule are considered. Normally, Tg is largely retained within the follicles, but it may be released into the blood stream in disease states. Tg is often produced by neoplasm derived from follicular cells and is a useful marker for recurrence of tumor. Production of thyroid hormone is regulated by the pituitary gland through the secretion of TSH, which in turn is regulated by

hypothalamic production of thyrotropin-releasing hormone (TRH). (Williams, 2003)

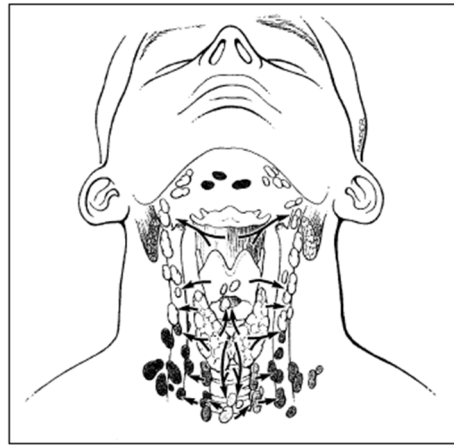


Figure 2.1. Anatomic distribution of lymph nodes that drain the thyroid gland. (Williams, 1991).

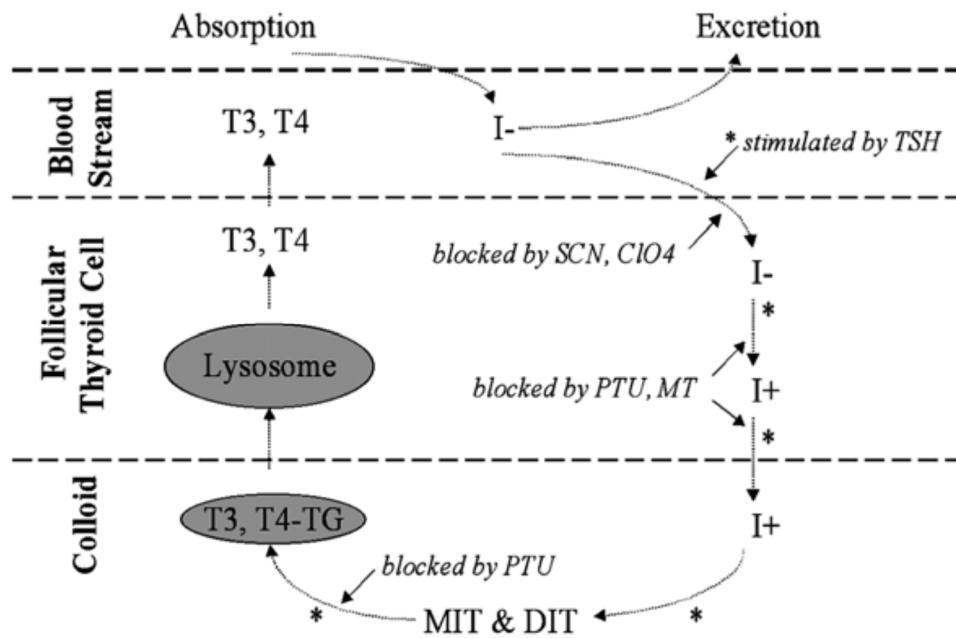


Figure 2.2 A schematic representation of iodine metabolism in the thyroid gland. SCN-thiocyanate; ClO₄-perchlorate; PTU-propylthiouracil; MT-methimazole; MIT&DIT-mono- and di-iodo-tyrosine; Tg-thyroglobulin; *-sites stimulated by TSH (Williams, 1991).

TRH is a tripeptide that may be transported to the pituitary along direct neuronal interconnections. Circulating levels of thyroid hormone, especially T3, provide the negative feedback required to regulate the level of TRH and TSH.

Circulating thyroid hormone is protein-bound. Thyroxine-binding proteins are present in the fetal blood stream by mid-gestation, an important consideration in Nuclear Medicine as maternal exposure to iodine isotopes will be associated with fetal uptake and retention through this mechanism.

Calcitonin, the secretory product of the C cells, is a polypeptide of 32 amino acids, whose major effect is to inhibit osteoclastic bone resorption. In humans the physiological importance of calcitonin remains unclear. Thyroidectomized patients with normal parathyroid gland function do not exhibit any apparent abnormality of bone metabolism. (Williams, 2003)

2.1.3 Nuclear Medicine Examination of thyroid:

Radionuclide imaging and the measurement of thyroid radioactive iodine uptake (RAIU) both play an important role in the investigation of patients with thyroid disorders, especially those with thyroid nodules. (Peter et.al, 2005)

2.1.4 Thyroid Scintigraphy:

With the development of fine needle aspiration biopsy (FNA) for evaluation of nodular disease combined with the exquisite anatomic detail provided by sonography, CT, and MRI, the use of thyroid scintigraphy has decreased appropriately. However, it will continue to play an important role in the functional evaluation of a variety of thyroid disorders as well as the detection of metastatic thyroid cancer. Technetium-99m pertechnetate is the most readily available radionuclide employed for thyroid imaging. Pertechnetate ions ($^{99m}\text{TcO}_4^-$) are trapped by the thyroid in the same manner as iodine through an active iodine transporter, but pertechnetate ions are not organified. ^{123}I iodine is both trapped and

organified by the thyroid gland, allowing overall assessment of thyroid function. Since ^{123}I is cyclotron-produced and has a relatively short half-life of 13.6 hours, it is more expensive and advance notice is necessary for imaging. Because of its inferior image quality and the high thyroid and total body radiation dose from its β -emission, ^{131}I is not used for routine thyroid imaging other than for metastatic thyroid cancer assessment. Due primarily to less background activity, ^{123}I imaging provides somewhat higher quality images than $^{99\text{m}}\text{Tc}$, but the diagnostic information provided by each is roughly equivalent. ^{123}I imaging is used in specific situations, such as retrosternal goiter. (Peter et.al, 2005)

The normal thyroid scintigram is shown in Figure 2.3 High-resolution images are obtained by using a pinhole collimator, thus permitting the detection of nodules as small as 5mm in diameter. The oblique views permit detection of small nodules obscured by overlying or underlying physiological activity. Pinhole SPECT has been used to better detect subtle abnormalities. The radionuclide is distributed homogeneously throughout the gland with some increase seen centrally due to physiological thickness of the gland there; activity within the isthmus is variable and must be correlated with physical examination and/or other imaging (Figure 2.3).

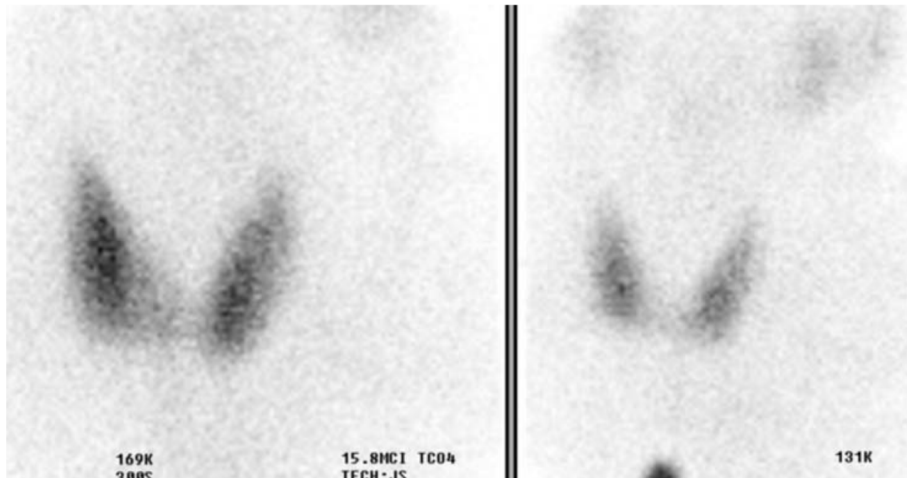


Figure 2.3 Normal ^{99m}Tc thyroid scan. Symmetric, homogeneous uptake with less intense salivary gland uptake and only mild background uptake. The inferior activity is due to a ^{57}Co marker at the suprasternal notch. (Peter et.al, 2005)

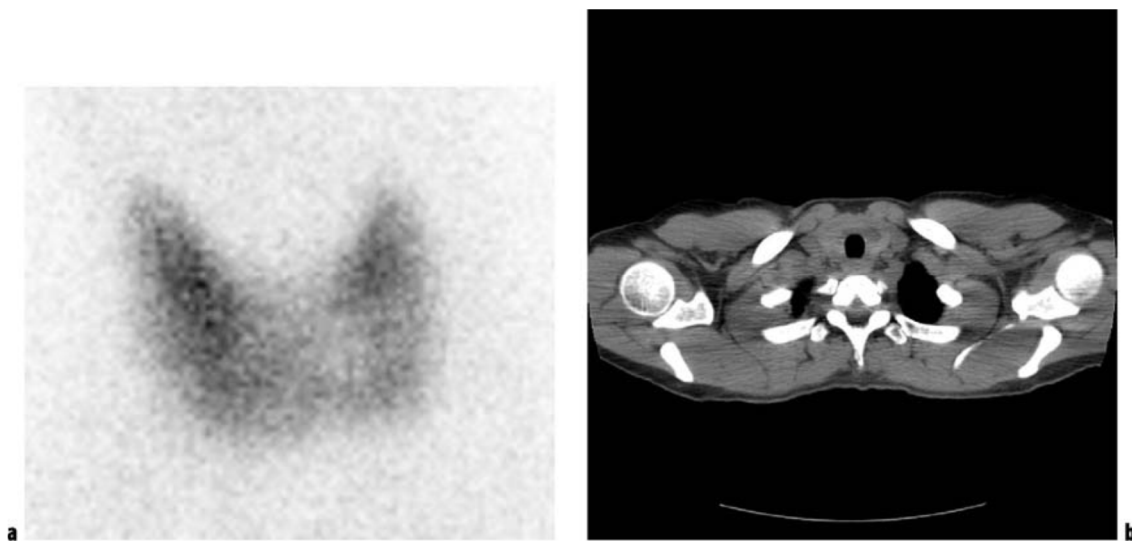


Figure 2.4 Subtle cold nodule. ^{99m}Tc pertechnetate anterior view **a** demonstrates a subtle hypofunctioning left lower pole nodule extending into the isthmus, confirmed on a subsequent contrast-enhanced CT **b** to be a thyroid cyst. (Peter et.al, 2005)

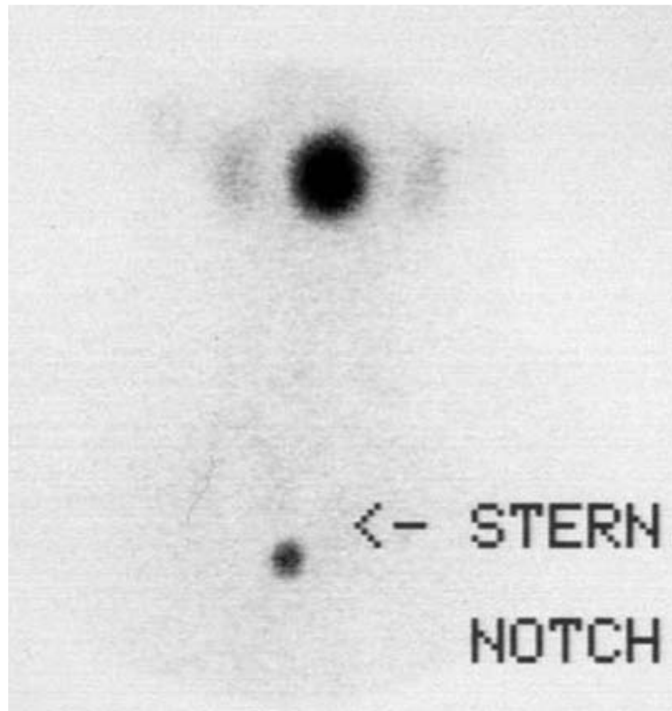


Figure 2.5. Lingual ectopic thyroid. An anterior ^{99m}Tc pertechnetate image demonstrates a focus of activity at the base of the tongue in this neonate. (Peter et.al, 2005)

With pertechnetate, salivary glands, gastric mucosa, esophagus, and blood pool background are seen in addition to thyroid activity. Due to delayed imaging, salivary gland activity is often absent with ^{123}I imaging. In the euthyroid gland, thyroid activity should be greater than that of the salivary glands. Anatomic variations are relatively frequent and may include agenesis, hemiagenesis, and ectopia (Figure 2.5) as well as mere asymmetry. Ectopia is typically associated with hypothyroidism. Significant concavity of the lateral margin should be considered suspicious of a hypofunctioning nodule, and exaggerated convexity is often seen with diffuse goiters. The pyramidal lobe, a remnant of the distal thyroglossal duct, is identified in less than 10% of euthyroid patients, but is visualized in as many as 43% of patients with Graves' disease (Figure 2.6).

Extrathyroidal accumulation of the radiopharmaceutical usually represents ectopic thyroid tissue or metastatic thyroid carcinoma if gastroesophageal and salivary gland activity can be excluded. (Peter et.al, 2005)

2.1.5 Multinodular Goiter:

The patient with multinodular goiter (MNG) may present with what seems to be a solitary thyroid nodule, diffuse enlargement of the gland, or hyperthyroidism. Development of MNG is related to cycling periods of stimulation followed by involution and may be idiopathic or occur as a result of endemic iodine deficiency. Over time the gland enlarges and evolves into an admixture of fibrosis, functional nodules, and non-functioning involuted nodules. (Peter et.al, 2005)

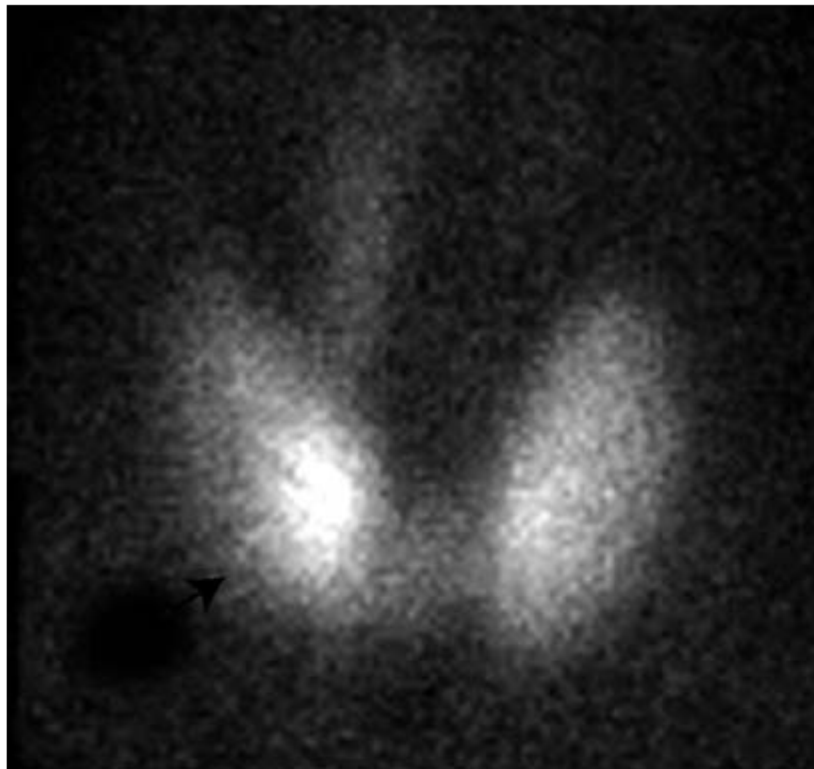


Figure 2.6. Graves' disease. ^{99m}Tc thyroid scan shows a pyramidal lobe emanating from the medial aspect of the right lobe. Note the convex contour of the gland and the diminished background activity. (Peter F et.al, 2005).

Scintigraphically, the MNG is a heterogeneously-appearing, asymmetrically enlarged gland with multiple cold, warm, and hot areas of various sizes (Figure 2.7). The incidence of thyroid carcinoma in MNG is low at 1–6%, but a dominant or enlarging cold nodule should be biopsied. The differential diagnosis includes autoimmune Hashimoto's thyroiditis, multiple adenomas, and multifocal carcinoma. Further characterization of the gland with ultrasound, CT, or MRI does not appreciably aid clinical diagnosis. (Peter et.al, 2005)

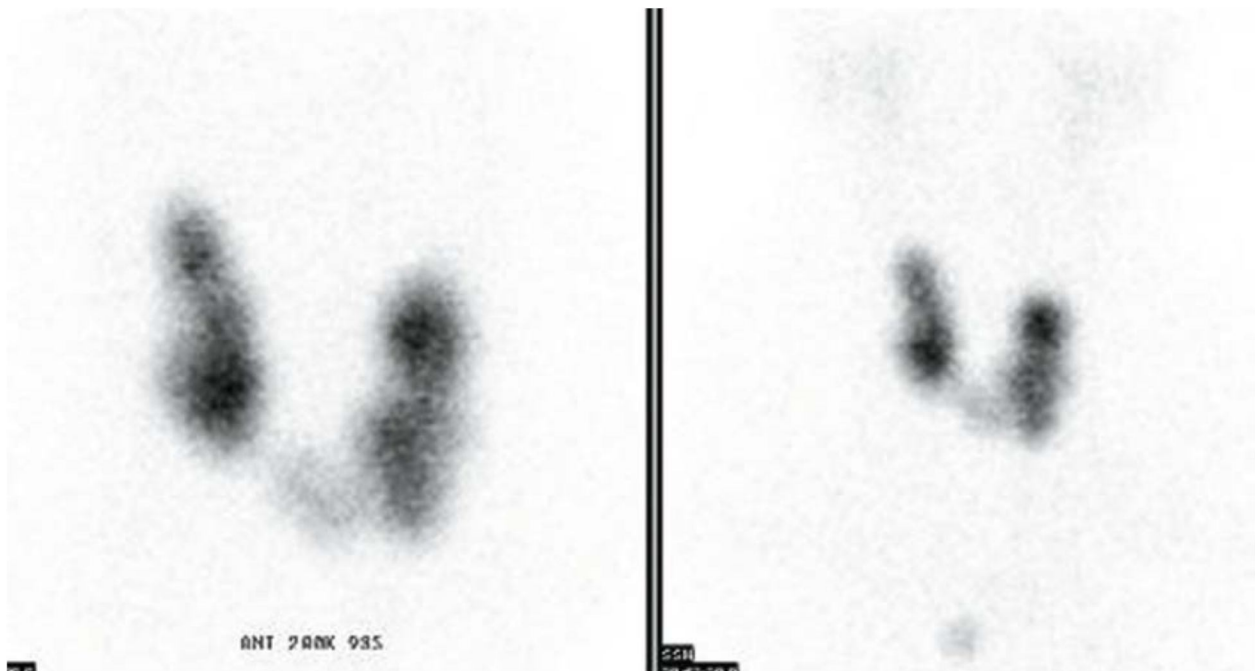


Figure 2.7. Multinodular goiter. An anterior ^{99m}Tc pertechnetate view demonstrates asymmetric enlargement of the gland with multiple areas of increased, decreased, and normal activity. The decreased background activity and

faint salivary gland activity is compatible with the clinical impression of toxic multinodular goiter. (Peter et.al, 2005)

2.1.6 Thyroid Nodules:

The management of patients with a solitary thyroid nodule remains controversial, related to the high incidence of nodules, the infrequency of thyroid malignancy, and the relatively low morbidity and mortality associated with differentiated thyroid cancer (DTC). Thyroid nodules may contain normal thyroid tissue, benign hypofunctioning tissue (solid, cystic, or complex), hyperplastic or autonomously functioning benign tissue, or malignant neoplasm. The evaluation of the patient with a solitary thyroid nodule is directed towards differentiating benign from malignant etiologies. Autopsy series have demonstrated a 50% incidence of single or multiple thyroid nodule(s), only 4% of which are malignant. Ultrasonography detects single or multiple thyroid nodules in 40% of patients with no known thyroid disease. The incidence of thyroid nodules increases with advancing age, and is more frequent in females and in patients with a prior history of neck or facial irradiation. Hypofunctioning (“cold”) nodules concentrate less radioisotope relative to the remainder of the thyroid gland (see Figure 2.4). Eighty-five to ninety percent of thyroid nodules are hypofunctioning, but only 10–20% of cold nodules are malignant. The remaining hypofunctioning nodules consist of degenerative nodules, nodular hemorrhage, cysts, thyroiditis, infiltrative disorders such as amyloid, and non-thyroid neoplasm. Clinical features that suggest thyroid cancer include male gender, a prior history of radiation exposure up to 15 Gy (1500 rad), a family history of medullary or papillary thyroid carcinoma, and relative youth. Local fixation of the nodule or palpable adenopathy is also suggestive. Recent

rapid enlargement of a nodule is more often related to hemorrhage into a cyst or nodule rather than carcinoma. (Bankman, 2000)

Although ultrasound and MRI are sensitive for the detection of thyroid nodules, specificity for malignancy is poor. Similarly, sensitivity for detection of thyroid cancer is approximately 90% with scintigraphy, but specificity is poor at 15–20%. If extrathyroidal activity is seen in the neck on thyroid scintigraphy in a patient with a solitary thyroid nodule, metastatic thyroid carcinoma is likely. Some investigators have recommended the use of serum thyroglobulin and calcitonin determinations to improve the accuracy of clinical assessment and scintigraphy.

A hot or warm (hyperfunctioning) nodule concentrates the radioisotope to a greater degree than the normal thyroid gland and represents 10–25% of palpable nodules in patients. In over 99% of cases, a hot thyroid nodule is benign and biopsy is unnecessary. Although a functioning thyroid nodule in the euthyroid patient may represent hyperplastic (sensitive to TSH stimulation) tissue, most are autonomously functioning thyroid nodules (AFTN) arising independently of TSH stimulation. Biochemical hyperthyroidism, often subclinical, is present in 74% of patients at presentation, although overt hyperthyroidism is less common. Over a period of 3 years after detection, 33% of AFTNs enlarge in patients not receiving definitive therapy, and 24% of euthyroid patients develop hyperthyroidism. In euthyroid patients, surrounding extranodular thyroid tissue will be visible (Figure 2.8a), thyroid function studies will be normal, and these patients can be followed on an annual basis. If hyperthyroidism exists, the surrounding normal thyroid tissue will be suppressed, and the TSH level will be undetectable (Figure 2.8b). Spontaneous cystic degeneration occurs in 27%, manifested by central photopenia; there is little concern for malignancy. Discordant thyroid imaging is a dissociation between trapping and organification, measured respectively with ^{99m}Tc pertechnetate and ^{123}I . It occurs in only 2–8% of thyroid nodules and is not specific

for malignant disease. A nodule that traps ^{99m}Tc (hot) but is unable to organify iodine (cold) is much more likely to be benign than malignant. If it is assumed that 8% of hot nodules with ^{99m}Tc are cold with ^{123}I , and if 10% of those are malignant, then less than 1% of hot nodules seen with ^{99m}Tc imaging are malignant. Additional radioiodine imaging of hot nodules identified on a ^{99m}Tc scan should probably be reserved for patients deemed at higher risk for malignancy. (Peter et.al, 2005)

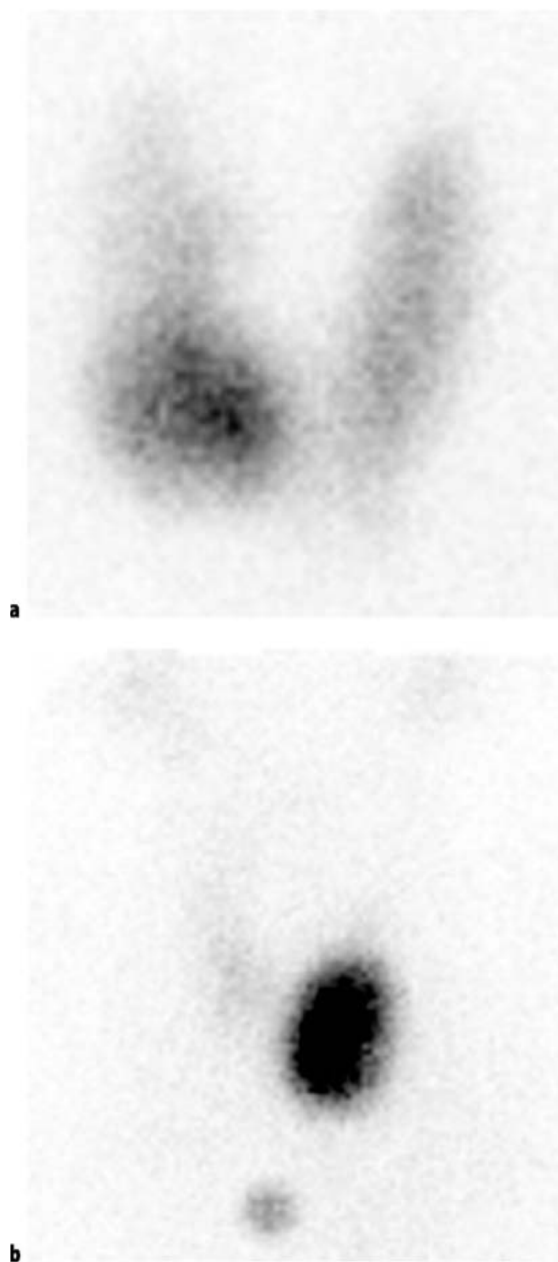


Figure 2.8. Autonomously functioning thyroid nodule. **a** An anterior ^{99m}Tc thyroid image reveals a focus of increased uptake in the lower pole of the right lobe consistent with a hyperfunctioning nodule. **b** A focus of markedly increased activity in the lower pole of the left lobe accompanied by virtual complete suppression of extranodular activity and decreased background and salivary gland activity is consistent with toxic adenoma, subsequently confirmed by an undetectable serum TSH. (Peter et.al, 2005)

2.1.7 Hyperthyroidism:

Hyperthyroidism is a clinical syndrome of tachycardia, weight loss, and hypermetabolism resulting from supraphysiological circulating levels of thyroid hormones, leading to suppression of TSH secretion. Most cases of hyperthyroidism are due to increased endogenous synthesis and secretion of thyroid hormones from the thyroid. Clinical assessment combined with circulating hormone and thyroid autoantibody measurements, thyroid scintigraphy, and RAIU usually allow identification of the various disease processes that may be responsible. Graves' disease (autoimmune diffuse toxic goiter) is due to the presence of thyroid-stimulating immunoglobulins and is associated with autoimmune exophthalmos and pretibialmyxedema. Although it occurs primarily in young women, it may also occur in children and in the elderly. Radioiodine uptake will usually be elevated at 4 hours and/or 24 hours, and the gland will reveal diffuse enlargement in most cases with increased thyroid activity and minimal background and salivary gland activity (Figure 2.6). Hyperplasia of the pyramidal remnant is seen as increased paramedial activity in as many as 43% of Graves' patients. Occasionally, the gland will appear normal size. The low RAIU (usually $\leq 5\%$) of hyperthyroid patients with subacute thyroiditis, postpartum thyroiditis, silent thyroiditis, and surreptitious thyroid hormone administration is easily differentiated from the normal RAIU. Although ultrasound demonstrates an enlarged homogeneously hypoechoic gland with prominent vascularity on color-flow Doppler imaging ("thyroid inferno"), it is usually unnecessary for diagnosis clinically. The thyroid scan should easily be able to distinguish toxic nodular goiters from Graves' disease. The clinical importance of this is that many patients with toxic nodular goiter will require a higher dose of ^{131}I for therapy than will Graves' disease patients. (Peter et.al, 2005)

2.1.8 Thyroiditis:

Thyroiditis may be classified as acute, subacute, chronic/autoimmune, and other miscellaneous types; these different types of thyroiditis are unrelated to each other. Acute suppurative thyroiditis is rare and is caused by hematogenous spread of infectious organisms. This is usually defined clinically and evaluated by

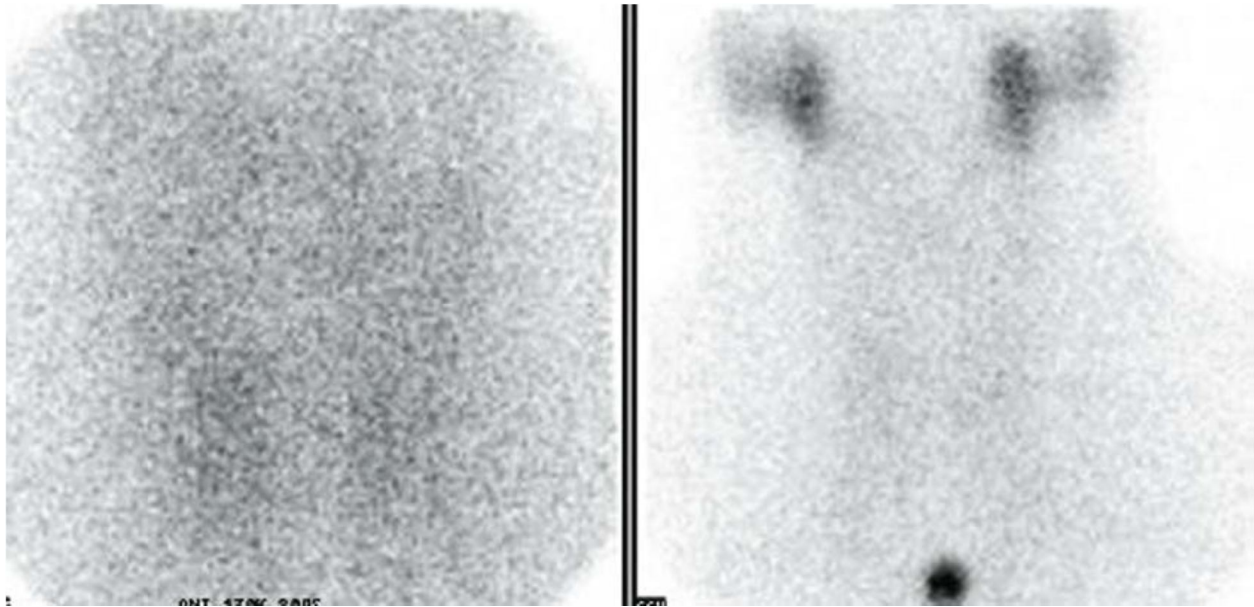


Figure 2.9. Subacute thyroiditis. An anterior ^{99m}Tc image reveals markedly reduced activity in the thyroid bed as compared to background and salivary glands. (Peter et.al, 2005)

CT and/or sonography; scintigraphy is only rarely performed. Subacute (de Quervain's) thyroiditis is a benign, self-limited transient inflammatory disease of the thyroid, presumed to be of viral etiology. It may affect the gland diffusely or focally and usually presents as a tender gland in a patient with mild systemic symptoms and an elevated erythrocyte sedimentation rate. Serum thyroglobulin (Tg) is elevated and antithyroid antibodies are only marginally increased. A short lived destruction-induced thyrotoxicosis is followed by several months of hypothyroidism, usually subclinical. Thyroid scintigraphy will show poor thyroid visualization with increased background activity and an RAIU of $<5\%$ (Figure

2.9). Most patients are eventually left with a normal thyroid gland, both histologically and functionally. Symptoms respond to non-steroidal or steroidal anti-inflammatory agents and beta blockade. A second variety of thyrotoxic subacute thyroiditis is termed silent lymphocytic thyroiditis and is similar in presentation to de Quervain's thyroiditis except for the absence of pain, tenderness, and prodromal systemic symptoms. The etiology is thought to be an exacerbation of underlying autoimmune thyroid disease. Thyroid autoantibodies are present in high titers, but often diminish as the thyrotoxic phase resolves. A destruction-induced hyperthyroidism accompanied by markedly suppressed RAIU and mild thyromegaly, all of which resolve over months. This entity presents more frequently in postpartum women (termed postpartum thyroiditis) and tends to recur with subsequent pregnancies. Many of these women will eventually develop permanent hypothyroidism. Chronic Hashimoto's autoimmune lymphocytic thyroiditis is the most common cause of hypothyroidism in the Western world and usually presents in women with a small to moderately enlarged firm goiter, elevated antithyroglobulin and/or antimicrosomal (antiperoxidase) antibodies, and rarely any tenderness. Patients may be euthyroid or hypothyroid and rarely hyperthyroid. Scintigraphy reveals inhomogeneous activity throughout the gland in 50%, though a pattern of multinodular goiter, solitary hot nodule, or solitary cold nodule as well as a normal scan may occur. RAIU may be normal, low, or elevated. Biopsy is rarely necessary for diagnosis, and most patients are treated with thyroid hormone supplementation. Iodine-induced thyrotoxicosis occurs most frequently in patients with pre-existing thyroid disease via the Jod-Basedow phenomenon. Patients with autonomously functioning thyroid adenoma(s), previously treated Graves' disease, and colloid goiter are most susceptible. Scintigraphy usually reveals a pattern of MNG, and RAIU is diminished. On the other hand, the patient with iatrogenic or factitious hyperthyroidism will exhibit only background activity on thyroid

scintigraphy and may not have a palpable goiter. RAIU will be very low. (Peter et.al, 2005)

2.1.9 Mediastinal Goiter:

The most common neoplasms of the anterior mediastinum are thymomas, lymphomas, and germ cell tumors. Although retrosternal thyroid accounts for only 7–10% of all mediastinal masses, the non-invasive demonstration of radioiodine uptake within a mediastinal mass is useful as it avoids more invasive tissue diagnosis. Retrosternal thyroid tissue is usually the result of inferior extension of a cervical goiter, but may be related to enlargement of ectopic mediastinal thyroid tissue. Continuity between the cervical and intrathoracic components of a mediastinal goiter may consist of only a narrow fibrous band and may not be demonstrable by CT or ultrasound. If goiter is considered, thyroid scintigraphy should be performed prior to CT imaging to avoid interference



Figure 2.10. Mediastinal goiter. An anterior ^{123}I image demonstrates a relatively normal appearing cervical thyroid accompanied by heterogeneous irregular uptake within the superior mediastinum. (Peter et.al, 2005)

by administration of iodinated contrast media, the most common cause of false negatives. Due to high background activity related to surrounding blood pool activity, $^{99\text{m}}\text{Tc}$ images are suboptimal and difficult to interpret. Iodine-123 is the radionuclide of choice for imaging retrosternal thyroid masses. ^{123}I scintigraphy

yields high-quality images of thoracic goiters, even when uptake is relatively decreased (Figure 2.10). Despite the fact that clinically significant thyroid cancer occurs in only 4% of mediastinal goiters, the majority of patients with significant mediastinal goiters eventually undergo surgical resection. However, ^{131}I treatment, sometimes augmented by administration of recombinant human TSH (rhTSH), can be used to reduce the size of the mass and alleviate tracheal compression in appropriate patients. (Peter et.al, 2005)

2.1.10 Neonatal Hypothyroidism:

Congenital hypothyroidism (CHT) has an incidence of 1 per 2500–5000 births, and most infants do not exhibit signs or symptoms of hypothyroidism at birth. A delay in the institution of thyroxine replacement therapy beyond 6–8 weeks of life is likely to be associated with measurable impairment of intellectual function (cretinism). Since the institution of newborn screening programs for CHT by measuring serum TSH and/or T4 levels, the intellectual impairment of CHT has been eradicated in developed countries. (Peter et.al, 2005)

Thyroid dysgenesis (agenesis, hypoplasia, and ectopia) is the most common cause of neonatal hypothyroidism in the industrialized world and USA. $^{99\text{m}}\text{Tc}$ pertechnetate thyroid scintigraphy is performed immediately after CHT is confirmed. It can easily detect eutopic and ectopic thyroid tissue as well as assess degree of thyroidal uptake. Using a pinhole collimator, a close-up and a more distant view (to include the face and chest) in the anterior projection as well as a lateral view are acquired 20–30 minutes after intravenous injection of 18 MBq (0.5 mCi). A normal image is seen in cases of false positive screening results. A small focus of relatively faint uptake cephalad to the thyroid cartilage is consistent with ectopia and indicates the need for lifelong thyroxine therapy (Figure 2.5). A eutopic enlarged gland with increased uptake, usually marked, is most consistent

with dysmorphogenesis; a small proportion of these are due to transient immaturity of the iodine organification process and will be normal at reassessment after age 3 years. Non-visualization of the thyroid on scintigraphy is due to agenesis in over 90% of cases, the remainder being due to the presence of maternal transmission of TSH receptor blocking antibodies; these latter patients will be euthyroid at reassessment when these maternal antibodies have cleared. Patients with a nonvisualized gland or patients with images suggesting dysmorphogenesis are all re-evaluated at age 3–4 years to exclude transient CHT; patients with ectopia are not reassessed. Therefore, thyroid scintigraphy in the neonate is indispensable in the proper diagnostic work-up of congenital hypothyroidism, because it (1) provides a more specific diagnosis, (2) is cost-effective for selecting patients for subsequent reassessment to uncover transient CHT and allow discontinuation of thyroid hormone replacement therapy, and (3) defines dysmorphogenesis, which is familial and requires genetic counseling. (Peter et.al, 2005)

2.2 Previous Studies:

2.2.1 Pattern of thyroid diseases in central Sudan:

Thyroid scintigraphy using Tc-99m pertechnetate is a frequently performed procedure in routine nuclear medicine practice in addition to thyroid hormonal assay by radioimmunoassay (RIA). There is no clear description of thyroid diseases pattern in Sudan using nuclear medicine as a diagnostic tool. The aim of this retrospective study is to determine the pattern of thyroid diseases using the nuclear medicine facilities in our institute during a period (2001-2003).

All patients referred to the department of nuclear medicine for thyroid scan from January 2001 to December 2003 were included in this study and the thyroid function test when available.

Data were analyzed by SPSS software.

A total of 2070 patients were referred to the department and only 1605 (77.5%) have thyroid function test results available for scan reporting. Female to male ratio is 9:1. The mean age is 34 ± 13.36 (1-86 years old). The most common pattern is simple multinodular goiter 784 (37.8%) and the second is solitary thyroid nodule 506 (24.4%), followed by simple diffuse goiter 415 (20%).

From a total of 1605 thyroid function test results, 1377 patients (85.8%) were euthyroid, 168 (10.5%) were having hyperthyroidism while only 60 (3.7%) were having hypothyroidism.

The study concluded that the vast majority of patients in this study were young females with simple goiter and normal radionuclide uptake. No more information gained particularly when the patient is known clinically and biochemically to have a simple goiter. A solitary cold nodule is also common. (Elmadani 2009).

2.2.3 Experience in thyroid scintigraphy with Ethiopian patients.

One thousand and thirty-seven thyroid scintigraphy examinations done in the Nuclear Medicine Unit of Tikur Anbessa Hospital, Addis Abeba, Ethiopia between

December 1984 and September 1989 were analyzed to assess their diagnostic value. Thirty-one percent of the referrals were to investigate clinically detectable solitary nodules, and of these fifty-six percent had "cold" nodules and twenty-three percent "hot" nodules. Fifty-five percent of the referrals for evaluation of goiter were for multinodular goiters and twelve percent for diffuse. (Demena 1993)

2.2.4 Is the current use of thyroid scintigraphy rational?

One hundred and thirty-one consecutive requests for thyroid scintigraphy were analysed to assess their diagnostic contribution to the subsequent medical management of the patient. Forty one percent of requests were to investigate the presence of a clinically detectable solitary nodule and, of these, one fifth had hot nodules. Diffuse goiters accounted for 38% of all referrals, but in only two patients (non-toxic hot nodule) did the results change management. A further 11% of referrals were for multinodular goitres and 8% for retrosternal goitres. In all cases of goiter no additional useful information was obtained from scintigraphy. It is concluded that thyroid scintigraphy was an unnecessary investigation in approximately 45% of cases. Its primary role was in the investigation of the solitary nodule and in detecting toxic nodules in thyrotoxic patients who had no evidence of Graves' disease. Greater discrimination of requests would avoid investigating patients unnecessarily and reduce costs. (Tindall 1987)

Chapter Three

Materials and Methods

Chapter Three

Materials and Methods

3.1 Materials:

Nuclear Medicine department (NM) in the National Cancer Institute (NCI), University of Gezira, Wad Medani, was established in 1994 and equipped with two gamma cameras (planner single head and SPECT dual head) serving patients in the Gezira state and nearby states and it's the second center in Sudan after radioisotope center in Khartoum (RICK).

All patients referred to the department for thyroid scan from January 2014 to December 2015 were included in this study, correlated with thyroid function tests whenever available.

The scintigraphies were obtained with a 5mm single-hole collimator-equipped gamma-scintillation camera 10-20 minutes after intravenous injection of 37-111MBq of sodium pertechnetate ($\text{Na}^{99\text{m}}\text{TcO}_4$).

Data were acquired with a 128 x 128 matrix and a zoom factor of 2.67–4.0. Imaging acquisition was terminated at 100 k counts or after 900 s of imaging, whichever occurred first.

Radionuclide uptake by the thyroid gland at 10-20 min was also calculated as a percentage of the dose injected, allowing for decay and correcting for background. The normal range of radionuclide uptake applied was 0.5–5%. Diffuse toxic goiter (Graves' disease) was diagnosed in a diffusely enlarged thyroid gland with a high uptake of tracer throughout in correlation with thyroid function test. Viral thyroiditis was diagnosed on the bases of thyroid function tests with short interval signs and symptoms compatible with thyrotoxicosis and the scan showing an inhomogeneous distribution of tracer throughout the thyroid with reduced tracer uptake.

Autonomously functioning thyroid nodules show focal areas of increased uptake, with suppressed uptake in the rest of the gland. Nodularity was detected as areas of reduced and nonhomogeneous in tracer uptake.

Descriptive analysis of the patients' data was done by SPSS statistical package to determine the thyroid diseases pattern in our region.

3.2 Methods:

3.2.1 Methods of data collection:

The samples of this study were selected from the entire thyroid scans done during the period (2014 – 2015). Theoretical data were collected from textbooks, magazines and websites.

3.2.2 Methods of data analysis:

All data were entered a computer, and statistical tests program was used to obtain frequencies and other statistical measures.

3.2.3 Thyroid imaging technique:

Tc-99m pertechnetate is injected intravenously into the arm and images of the thyroid are obtained with a scintillation camera approximately 20 minutes later. The radionuclide emits gamma rays (photons) at a predictable rate. The camera is set to detect a predetermined minimum number of photons. Images are usually obtained from anterior projection.

The bilobed thyroid gland has reasonably homogenous distribution of activity in both lobes.

There is usually slight asymmetry of the lobes (the right being slightly larger), with the lobes joined inferiorly and medially by the isthmus. The image is taken with a sternal notch marker (at a greater stand-off) to check for substernal extension of the thyroid. Static spots views of the anterior neck were acquired 20 minutes following

administration of 5 mCi, 111MBq of ^{99m}Tc pertechnetate under planar gamma camera.

3.4 Duration of the study:

This study was done during the period from November 2016 to February 2017.

3.5 Area of the study:

This study was carried out at the Department of Nuclear Medicine – National Cancer Institute, University of Gezira- Wad Medani, Sudan.

3.6 Population of the study:

The study included patients with thyroid Nodules that were referred to the Department of Nuclear Medicine – National Cancer Institute – during 2014-2015.

3.7 Ethical issue:

- Permission from the Nuclear Medicine department In National Cancer Institute.
- No patients' details were disclosed.

Chapter four

The Results

Chapter four

The Results

A total of 1538 patients were referred during study period for thyroid scan were included in this study. The female to male ratio is 9:1 (1396 female and 142 male). The mean age is 38.4 ± 15.08 (1.5-85 years old) and about 72 % of age ranges from 27 to 49 years (Fig4.1).

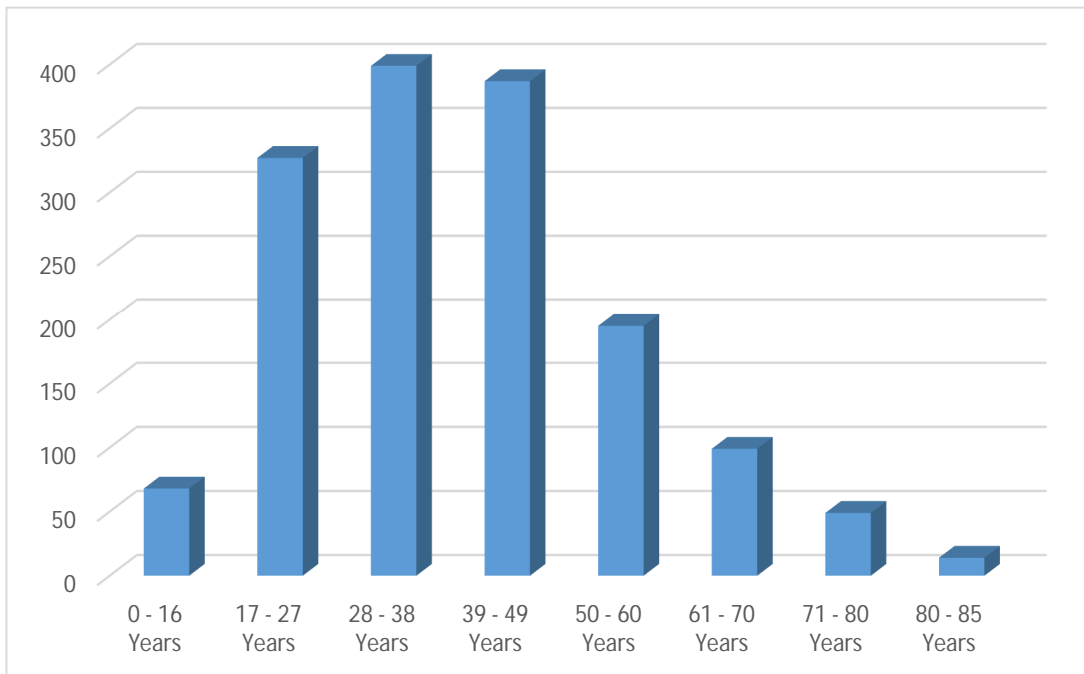


Fig (4.1): Shows frequency and percentage of patients ages.

Table (4.1) shows frequency and percentage of patients ages.

| Age Groups | Frequency | Percent |
|----------------------|------------------|----------------|
| 0 - 16 Years | 68 | 4.4 |
| 17 - 27 Years | 327 | 21.3 |
| 28 - 38 Years | 399 | 25.9 |
| 39 - 49 Years | 387 | 25.2 |
| 50 - 60 Years | 195 | 12.7 |
| 61 - 70 Years | 99 | 6.4 |
| 71 - 80 Years | 49 | 3.2 |
| 80 - 85 Years | 14 | 0.9 |
| Total | 1538 | 100 |

Table (4.2) shows thyroid diagnosis and patients gender distribution.

| Scan Diagnosis | Female | Male | Total |
|------------------------------------|--------|------|-------|
| Simple Diffuse Goiter | 487 | 27 | 514 |
| Simple Nodular Goiter | 281 | 26 | 307 |
| Simple Multi-Nodular Goiter | 426 | 51 | 477 |
| Toxic Diffuse Goiter | 101 | 7 | 108 |
| Toxic Nodular Goiter | 13 | 3 | 16 |
| Toxic Multi-Nodular Goiter | 53 | 8 | 61 |
| Hypothyroidism | 18 | 3 | 21 |
| Others | 11 | 15 | 26 |
| Normal thyroid | 6 | 2 | 8 |
| Total | 1396 | 142 | 1538 |

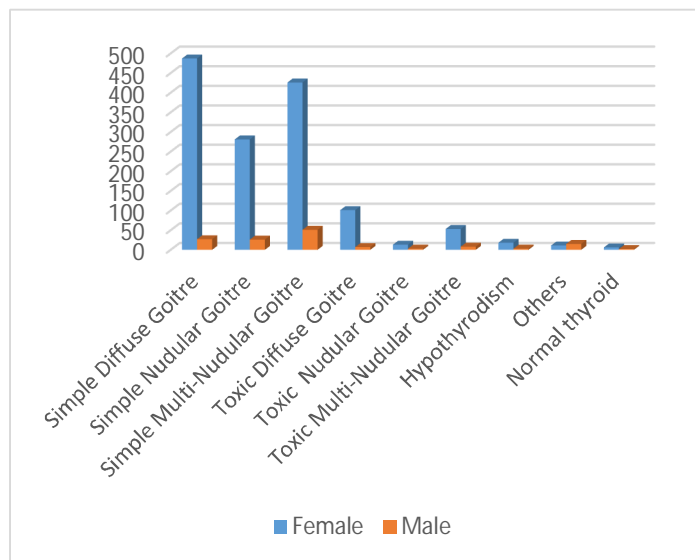


Figure (4.2) shows thyroid diagnosis and patients gender distribution.

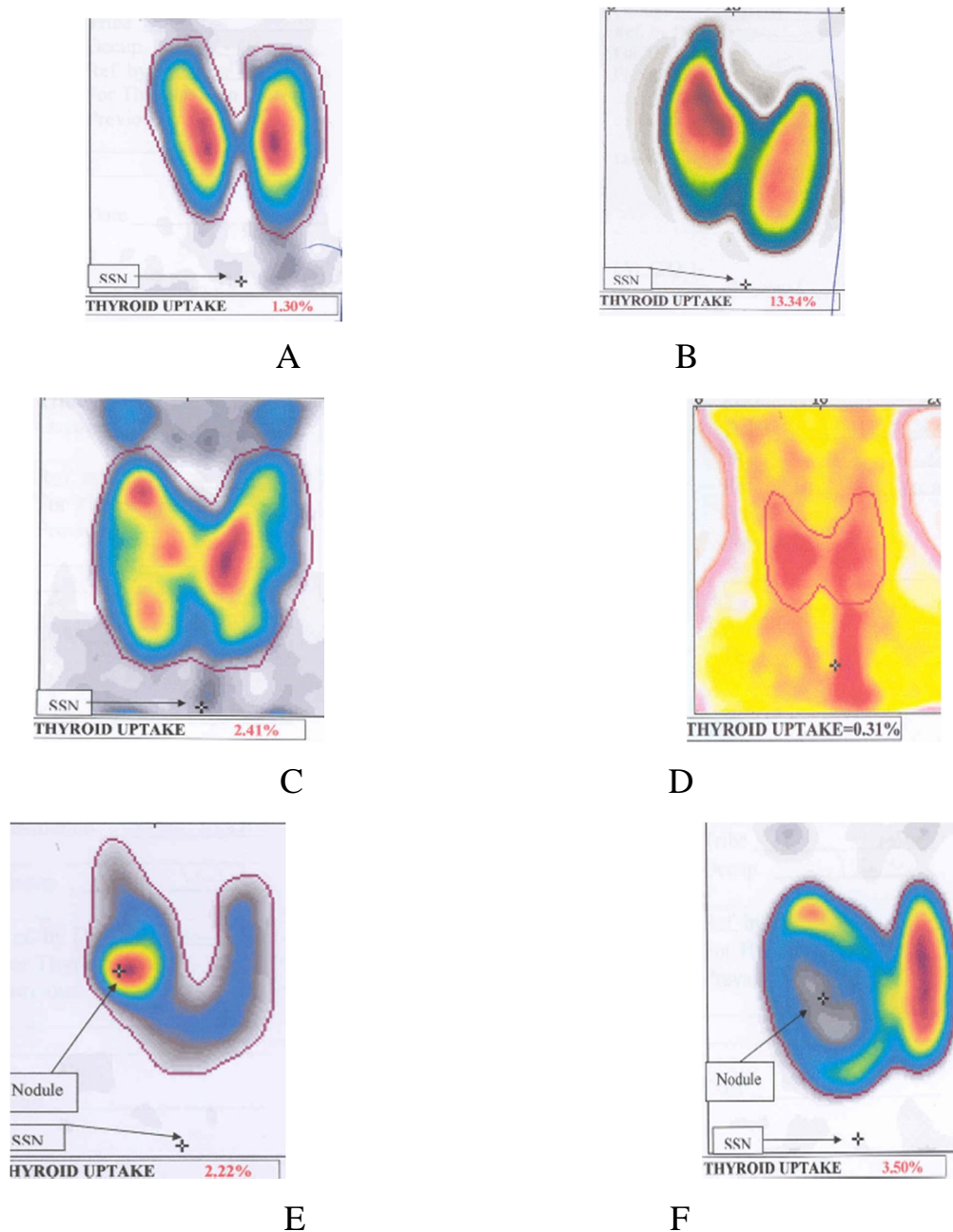


Fig (4.3) Different patterns of thyroid scan and uptake: (A) illustrates a simple diffuse goiter with normal radionuclide uptake (1.3%), (B) toxic diffuse goiter with increased uptake (13.34%), (C) simple multinodular goiter with normal uptake (2.41%), (D) thyroiditis with low uptake (0.31%), (E) solitary cold thyroid nodule

with normal uptake (3.50%), and (F), hot thyroid nodule suppressing the rest of the gland but the uptake is not increased.

Table (4.3) shows thyroid scan diagnosis, frequency and percentage.

| Scan Diagnosis | Frequency | Percent |
|-----------------------------|-----------|---------|
| Simple Diffuse Goiter | 514 | 33.4 |
| Simple Nodular Goiter | 307 | 20 |
| Simple Multi-Nodular Goiter | 477 | 31 |
| Toxic Diffuse Goiter | 108 | 7 |
| Toxic Nodular Goiter | 16 | 1 |
| Toxic Multi-Nodular Goiter | 61 | 4 |
| Hypothyroidism | 21 | 1.4 |
| Others | 26 | 1.7 |
| Normal thyroid | 8 | 0.5 |
| Total | 1538 | 100 |

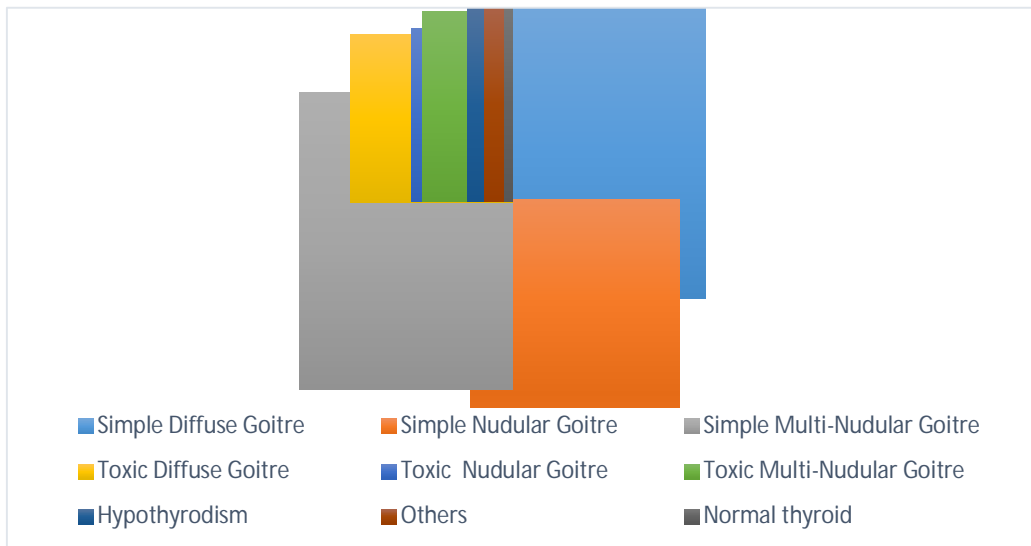


Fig (4.4) shows thyroid scan diagnosis, frequency and percentage.

Table (4.4) shows frequency and percentage of thyroid nodules.

| Scan Diagnosis | Frequency | Percent |
|-----------------------|------------------|----------------|
| Hot Nodule | 30 | 9 |
| Cold Nodule | 293 | 91 |
| Total | 323 | 100 |

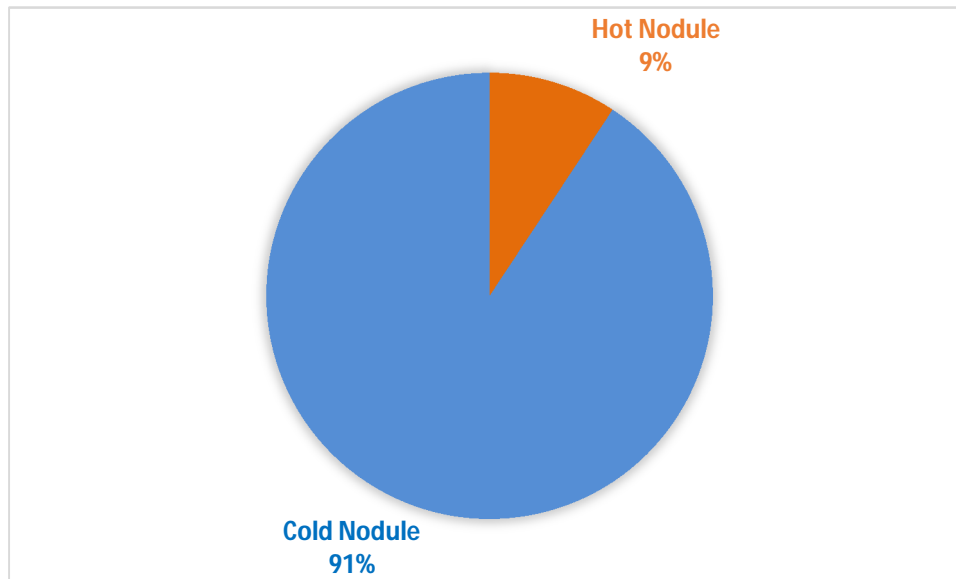


Table (4.5) shows simple and toxic nodular goiter classification according to the uptake.

| Scan Diagnosis | Hot Nodule | Cold Nodule |
|-----------------------|-------------------|--------------------|
| SNG | 25 | 282 |
| TNG | 5 | 11 |
| Total | 30 | 293 |

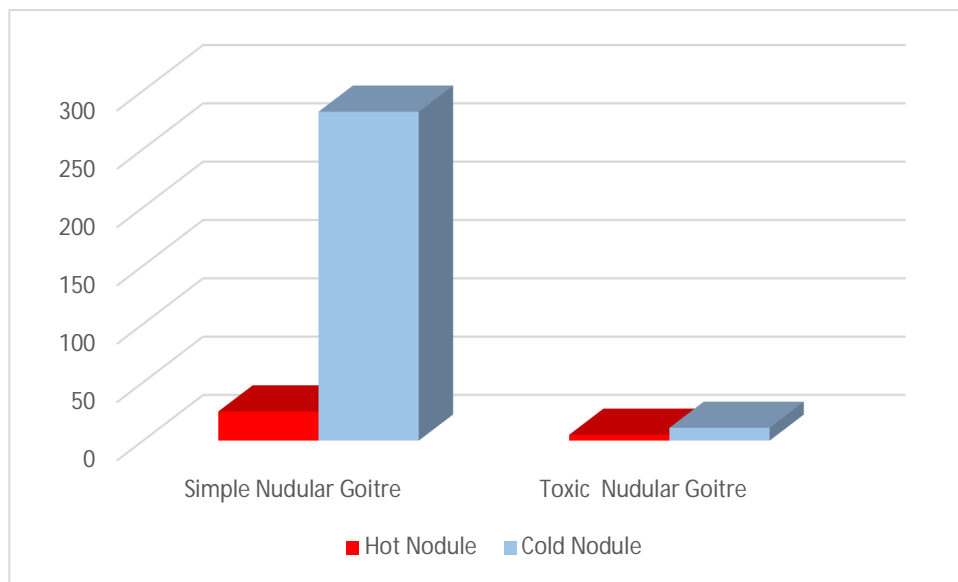


Fig (4.6) shows simple and toxic nodular goiter classification according to the uptake.

Table (4.6) shows frequency of scan diagnosis in 2 years.

| Scan Diagnosis | 2014 | 2015 | Total |
|------------------------------------|------|------|-------|
| Simple Diffuse Goiter | 304 | 210 | 514 |
| Simple Nodular Goiter | 168 | 139 | 307 |
| Simple Multi-Nodular Goiter | 213 | 264 | 477 |
| Toxic Diffuse Goiter | 52 | 56 | 108 |
| Toxic Nodular Goiter | 6 | 10 | 16 |
| Toxic Multi-Nodular Goiter | 28 | 33 | 61 |
| Hypothyroidism | 10 | 11 | 21 |
| Others | 12 | 14 | 26 |
| Normal thyroid | 5 | 3 | 8 |

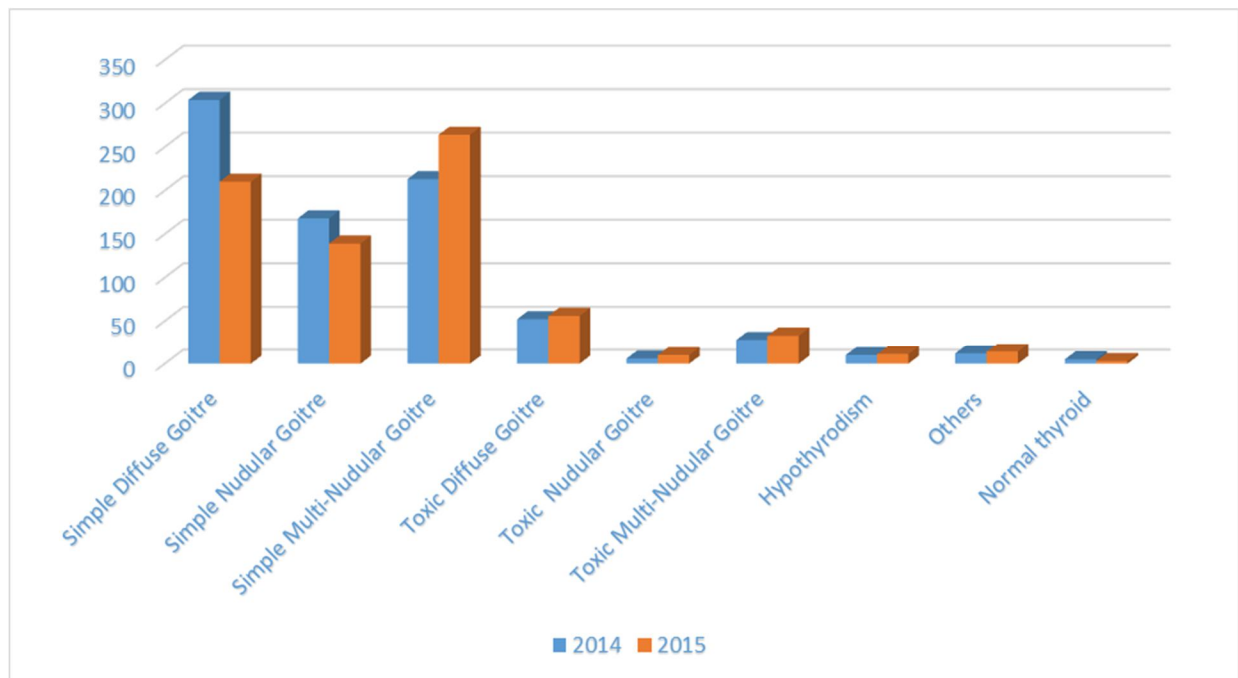


Fig (4.7) shows frequency of scan diagnosis in 2 years.

Table (4.7) shows thyroid diagnosis according to age groups.

| Scan Diagnosis | 0 - 16 Year s | 17 - 27 Year s | 28 - 38 Year s | 39 - 49 Year s | 50 - 60 Year s | 61 - 70 Year s | 71 - 80 Year s | 80 - 85 Year s | Total |
|----------------------------|------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|--------------|
| SDG | 23 | 179 | 148 | 104 | 42 | 11 | 6 | 1 | 514 |
| SNG | 4 | 54 | 92 | 91 | 31 | 21 | 12 | 2 | 307 |
| SMNG | 3 | 42 | 107 | 140 | 96 | 55 | 25 | 9 | 477 |
| TDG | 7 | 28 | 35 | 23 | 10 | 3 | 1 | 1 | 108 |
| TNG | 0 | 5 | 3 | 5 | 2 | 1 | 0 | 0 | 16 |
| TMNG | 4 | 9 | 10 | 20 | 9 | 5 | 4 | 0 | 61 |
| Hypothyroidis m | 0 | 6 | 2 | 3 | 5 | 3 | 1 | 1 | 21 |
| Others | 24 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 26 |
| Normal thyroid | 3 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 8 |
| Total | 68 | 327 | 399 | 387 | 195 | 99 | 49 | 14 | 1538 |

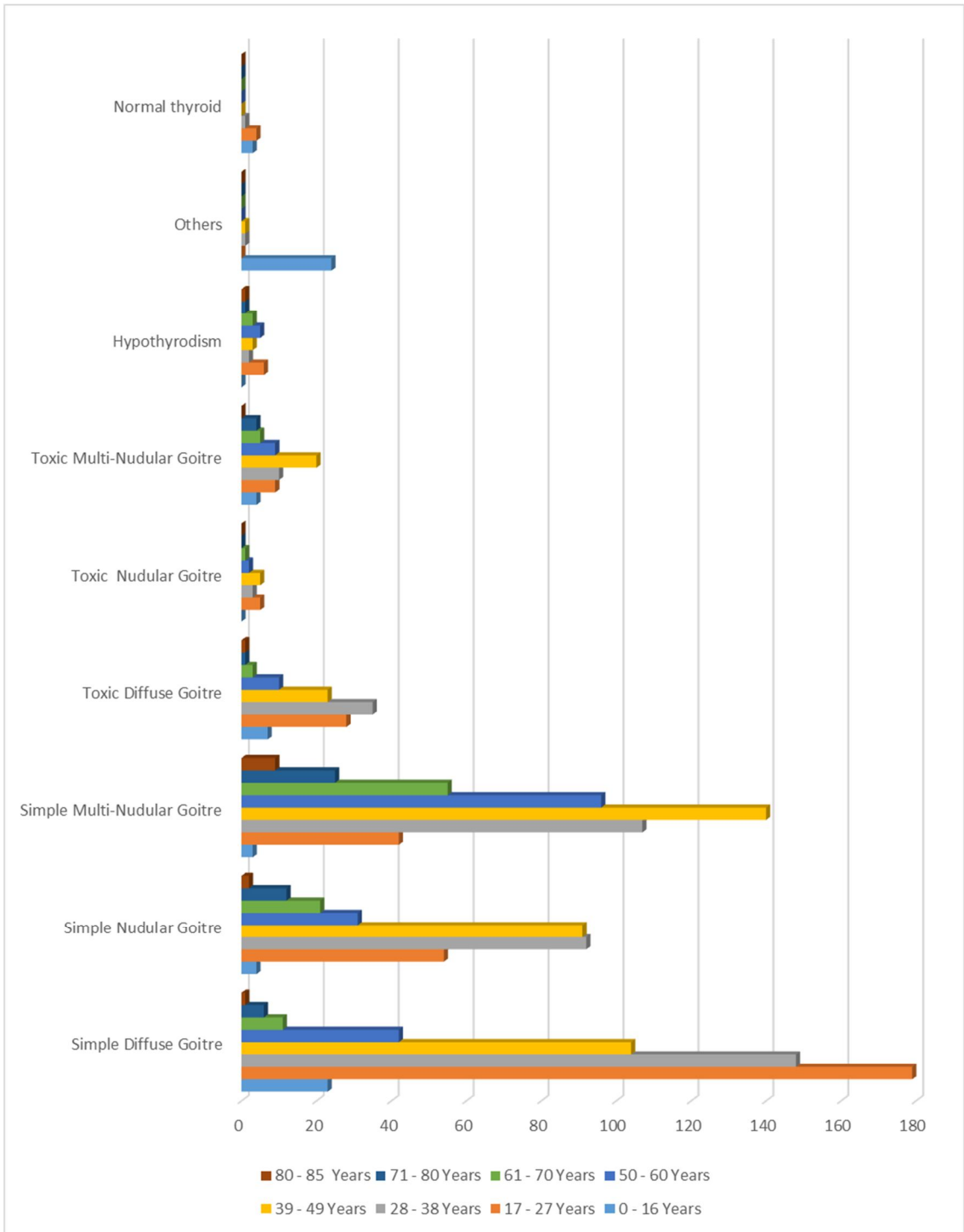


Fig (4.8) shows thyroid diagnosis according to age groups.

Table (4.8) shows hot and cold nodules according to age groups.

| Type of nodules | 0 - 16 Years | 17 - 27 Years | 28 - 38 Years | 39 - 49 Years | 50 - 60 Years | 61 - 70 Years | 71 - 80 Years | 80 - 85 Years | Total |
|-----------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-------|
| Hot Nodule | 1 | 4 | 7 | 9 | 2 | 5 | 2 | 0 | 30 |
| Cold Nodule | 3 | 55 | 88 | 87 | 31 | 17 | 10 | 2 | 293 |
| Total | 4 | 59 | 95 | 96 | 33 | 22 | 12 | 2 | 323 |

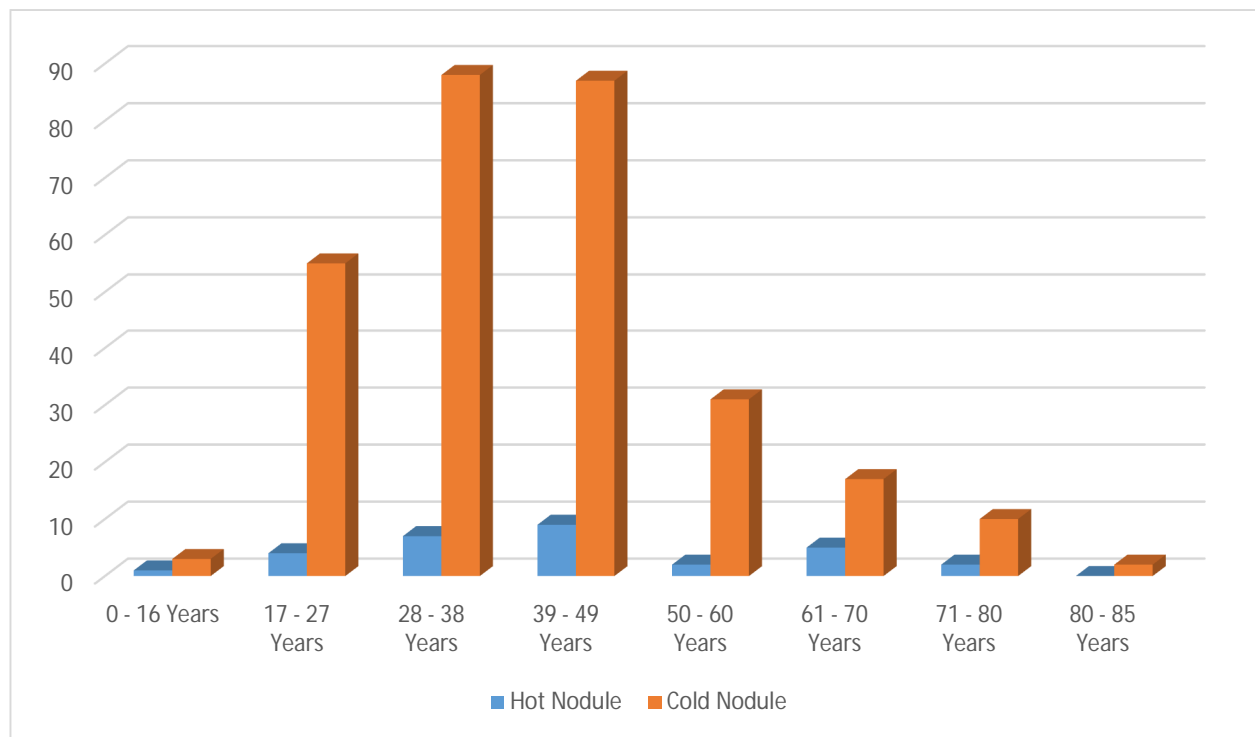


Fig (4.9) shows hot and cold nodules according to age groups.

Chapter five

Discussion, Conclusion and Recommendations

Chapter five

Discussion, Conclusion and Recommendations

5.1 Discussion:

Distribution of the study population according to ages, which revealed that: the common involved age with thyroid diseases were the age groups of 17-49 years old with peak incidence in the range from 28-38 years. This is matched with information given by Elmadani et.al 2009 (about 60% of age ranges from 20 to 40 years) as shown in figure (4.1).

Distribution of the study population according to gender, which revealed that: the ratio of the female to male was 9:1 comparing this result with Elmadani et.al (2009), which showed that there is increase in ratio of female to male (9:1) and also agree with Dina (2010) which found the ratio is 4:1, so this result shows that the thyroid disease in female is more than in male. As shown in figure (4.2).

Also this study showed that, the most common pattern of thyroid disease is simple diffuse goiter was 514 (33.4%) as in fig (4.3) A, and the second is multinodular goiter was 477 (31%) as in fig (4.3) C, followed by solitary thyroid nodule was 307 (20%) as in fig (4.3) E. In Elmadani et.al (2009) study, the most common was multinodular goiter 784 (37.8 %) and the second is solitary thyroid nodule 506 (24.4%), followed by simple diffuse goiter 415 (20%).

In this study with consider to the thyroid uptake showed 185 cases (12%) were hyperthyroidism while only 21 (1.4%) were hypothyroidism and this is agreed with Elmadani et.al (2009), who found that, there was more hyperthyroidism 168 (10.5%) than hypothyroidism 60 (3.7%).

The number of normal cases is 8 (0.5%) and all of them have no neck swelling clinically, normal scan pattern and uptake with normal thyroid function test.

Thyroid uptake measurements were normal in 1.332 (86.6%), decreased in 21 (1.4%) and increased in 185 (12%).

Taking the simple nodular goiter 307(20%) there was solitary thyroid hot nodules 25 (8.1%) and cold nodules about 282 (91.9%) with normal thyroid uptake.

Also toxic nodular goiter 16 (1%) has hot nodules 5 (31.2) and cold nodules 11 (68.8) with high thyroid uptake. Table (4.5)

Regarding to nodular thyroid disease in study revealed that, from 1538 patients there was 323subjects (21%) were nodular goiters, and of these (9%) had "hot" nodules and (91%) had "cold" nodules (see table 4.4). This findings is agreed with Demena study (Demena, 1993), he found that, (31%) of the referrals were to investigate clinically detectable solitary nodules, and of these (56%) had "cold" nodules and (23%) were "hot" nodules, hence there was more "cold" nodules than "hot" nodules. Also he found that (55%) of the referrals for evaluation of goiter were for multinodular goiters and (12%) for diffuse goiter.

The overall percentages of Demena study is disagreed with this study because there is simple diffuse goiters (33.4%) than multinodular goiters (31%).

The samples of this study were selected from the entire thyroid scans done during the period (2014 – 2015) there was slightly different between 2 years, see table (4.6).

Little useful information was obtained in the evaluation of goiter when it's the only indication of the thyroid scan (as shown fig 4.3 A). Demena, in his study of 1037 thyroid scans concluded that thyroid scintigraphy was an unnecessary investigation in the evaluation of goiters in euthyroid patients. Its primary role was in the investigation of the solitary nodule, ectopic thyroid tissue and the retrosternal goiter. Therefore, only selected patients should be investigated with thyroid scintigraphy.

Tindall and his group also concluded that thyroid scintigraphy was an unnecessary investigation in approximately 45% of cases. In all cases of goiter no additional useful information was obtained from scintigraphy.

Its primary role was in the investigation of the solitary nodule and in detecting toxic nodules in thyrotoxic patients who had no evidence of Graves' disease. Greater discrimination of requests would avoid investigating patients unnecessarily and reduce costs.

In this study, the toxic diffuse goiter (7%) , and the simple diffuse goiter (33.4%) and the normal (0.5%), no additional information gained and hence the management will not change on the bases of the thyroid scan result, but it necessary to detect and assess the thyroid nodules, which in this study was 56% of patients.

5.2 Conclusion:

This study was conducted at the Department of Nuclear Medicine – National Cancer Institute, University of Gezira- Wad Medani during the period 2014-2015. The main objective of this study was to classify the thyroid Nodules among patients referred for thyroid scan.

The study has come out with a group of results and recommendations. The most important results included that the vast majority of patients in this study were females with nodular goiter, the common pattern was solitary cold nodule and thyroid scan is more useful in cases of nodular goiters.

So thyroid scan should not be requested as a routine for very patients with thyroid disease for two reasons: the radiation hazards and the cost.

5.3 Recommendations:

- More studies should be done to correlate, TFT, US and Thyroid Scan for thyroid diseases.
- Thyroid scan should be done only for disorders of size, site and shape including nodular goiter.
- ALARA principle should always be adopted for any radiation application.
- People should not ignore any swelling or mass within thyroid gland.
- The real dose for the real patient should always be considered to avoid radiation hazard and repetition.
- Pin hole collimator should be used for thyroid imaging to have images with good resolution.

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Appendices

Appendix 1: Thyroid scan and report

Appendix 2: Clerking sheet of thyroid scan

