

**Sudan University of Science and Technology**

**College of Graduate Studies**

**Measurement of Thyroid Volume in Normal Adult Sudanese  
Women Using Ultrasonography**

قياس حجم الغدة الدرقية للنساء السودانيات البالغات السليمات باستخدام التصوير بالموجات فوق  
الصوتية

A Thesis Submitted For Partial Fulfillments for the Requirement of  
M.S.c Degree in Medical Diagnostic Ultrasound

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2017

# الآية

بسم الله الرحمن الرحيم

قال تعالى:

(قُلْ إِنِّي هَدَانِي رَبِّي إِلَى صِرَاطٍ مُسْتَقِيمٍ دِينًا قِيمًا مِثْلَ دِينِ إِبْرَاهِيمَ حَنِيفًا وَمَا كَانَ مِنَ الْمُشْرِكِينَ ﴿161﴾ قُلْ

إِنَّ صَلَاتِي وَنُسُكِي وَمَحْيَايَ وَمَمَاتِي لِلَّهِ رَبِّ الْعَالَمِينَ ﴿162﴾ لَا شَرِيكَ لَهُ وَبِذَلِكَ أُمِرْتُ وَأَنَا أَوَّلُ

الْمُسْلِمِينَ ﴿163﴾)

سورة الانعام الآيات (161-162)

# Dedication

*To my parents always stay behind me*

*To my sisters and brothers especially (Abdalmageed Ali)*

*To my teacher and colleagues*

*To my friend Osama Abdalgadeer*

*To all people I love and they love me*

## **Acknowledgements**

Full regards to my supervisor Dr. Ahmed Mostafa who gave perfect advices, ideas and motivations to complete this research in success. I would like to thank people contributed to this thesis.

## Abstract

The thyroid gland is a vital endocrine gland in the body, estimation of its volume is generally considered to be an important in several pathologic situations such as iodine deficiency, Goiter, thyroiditis, multinodular goiter and others.

The aim of this study was to measure the thyroid volume in normal adult Sudanese female. 48 normal adult Sudanese female were scanned with high resolution sonography of the thyroid gland using Toshiba ultrasound machine (7.5 MHz linear transducer) the volume of each lobes of thyroid gland was calculated automatically in the machine by using Ellipsoid formula (the volume = length×width×depth ×0.52). And the total thyroid volume obtained by adding the volume of both lobes.

The result of the study showed that the mean age was  $33.40 \pm 10.076$  years old, the overall mean volume of thyroid gland was  $5.367 \pm 0.8028$ ml. The mean volume of right lobe was  $2.824 \pm 0.4296$ ml. The mean volume of left lobe was  $2.544 \pm .4617$ ml. The right lobe volume was significantly differing from left lobe volume. Furthermore, a significant correlation was observed between thyroid volume, weight and age of the subject.

The study concluded that ultrasound has been proven as a useful method for assessment of the thyroid volume for its safety and less expensive. The result can be used as a local reference of thyroid volume in adult Sudanese female for goiter screening in the context of iodine deficiency disorders monitoring.

## ملخص البحث

الغدة الدرقية هي غدة صماء حيوية في الجسم، وتقدير حجمها يعتبر مهما في عدة حالات مرضية مثل نقص اليود، الدراق، التهاب الغدة الدرقية، عقيدات الغدة الدرقية وغيرها.

كان الهدف من هذه الدراسة هو قياس حجم الغدة الدرقية في الإناث السودانيات البالغات. تم مسحهن بجهاز الموجات فوق الصوتية ماركة توشيبا بمسبارخطي (7.5 ميقاهيرتز). تم قياس حجم كل فصوص الغدة الدرقية وحسب الحجم تلقائيا في الجهاز باستخدام المعادلة (الحجم = الطول × العرض × عمق × 0.52). وإجمالي حجم الغدة الدرقية يمكن الحصول عليه بإضافة حجم كل من الفصوص.

أظهرت نتائج الدراسة أن متوسط سنوات العمر كان  $10.076 \pm 33.40$  سنة ، و كان متوسط حجم الغدة الدرقية  $0.8028 \pm 5.367$  مل. بلغ حجم متوسط الفص الأيمن  $0.4296 \pm 2.824$  مل. و متوسط حجم الفص الأيسر  $0.4617 \pm 2.544$  مل. حجم الفص الأيمن متباين بشكل كبير من حجم الفص الأيسر. وعلاوة على ذلك، لوحظ وجود ارتباط كبير بين حجم الغدة الدرقية والوزن والعمر

خلصت الدراسة الي أن الموجات فوق الصوتية كوسيلة من وسائل مفيدة لتقييم حجم الغدة الدرقية لسلامتها وقلة تكلفتها. هذه النتيجة يمكن استخدامها كمرجع محلي لحجم الغدة الدرقية في الإناث البالغات السودانيات للكشف عن الإصابة بتضخم الغدة الدرقية في سياق رصد اضطرابات عوز اليود.

## List of Content

Figure Name	Page
الآية	I
Dedication	II
Acknowledge	III
Abstract	IV
المستخلص	V
List of content	VI
List to table	VII
List of figure	VIII
List of Abbreviations	IX
<b>Chapter one</b>	
Introduction	1
Problem of the study	2
Objective of the study	3
<b>Chapter two</b>	
Thyroid Anatomy	3
Thyroid Physiology	14
Thyroid Pathology	17
Thyroid Ultrasound	23
Previous studies	24
<b>Chapter Three</b>	
Materials	26
Method	26
<b>Chapter four</b>	
Results	28
<b>Chapter five</b>	
Discussion	32
Conclusion	33
Recommendation	34
References	35
Appendix	

## List of Table

Table	Table	Page
<b>4.1</b>	The mean and standard deviation of the variables.	28
4.2	Shows correlation between age, weight, Rt lobe volume, left lobe volume and total thyroid volume.	31



## List of Figures

Fig	Figures name	Page
2-1	normal thyroid gland	6
2-2	gray scale sonogram of lymph node	10
	2-3 Show anatomic variations	11
2-4	gray scale sonogram of two lobes and isthmus	12
2-5	gray scale of two lobes and connecting isthmus	13
2-6	normal thyroid	14
2-7	panoramic transverse view	15
2-8	Show vessels	16
2-9	Show multi nodular goiter	25
2-10	Show adenomatous goiter	26
2-11	Show hashimotos thyroiditis	27
2-12	Show thyroid adenoma	28
3-1	Measurement of left lobe volume sonogram	29
3-2	Measurement of right lobe volume sonogram	29
4-1	Show the mean and standard deviation of variables	31
4-2	Show linear relationship between right lobe volume and weight	31
4-3	Linear relationship between left lobe and weight	32
4-4	Correlation of variables	34
4-5	Relationship between total thyroid volume and age	35

### List of Abbreviation

CT	Computed Tomography
ICCIDD	International Council for iodine Deficiency Disorders
LT	LEFT
MHz	Megahertz
ML	Milliliter
MM	Millimeter
MRI	Magnetic resonance imaging
RT	Right
TPO	Thyroperoxides
U/S	Ultrasound
WHO	World Health Organization

## Chapter one

### 1.1 Introduction:

The thyroid gland is a vital endocrine gland in our body it is the most common gland imaging by ultrasound especially in tropical Africa where other modern imaging modalities as computed tomography (CT) and magnetic resonance imaging (MRI) are may not be available or more expensive (Lee and Anzai, 2013).

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

Surveys for assessing the prevalence of goiter currently rely on thyroid palpation, and thyroid size is usually scored according to WHO classification. Although in severe or moderate iodine deficiency, thyroid palpation provides a reliable method for goiter assessment, serious problems are encountered in areas with mild iodine deficiency, where most goitrous subjects have small goiters. Moreover, thyroid palpation is less reliable in children than in adults, although, because of their easy recruitment and representativeness of different social classes, school children are commonly used (Vazquez and Richards, 2011).

Thyroid gland ultrasonography has proven a useful and practical method for assessment of thyroid volume various investigators over the world have measured the thyroid volume and have found different values of normal thyroid volume (Lee and Anzai, 2013). So this study was done to established the thyroid volume in normal adult Sudanese female from 18 -50.

## **1.2 Problem of the study:**

To the best of knowledge of the researcher, there is no reference value of thyroid volume in for Sudanese population, especially adult female aged from 18 to 50 years old.

## **1.3 Objectives of the study:**

### **1.3.1 General objectives -**

Measurement of Thyroid volume in Normal adult Sudanese Women Using Ultrasonography

### **1.3.2 Specific objectives:**

- To measure right lobe volume.
- To measure left lobe volume.
- To correlate thyroid volume to age and weight.

## **1.4 Overview of the study:-**

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

## Chapter two

### 2. Literature review

#### 2.1 Embryology:-

The thyroid gland is derived from an embryologic tube called the foramen cecum. The foramen cecum originates from the base of tongue. It grows downwards anterior to the trachea and thyroid cartilage to reach the adult site .the distal end forms the thyroid gland and the reminder should degenerate and disappear. If the foramen cecum persists and remains patent; it is called a hypoglossal duct. If parts of the tubes close, the remaining patent segments are called hypoglossal cysts. Hypoglossal cyst is the most common congenital malformation of the neck (Patton, 2015).

#### 2.2 Anatomy:

All muscles are paired and appear hypo echoic relative to the more echogenic thyroid gland. The fascia enclosing the muscle is highly echogenic.

Sternocleidomastoid (Stern o mastoid) Muscle is a prominent superficial muscle that arises from the sternum and the medial third of the clavicle. It passes obliquely across the side of the neck and inserts behind the ear into the mastoid process and the posterior skull. At the level of the thyroid gland the sternocleidomastoid is demonstrated on the anterolateral aspect of the neck. It overlaps the lateral portions of the stern hyoid and stern thyroid muscles. The internal jugular vein is deep (posterior) to the sternocleidomastoid muscle (Patton, 2015).

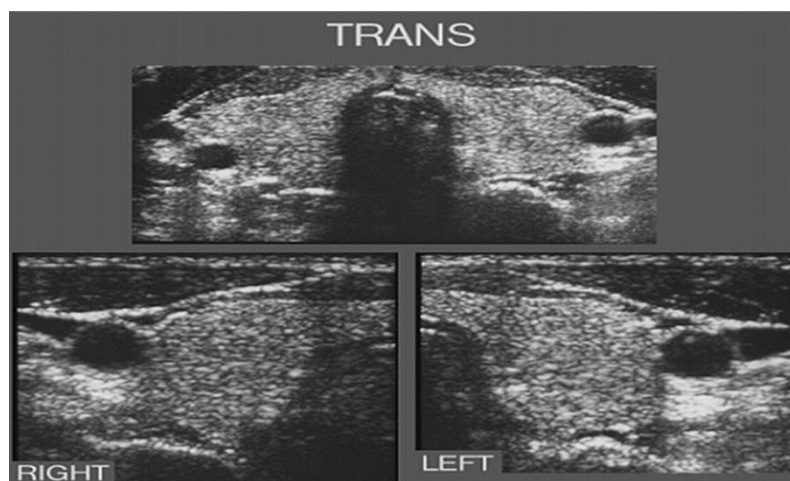
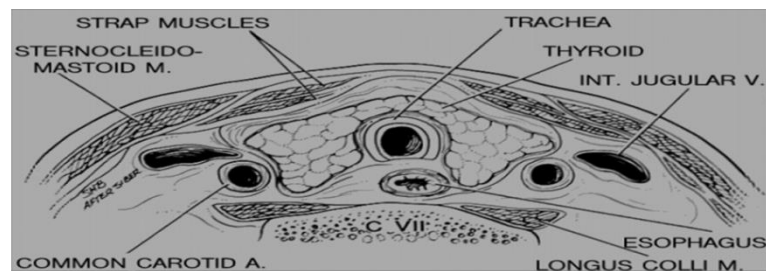
The Stern hyoid Muscle is the most anterior of the strap muscles of the neck. It originates at the sternum and inserts into the lower border of the body of the hyoid

bone. The stern hyoid muscle lies anterior to the stern thyroid muscle and is overlapped anterolateral by the medial end of the sternocleidomastoid muscle.

The Stern thyroid Muscle is strap muscle originates at the sternum posterior to the stern hyoid muscle and inserts into the outer surface of the thyroid cartilage. It lies against the anterolateral surface of the lateral lobe of the thyroid gland.

The Lingus Coli Muscle is a muscle lies on the anterolateral aspect of the cervical vertebral bodies and is visualized posterior to the lateral lobe of the thyroid gland.

The Anterior Scalene (Scalene Anterior) Muscle is arises from the transverse processes of C3-6 and inserts into the first rib. It lies lateral to the long us celli muscle and posterior to the internal jugular vein (Saladin, 1998).



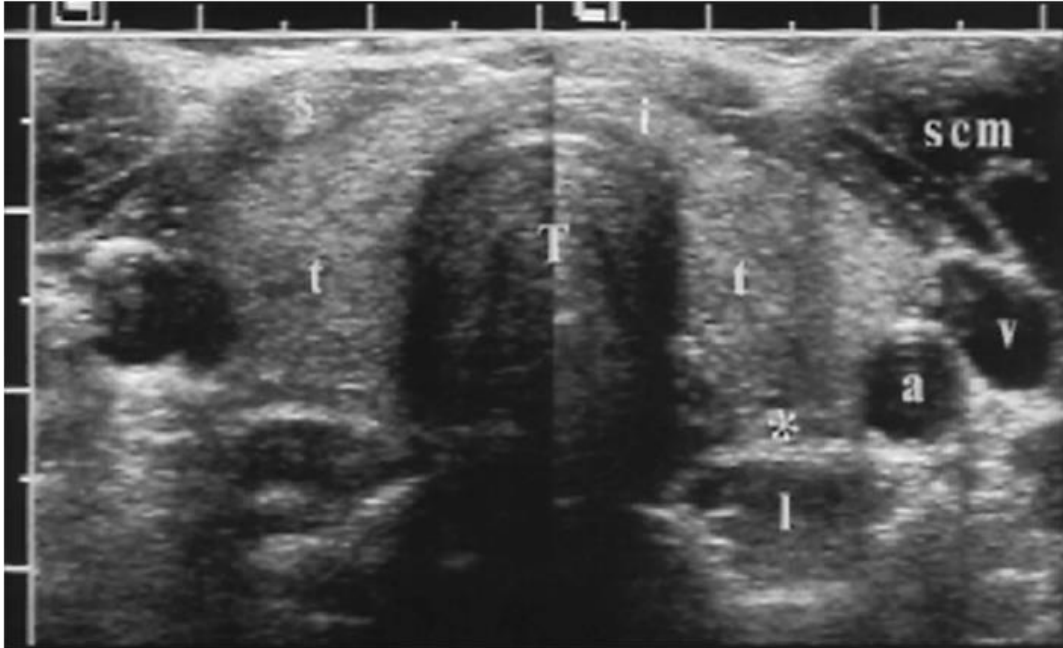


Figure: (2-1) Normal Thyroid Anatomy.

A transverse image through the mid-thyroid gland demonstrates normal sonographer landmarks. a, common carotid artery; i, thyroid isthmus; l, longus colli muscle; s, strap muscles; Scan, sternocleidomastoid muscle; t, thyroid lobes; T, trachea (note the acoustic shadow); v, internal jugular vein; \*, normal location of the parathyroid glands (Saladin, 1998).

### **2.1.1 Neurovascular Bundles:**

The Major Neurovascular Bundle, in the sagittal plane, the major neurovascular bundle is a tubular structure. The bundle consists of the common carotid artery, internal jugular vein and the vagus nerve. The fascia enclosing the artery, vein and nerve is called the carotid sheath.

The Minor Neurovascular Bundle is in the transverse plane, the minor neurovascular bundle is a tubular structure. The bundle consists of the inferior thyroid artery and the recurrent laryngeal nerve. The minor neurovascular

bundle intervenes between the posterior aspect of the lateral lobe of the thyroid gland and the longus colli muscle (Saladin, 1998).

Sonographic assessment of the neck vessels is a major subspecialty of diagnostic ultrasound called Vascular Technology. Normal vessels have well defined, smooth walls with anechoic lumens. The internal jugular vein changes caliber with respiration whereas the carotid artery pulsates. Superficial veins are easily compressible when pressure is applied to the transducer (Saladin, 1998).

### **2.1.2 Lymphatic's of the Neck: Zoography**

High resolution sonography (using scanners with frequencies ranging from 7.5 up to 12MHz) can detect cervical lymph nodes as small as 2 mm in diameter. “Conventional sonography is generally considered the method of choice in the detection of enlarged superficial lymph nodes, because computed tomography and magnetic resonance imaging have lower spatial resolution than high resolution sonography, and palpation is unable to detect enlarged nodes located in the deeper planes of the superficial stations (Dumont et al., 2000).

### **2.1.3 Gray Scale Features:**

Normal nodes are flattened, oblong and small. They are hypoechoic in comparison to the surrounding fatty tissue. Some normal nodes exhibit a central linear echogenic hilum. This was formerly thought to be fat, “however, it is now generally accepted that the echogenic hilum is mainly the result of multiple fluid-filled sinuses, each of which acts as an acoustic interface, partially reflecting incident sound waves and imparting an echogenic structure.

An echogenic hilum may also be found in malignant nodes, therefore, this feature does not represent normalcy or malignancy. A node may be measured in its short and long axes to obtain a short to long axis ratio. A short to long axis



ratio of less than 0.5 is normal indicating a long or oval node. Inflamed nodes are enlarged but retain the normal relationship of length to thickness. Neoplastic nodes are characterized by increased thickness and have a short to long axis ratio of 0.5 or greater (Dumont et al., 2000).

Another approach is to measure the maximum transverse diameter of the nodes. A measurement of 1 cm or less is considered normal.

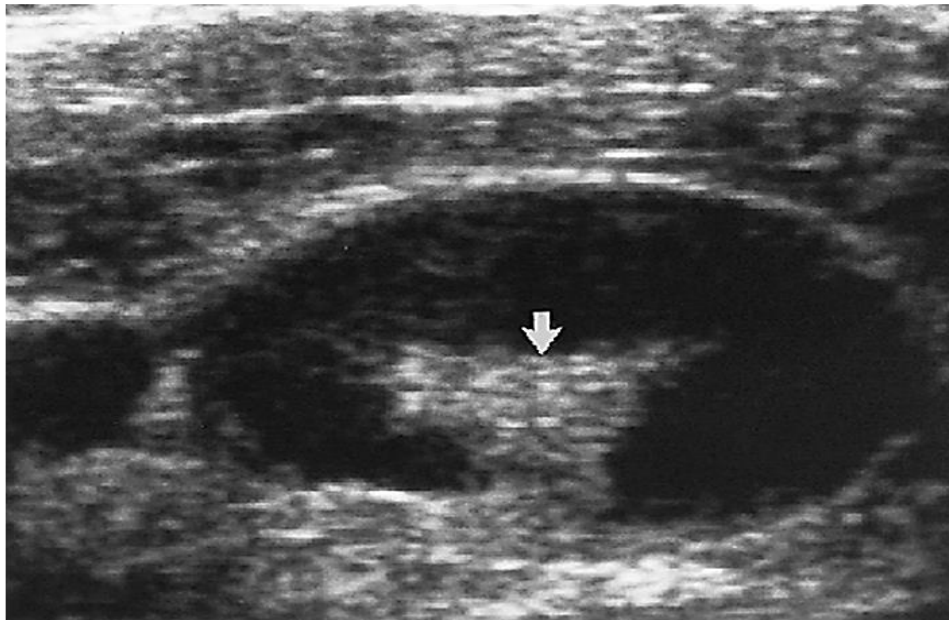


Figure (2-2) Gray-scale sonograms of lymph nodes

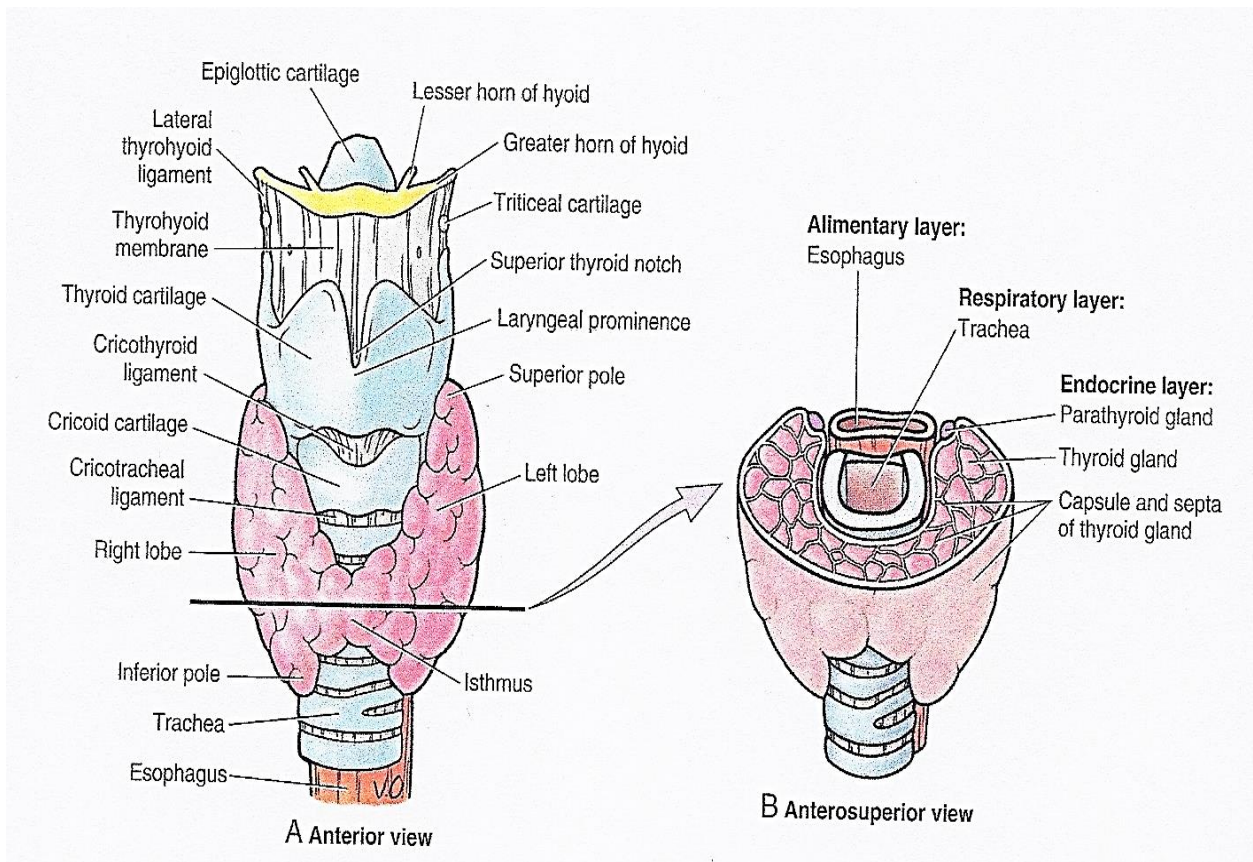


Figure (2-3) Anatomic Variations

### 2.1.4 Anatomical Variations

Hypoglossal Duct Cyst Thyroglossal duct fails to involute completely.

A thyroid Absence of Thyroid gland

- Pyramidal Lobe
- Absence of Isthmus
- Ectopic Gland

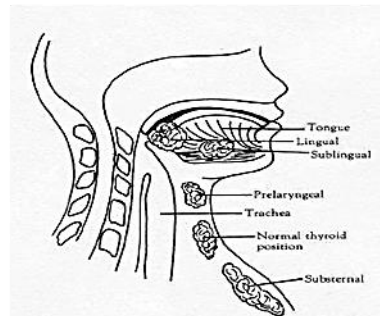
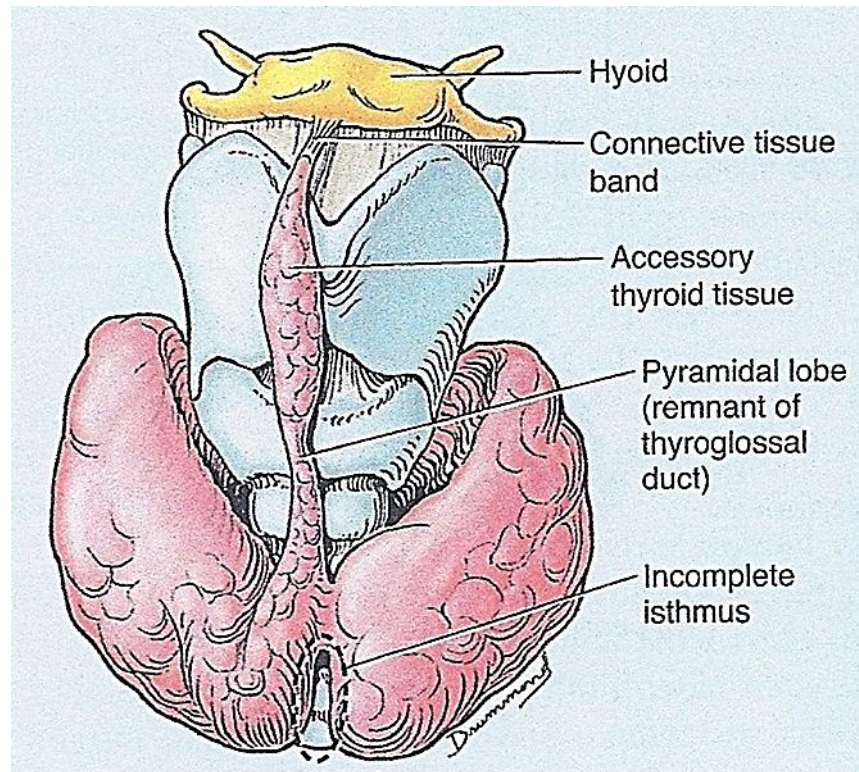
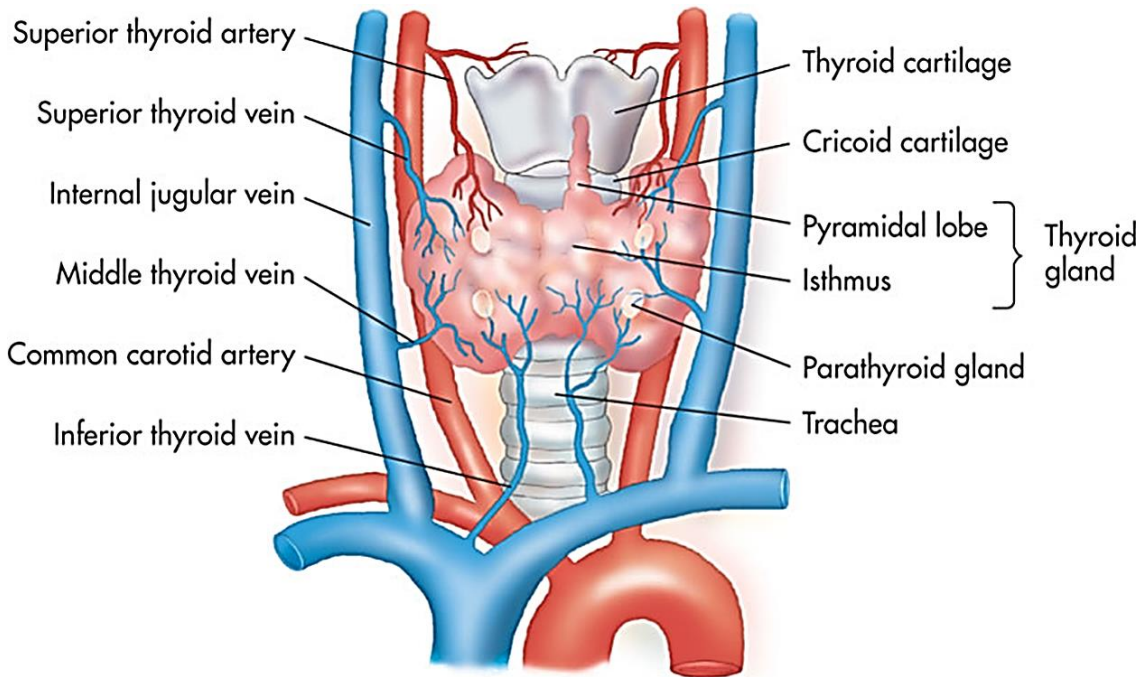


Figure (2-4) Gray-scale sonograms OF two lateral lobes and a connecting isthmus

- The thyroid gland consists of **two lateral lobes** and a **connecting isthmus**.
- The average gland is 40 to 60 mm in length and 13 to 18 mm thick with the
- Isthmus approximately 4 to 6 mm thick. A **pyramidal lobe** is present in 10% to 40% of

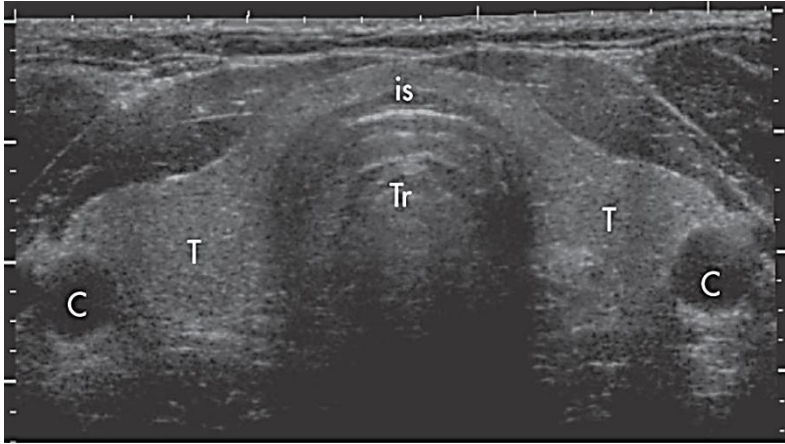
- It is a finger-like lobe of tissue which extends superiorly from the isthmus and is of variable height.
- The normal thyroid gland has a wide range of sizes.
- Normal variations in size occur with age, sex and nutrition: the gland is larger in youth, the well-nourished and in women - especially during menstruation and pregnancy.



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Figure (2-5) two lateral lobes and a connecting isthmus





# Normal Thyroid

Newborn: 18-20 mm long;

8-9 mm AP

Age 1: 25 mm long;

12-15 mm AP

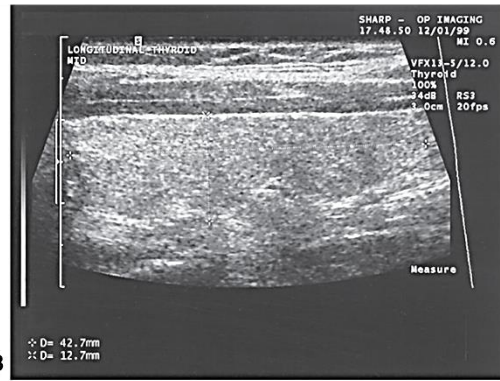
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## Adult Thyroid

40-60 mm long

13-18 mm AP

Isthmus 4-6 mm AP



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Figure (2-6) Normal thyroid

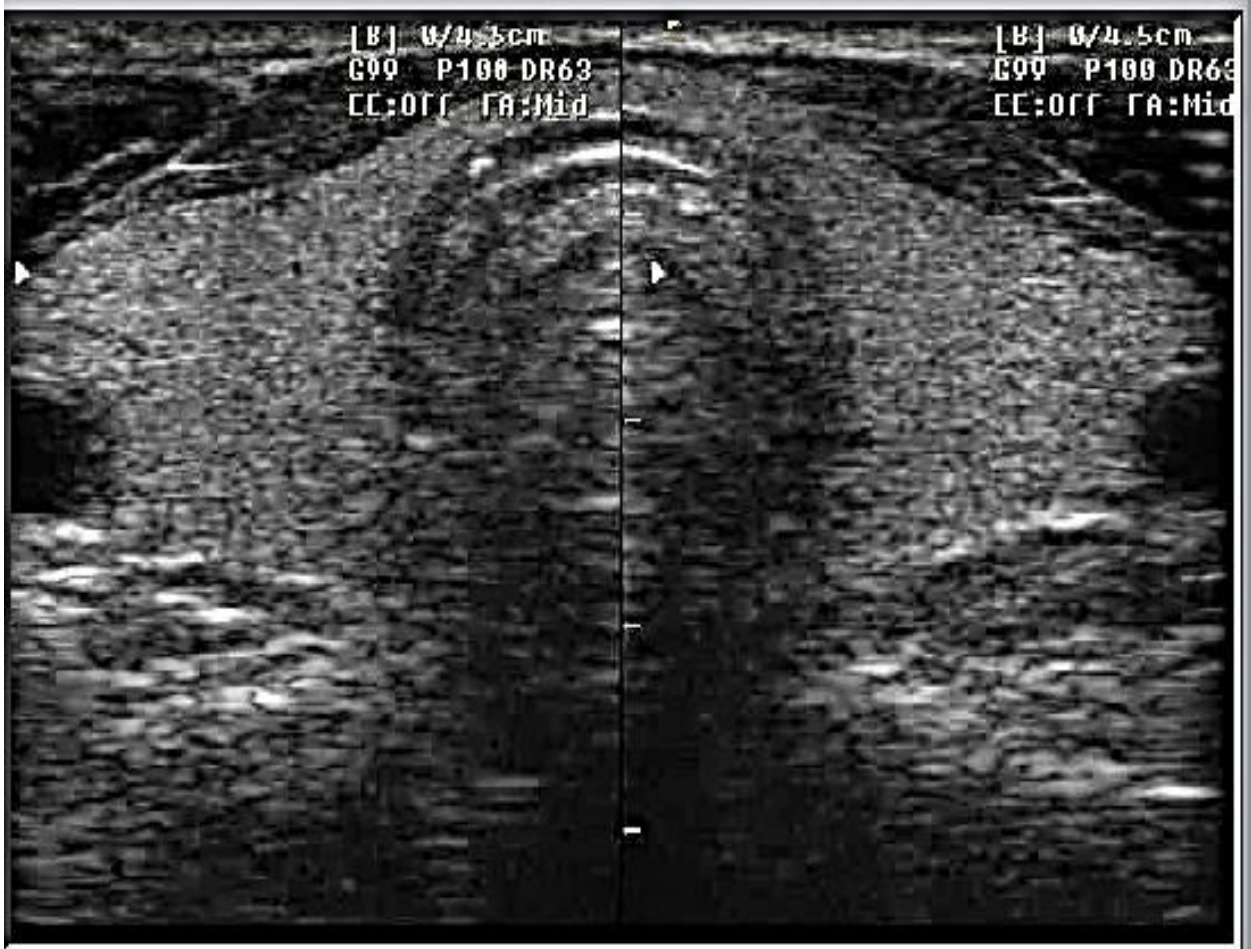


Figure (2-7 a panoramic transverse view

Extended field of view imaging provides a panoramic transverse view which is useful for comparing the size and echogenicity of the lobes. Patient swallowing tends to raise the thyroid gland in the neck and may be helpful to image the lower poles (Dumont, 2000 #1366).

Intrathoracic extension of the thyroid gland can be demonstrated by angling the transducer inferiorly into the mediastinum from a supramanubrial position (Dumont et al., 2000).

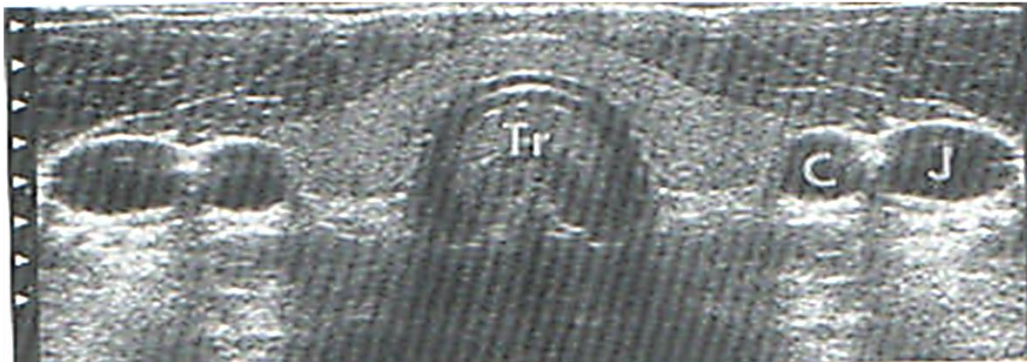
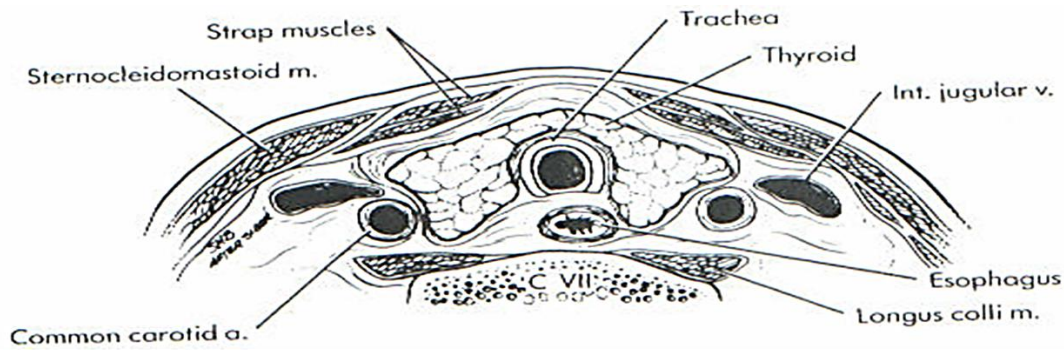


Figure (2-8) vessels of thyroid

If the neck is thin and the thyroid is very superficial, an offset gel pad may help to place the gland in the focal zone and improve detail. However, ample gel applied to the patient's neck usually ensures good performance of the transducer.

Color Doppler is used to confirm any focal abnormalities and assess general vascularity. Neoplastic nodules (adenomas, carcinomas) usually contained intranodular flow signals. The majority of the colloid nodules are either avascular or have halo flow signals while many of them show a comet-tail artifact (Nduka and Adeyekun, 2016).

Sonographically the normal thyroid gland is homogeneously fine textured with medium to high levels of echogenicity. The echogenicity is usually greater than the normal neck muscles (Nduka and Adeyekun, 2016).

The capsule is the hyper echoic line that forms the margins of the gland. It should be smooth and well defined. On transverse section, a normal gland has a concave (or straight) anterior border, indented by the sterno thyroid muscle. Longitudinal section through a normal gland also demonstrates a flat or minimally bulged anterior border (Nduka and Adeyekun, 2016).

### **2.3 Thyroid physiology:-**

The thyroid gland located immediately below the larynx on each lobe of and anterior to the trachea, is one of the largest endocrine glands, normally weighting 15 to 20 grams in adults. The thyroid secrete two major hormones, thyroxin and tri iodothyroxine, commonly called T4 and T 3, respectively (Stathatos, 2012).

both of these hormones profoundly increase the metabolic rate of the body. complete lack of thyroid secretion usually causes the basic metabolic rate to fall 40 to 50 per cent below normal, and extreme excesses of thyroid secretion can increase the basal metabolic rate to 60 to 100 per cent above normal. Thyroid secretion is controlled primarily by thyroid -stimulating hormone (TSH) secreted by the anterior thyroid pituitary gland. The thyroid gland also secretes calcitonin, an important hormone for calcium metabolism (Stathatos, 2012).

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

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



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

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

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

Enzyme the process to occur within seconds or minute. Therefore, almost as rapidly as the thyroglobulin molecule is released from the golgi apparatus or as it is

secreted through the apical cell membrane into the follicle, iodine binds with about one sixth of the tyrosine amino acids within the thyroglobulin molecule, the stage of iodination of tyrosine and final formation of the two important thyroid hormones, thyroxine and triiodothyronine (Mariotti and Beck-Peccoz, 2000).

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

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

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

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

Thyroid Hormones Increase Active Transport of ions Through Cell Membranes:

One of the enzymes that increase its activity in response to thyroid hormone is Na<sup>+</sup>-K<sup>+</sup>-ATPase. this in turn increases the rate of transport of both sodium and potassium ions through the cell membranes of some tissues. Because this process uses energy and increases the amount of heat produced in the body, it has been suggested that this might be one of the mechanisms fact, thyroid hormone also causes the cell membrane of most cells to become leaky to sodium ions, which further activate the sodium pump and further increases heat production.

## **2.4 Thyroid Pathology:**

Ultrasound is unable to differentiate benign from malignant lesions. Ultrasound is used to determine the solid or cystic nature of a nodule. A definitive diagnosis requires either fine needle aspiration and biopsy or surgery (Cignini et al., 2012).

### **2.4.1 Goiter**

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

### **2.4.2 Nodules**

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

### **2.4.3 Diffuse Colloid (Simple) Goiter**

Zones of glandular hyperplasia result in dilated follicles filled with colloid. These dilated follicles appear as cold nodules. They can undergo hemorrhage and

necrosis. Colloid nodules are the most common type of thyroid nodule but thyroid function is normal.

Sonographically; the gland is symmetrically enlarged with normal echogenicity.

#### **2.4.4 Adenomatous or Multinodular Goiters (MNG)**

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

Sonographically; the gland may be diffusely inhomogeneous with no recognizable normal thyroid tissue or there may be multiple discrete nodules scattered throughout an otherwise normal gland. The nodules may have isoechoic, hypoechoic or hyperechoic echogenicities. They may also have mixed echogenicity if they undergo hemorrhage or necrosis. Coarse calcifications may be present. Adenomatous Goiter. Although this condition is commonly termed multinodular goiter, it frequently manifests as diffuse, heterogeneous thyroid enlargement without distinct nodules. The superior thyroid artery and vein are located at the upper pole of each lobe. The inferior thyroid vein is located at the lower pole of each lobe. The inferior thyroid artery is located posterior to the lower third of each lobe. These arteries (1-2 mm diameter) and their accompanying veins (6-8 mm diameter) course between the thyroid lobes and the longus colli (Cignini et al., 2012).

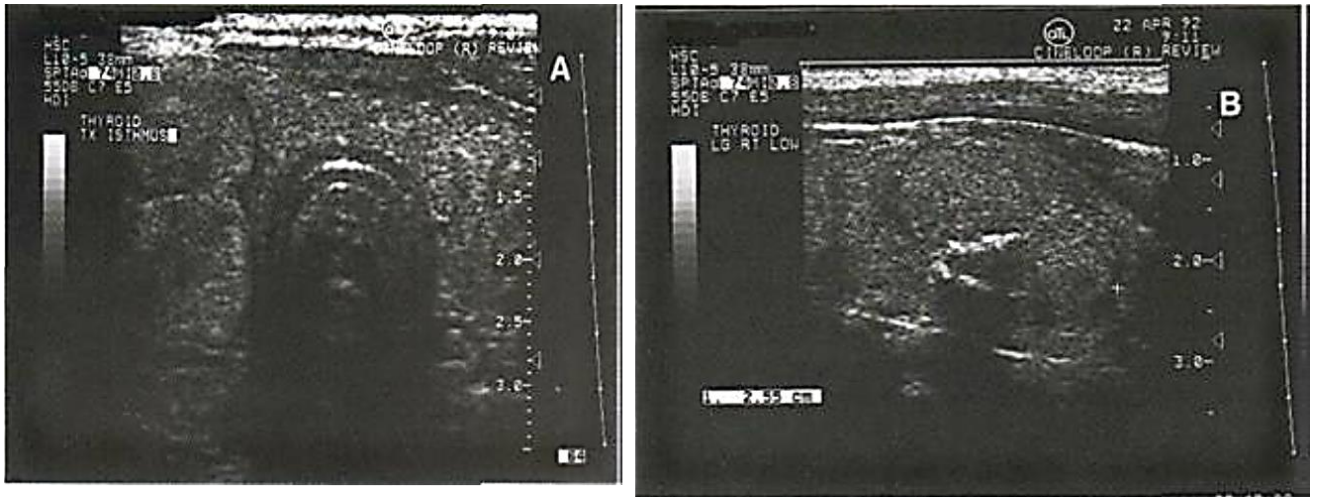


Figure (2-9) multinodular goiter, diffuse multinodular goiter in a 42 year old female. A Transverse. The gland is asymmetrically enlarged with several large discrete nodules. There are hypo echoic rims defining the nodules. B Longitudinal. The parenchymal disruption is demonstrated along with areas of shadowing calcifications within the nodules.

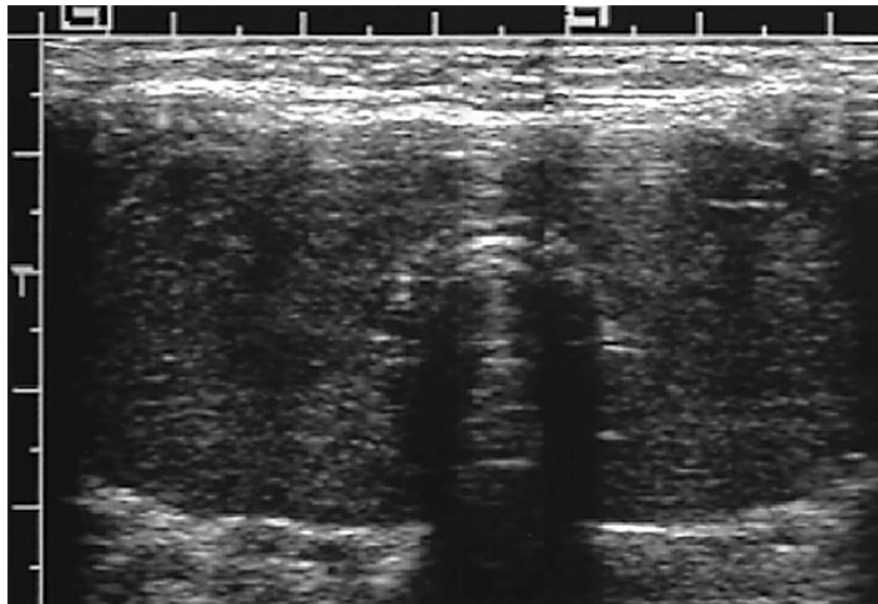


Figure (2-10) Adenomatous Goiter



Figure (2-11) Hashimoto's thyroiditis

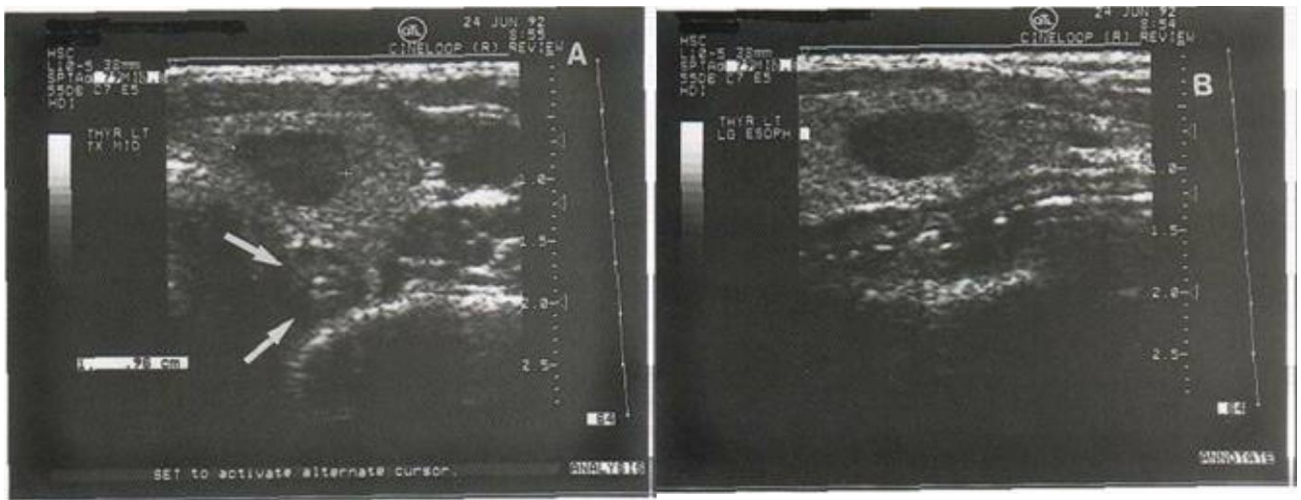


Figure (2-12) Thyroid adenoma. A Transverse of the left lobe demonstrates a hypoechoic focal lesion 0.96 cm (9.6 mm) encircled by normal gland. Posterior to the left lobe is the target-like esophagus (arrows). The origin of the esophagus is often left sided. B Longitudinal scan through the adenoma demonstrates the esophagus posterior to the thyroid gland.

### **2.4.5 Hashimoto's Thyroiditis:**

This is the most common form of thyroiditis and is characterized by often painless, moderate, symmetrical enlargement, mild hypothyroidism, massive infiltration of lymphatic cells and the presence of serum autoantibodies against the thyroid gland.

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

Sonographically; a diffuse micronodular pattern is characteristic. The micronodules are hypoechoic and range in size from 1-6 mm although most are 2-3 mm size. The gland is usually enlarged but may be normal. Distinct nodules may be present. CD demonstrates marked hypervascularity (Cignini et al., 2012).

**Subacute Hashimoto's thyroiditis: (de Quervain's) Thyroiditis** is believed to be caused by a virus rather than autoimmunity and is also more common in women. The gland is swollen and painful usually 2-3 weeks after an upper respiratory infection. Severe destruction of the gland releases hormone, resulting in a period of hyperthyroidism, followed by a short period of hypothyroidism caused by hormone depletion. Most patients recover fully (Zhang et al., 2016).

Sonographically; the gland is enlarged initially but as the disease progresses, the gland becomes atrophic. The gland appears heterogeneous with both hyperechoic and hypoechoic nodules. There is an overall decrease in parenchymal echogenicity.

### **2.4.6 Adenomas and Carcinomas**

Evaluation of thyroid nodules is particularly annoying because thyroid nodules are exceedingly common and US detects most of them, even as small as 1-2 mm, but can rarely unequivocally differentiate benign from malignant nodules. US is used to evaluate nodules and indicate whether a biopsy is necessary. It is also used to

direct aspiration biopsies of thyroid nodules and to guide alcohol ablation of thyroid lesions (Zhang et al., 2016).

Adenomas are benign tumors of thyroid follicles. Usually the adenoma is a solitary, well encapsulated lesion. The remainder of the gland appears normal. Occasionally adenomas are hyperfunctioning and result in hyperthyroidism with suppression of the rest of the gland. Hyperfunctioning adenomas usually result in "hot" lesions on radioisotope nuclear medicine scans.

Sonographically most adenomas are solitary, solid, homogeneous lesions with regular margins and an oval or round shape. Adenomas can be hypoechoic, isoechoic or hyperechoic to the normal thyroid tissue. They tend to undergo cystic degeneration. An anechoic peripheral halo may be seen with adenomas however, it may also be present with malignant lesions and is therefore nonspecific. Adenomas may have localized peripheral calcification or may be entirely calcified resembling a calculus (Zhang et al., 2016).

**Carcinomas** is the most common malignancy of the endocrine glands, it remains a rare disease accounting for less than 1% of all malignancy, and is the cause of death in only 0.005% of the United States population. Most thyroid cancers are relatively nonaggressive and have a good prognosis with 90% 10-year survival for early disease. Thyroid carcinoma is 2-3 times more common in women. Neck irradiation, especially as a child, is a major risk factor, greatest 20 years after radiation. The most common age for developing papillary carcinoma is 30 years of age and for follicular carcinoma, 45 year of age. A thyroid nodule found in a very young or very old patient is probably malignant. The most common presentation is an asymptomatic neck lump. The ultrasound appearances of thyroid cancer are highly variable.



#### **2.4.7 Colloid Cysts:**

Are collections of colloid in large thyroid follicles which appear as tiny cysts (<5mm in size) with no solid component. They are benign, can be considered a normal finding and are of no clinical significance.

**Simple cysts** of the thyroid are rare. Most thyroid cysts are complex and represent degeneration of either an adenoma or a colloid nodule.

Because of the rare occurrence of pure simple thyroid cysts and because both benign and malignant lesions can have cystic components, doing a thyroid ultrasound scan to distinguish a cyst from a solid mass is generally not of much clinical value (Zhang et al., 2016).

**Hemorrhagic cysts** are most often the result of acute hemorrhage within a follicular adenoma according to pathologic analysis. These lesions appear complex (cystic and solid). Septations and fluid-fluid levels can sometimes be seen in the cystic component. Fluid in a thyroid nodule is most consistent with a degenerating adenoma however, malignancy cannot be excluded.

#### **2.5 Ultrasound of thyroid gland:-**

The anterior neck is depicted rather well with standard gray scale .the thyroid gland is slightly more echodense than the adjacent structures because of its iodine content. it has a homogenous ground glass appearance .each lobe has a smooth globular shaped contour and no more than 3-4centimeters in height, 1-1,5cm in width , and 1 cm in depth.

The isthmus is identified, anterior to the trachea as a uniform surface that is approximately 0.5 cm in height and 2-3 mm in depth. The pyramidal lobe is not seen unless it is significantly enlarged. In the female, the upper pole of each

thyroid lobe may be seen at the level of the thyroid cartilage, lower in the male. The surrounding muscles are of lower echogenicity than the thyroid and tissue planes between muscles are usually identifiable. The air filled trachea does not transmit the ultrasound and the only the anterior portion of the cartilaginous ring is represented by dense, bright echoes. The carotid artery and blood vessels are echo-free unless they are calcified. The jugular vein is usually in a collapsed condition and it distends with aValsalva maneuver. There are frequently 1-2 mm echo free zones on the surface and within the thyroid gland that represent blood vessels. The vascular nature of all of these echoless areas can be demonstrated by color Doppler imaging to differentiate them from cystic structure lymph nodes may be observed and nerves are generally not seen. The para thyroid glands are observed only when they are enlarged and are less dense ultrasonically than thyroid tissue because of absence of iodine. The esophagus may be demonstrated behind the medial part of the left thyroid lobe, especially if it is distended by a sip of water (Zhang et al., 2016).

Volumes are calculated using the standard formula for an ellipse (length x width x height x 0.52). In approximately one-third of cases, the sonographic measurement of volume differs from the physical size estimate derived from examination. Normal volume in adults is 10 to 11 + 3 ml.<sup>7</sup> Thyroid volume is larger in patients with iodine deficiency or who have acute hepatitis or chronic renal failure. Thyroid volume is smaller in patients with chronic hepatitis or who have been treated with thyroxine or radioactive iodine (Zhang et al., 2016).

## **2.6 Previous study;-**

Mohamed yousef et al in 2010 concluded that the thyroid volume in Sudanese normal subjects using ultrasound. A total of 103 healthy subjects were studied.

28(27.18%) females and 75(72.82%) males. thyroid volume was estimated using ellipsoid formula. the mean age and range of subjects was 21.8(19-29) years, the mean body mass index (BMI) was 22.3 (16.46--26.07) Kg/m<sup>2</sup>. the overall mean volume  $\pm$ SD volume of the thyroid gland for both lobes in all patients studied was 6.44 $\pm$ 2.44 mL. the mean volume for both lobes in females and males were 5.78 $\pm$ 1.96 mL and 6.69  $\pm$ 2.56 mL, respectively. The male's thyroid volume was greater than the females. The mean volume of the right and left lobes of the thyroid gland in males and females were 3.38 $\pm$ 1.37 mL and 3.09 $\pm$ 1.24mL, respectively. The right thyroid lobe volume was greater than the left.

Kyuing Kim and Young SiK et al in 2012 concluded that the thyroid volume in school children aged 6 to 12 years living in Cagayan areas in Philippines. The mean weight was 9.4 $\pm$ 2.9. The mean thyroid volume was 6.44 $\pm$ 2.2 mL.

The work of Brunn et al in 1981 was based on volume measurement of cadaver glands subsequently immersed in water. Brunn et al. concluded that a modified correction factor of 0.52 resulted in a more accurate assessment of thyroid volume.

P. Kayastha, S. Paudel, S. Shrestha et al in 2010 concluded that among 485 individuals between 1 to 83 years of age, 221(45.57%) were males and 264(54.43%) were females. Maximum {354 individuals (72.99%)} were from hilly region and minimum {16 individuals (3.30%)} were from Himalayan region. Mean thyroid volume was 6.629 $\pm$ 2.5025 mL. In general, thyroid volume was found to be more in older individuals than in young age group.

There was no significant difference of thyroid volume between males and females. Thyroid volume best correlated with body surface area ( $r=0.444$ ,  $p<0.0001$ ), the volume had a positive correlation with weight ( $r=0.443$ ,  $p<0.0001$ ), body mass index ( $r=0.371$ ,  $p<0.0001$ ) and height ( $r=0.320$ ,  $p<0.0001$ ) of the individuals.

## **Chapter Three**

### **3. Material and method**

#### **3.1 Materials:**

##### **3.1.1 Subjects:**

48 healthy adult Sudanese female were enrolled in the study. Subjects with anterior neck swelling or clinical evidence of thyroid disease were excluded, as well as women under 18 years. The study has been approved by college research board and participant were verbally agreed to participate in the study.

##### **3.1.2 Machine used:**

Toshiba ultrasound machine with 7.5 MHz linear transducer.

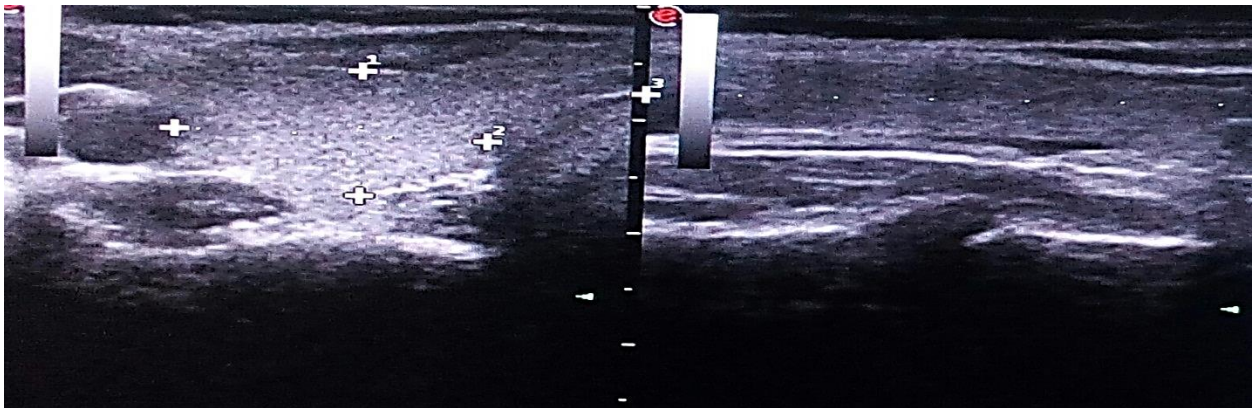
#### **3.2 Method:**

##### **3.2.2 Technique used and measurements:**

All the individuals were examined in the supine position with the neck hyper extended using linear 7.5 MHz probe, transverse and longitudinal sections of the both lobes of the thyroid gland were scanned. Measurement of Maximum length of the lobe from the sagittal images was recorded. The maximum transverse diameter (breadth) and the maximum depth of each lobe were recorded from the transverse images. To bring the volume of right lobe, bring firstly transverse section then longitudinal section then lastly the volume of right lobe, the left lobe the same steps then collect the otal of two lobes.



**Figure (3-1) Measurement of volume of left thyroid lobe.**



**Figure (3-2) Measurement of volume of right thyroid lobe.**

The volume of each lobe was calculated mathematically by the machine using the formula for ellipsoid, where thyroid volume=length×breadth ×depth x0.523. The total thyroid volume was obtained by adding the volume of both lobes. Volume of isthmus was not included in the total thyroid volume.

### **3.2.2 Data analysis:**

All obtained measurement were analyzed using SPSS Software version 19. Descriptive ststistics as well as frequency table and correlation were obtained.

## Chapter four

### Results

The following tables and figures presented the data obtained from 48 female Sudanese women aged from 18 -50 years old all were examined by ultrasound for thyroid gland.

**Table 4.1 the mean and standard deviation of the variables.**

#### Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	48	18	50	33.40	10.076
Weight	48	40.0	80.0	60.687	9.8912
Rt lobe Volume	48	2.0	3.6	2.824	.4296
Lt lobe Volume	48	2.0	3.3	2.544	.4617
Total Thyroid Volume	48	4.0	6.6	5.367	.8028

### Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean	Sig(2tail)
Rt lobe Volume	2.824	48	.4296	.0620	0.000
Lt lobe Volume	2.544	48	.4617	.0666	

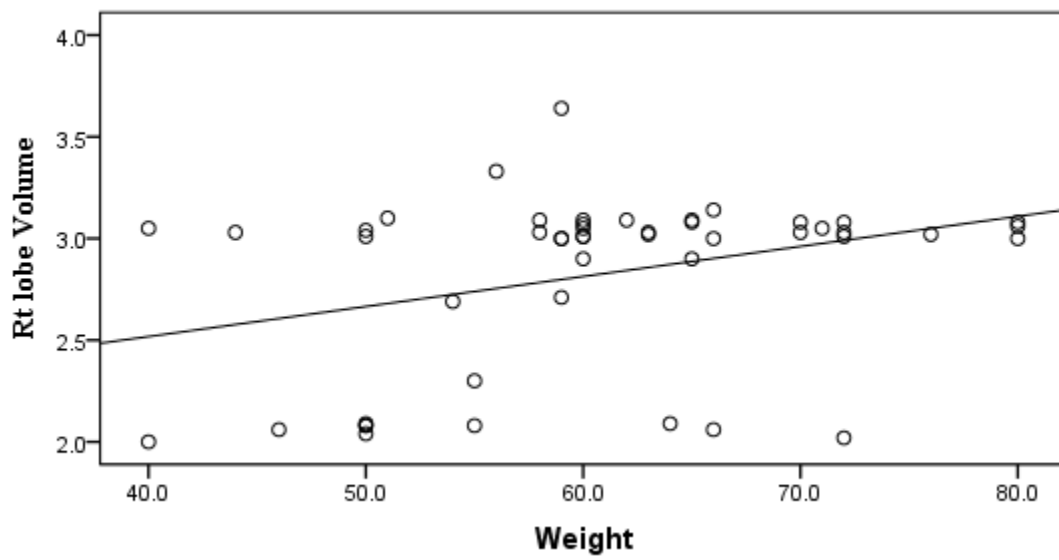


Figure 4.2 shows linear relationship between Rt lobe volume and weight.

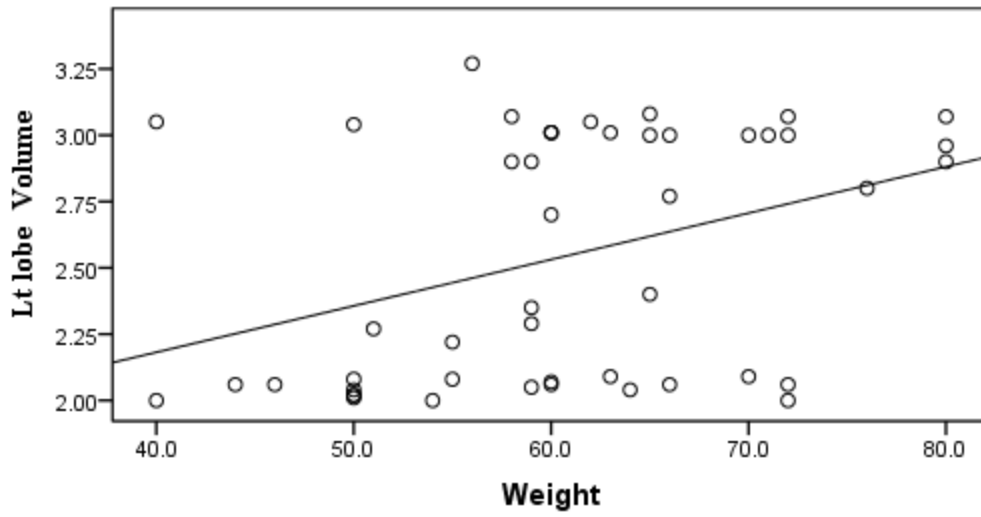


Figure 4.3 shows relationship between Lt lobe of volume and weight.

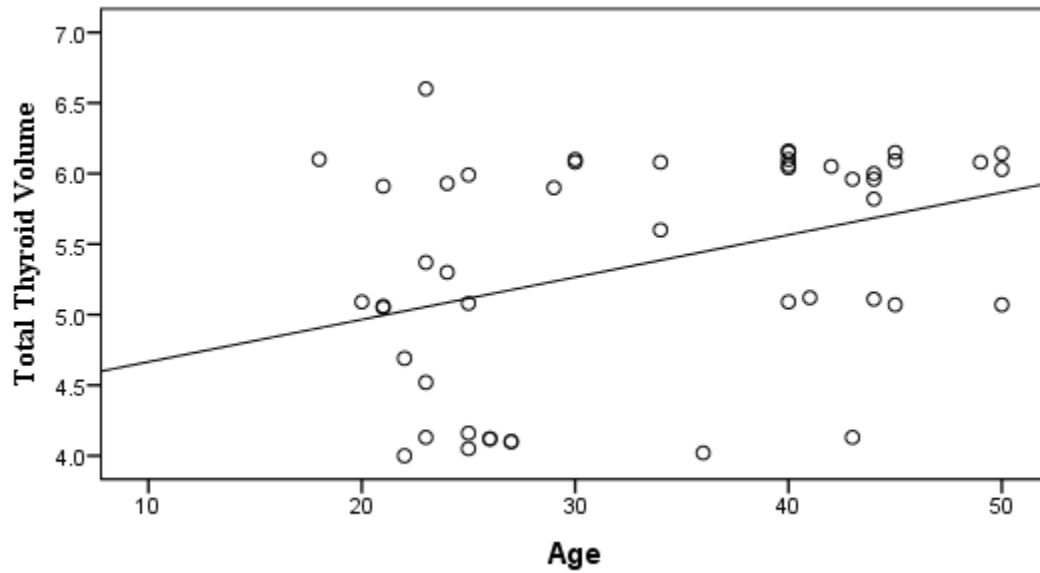


Figure 4.4 shows linear relationship between total thyroid volume and age.



Table 4.2 shows correlation between age, weight, Rt lobe volume, left lobe volume and total thyroid volume.

		Age	Weight	Rt lobe Volume	Lt lobe Volume	Total Thyroid Volume
Age	Pearson Correlation	1	.668**	.298*	.377**	.376**
	Sig. (2-tailed)		.000	.039	.008	.008
	N	48	48	48	48	48
Weight	Pearson Correlation	.668**	1	.340*	.375**	.398**
	Sig. (2-tailed)	.000		.018	.009	.005
	N	48	48	48	48	48
Rt lobe Volume	Pearson Correlation	.298*	.340*	1	.622**	.893**
	Sig. (2-tailed)	.039	.018		.000	.000
	N	48	48	48	48	48
Lt lobe Volume	Pearson Correlation	.377**	.375**	.622**	1	.908**
	Sig. (2-tailed)	.008	.009	.000		.000
	N	48	48	48	48	48
Total Thyroid Volume	Pearson Correlation	.376**	.398**	.893**	.908**	1
	Sig. (2-tailed)	.008	.005	.000	.000	
	N	48	48	48	48	48

## Chapter Five

### Discussion, Conclusion and Recommendation

#### 5.1 Discussion:

The aim of this study was to estimate the reference values of total thyroid volume based on sonographic measurements of thyroid gland for adult Sudanese female. Female population have been chosen exclusively, because women have been shown to develop goiter significantly more often than men (Vanderpump and Tunbridge, 2005).

The study found that (mean  $5.367 \pm 0.82$  mL) the thyroid volume was below recommended upper limit for adult population of 18 mL (Vanderpump and Tunbridge, 2005). Furthermore, in all our subjects, thyroid volume was even below 16 mL that is a recommended upper limit for thyroid volume in children under 15 years of age. The result of the study showed that the right lobe volume was greater than the left lobe volume; this result was in line with the previous studies (Marchie et al., 2012). The results also show that thyroid volume was best correlated with body weight and with age. This is in accordance with previously published data (Marchie et al., 2012).

The results support the notion that iodine insufficiency, in the county of Sudan, has been substantially improved over the last decade. This especially after the recent household salt iodization took place. Nevertheless, having in mind earlier findings and the relatively small number of our subjects, and also that our subjects were all young and educated, coupled with the fact that our study encompassed population from only one region in Sudan, further research in this important field is mandatory.

## **5.2 Conclusion:**

This study aim to establish a local reference of thyroid volume in normal adult Sudanese female which will be useful in the clinical practice especially for the diagnosis of goiter.

50 healthy adult Sudanese female were scanned in supine position with full extended neck by using Toshiba with 7.5 MHZ. linear transducer there is no special patient preparation for thyroid scan sonograms were analyzed by SPSS.

The estimated mean thyroid volume in our population is seen to be significantly lower compared to the thyroid volume in the other previous study and WHO and ICCIDD thyroid volumes.

### **5.3 Recommendation:-**

This study would like to highlight some points in a form of recommendation as follow:-

- Care must be taken in bringing of ultrasound machine about capability of volume measurement and resolution.
- Measurement of thyroid volume should consider the iodine deficiency.
- Larger thyroid further study with larger size, sample size and duration should be done to assess thyroid volume for Sudanese female.

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## Appendix

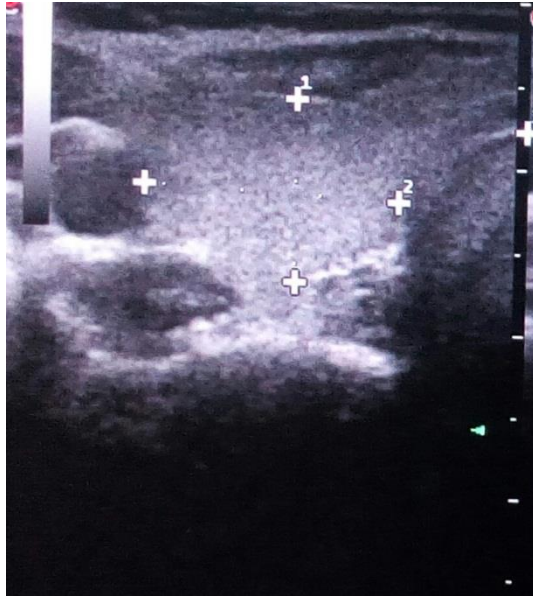


Image1 Thyroid lobe transverse view for female 34 years old show normal thyroid (volume 3.06 cm)

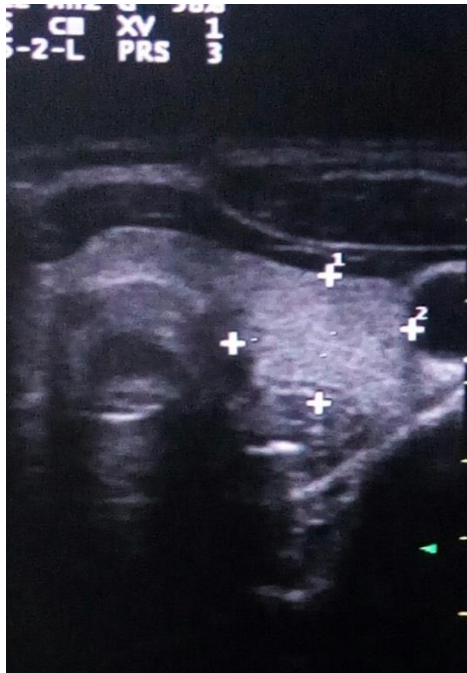


Image 2 Thyroid lobe transverse view for female 25 years old show normal thyroid (volume 2.90 cm)



Image 3 Thyroid lobe longitudinal view for female 40 years old show normal thyroid (volume 3.1 cm)

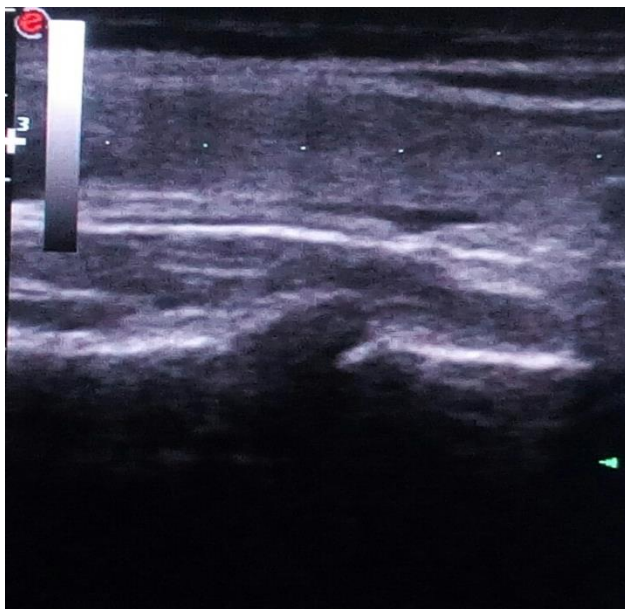


Image 4 Thyroid lobe longitudinal view for female 23years old show normal thyroid (volume 3 cm)



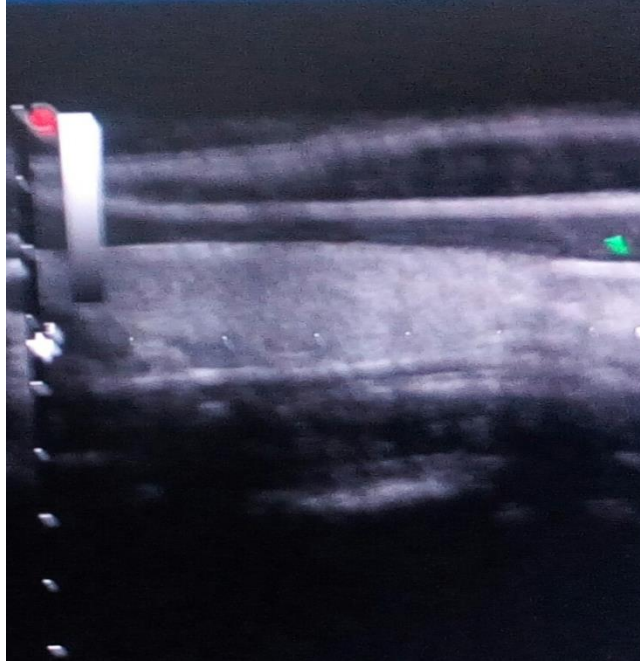


Image 5 Thyroid lobe longitudinal view for female 29 years old show normal thyroid (volume 2.4.cm)