Introduction

Thyroid nodular disease refers to an abnormal growth of thyroid cells that forms a lump within the thyroid gland. Although the vast majority of thyroid nodules are benign, a small proportion do contain thyroid cancer. Thus 15-30% are classified as a suspicious malignant nodules ***(Vorländer et al. 2010).*** Although 70% of them are benign they are all treated with surgical excision ***(Bahn and Castro, 2011).***

As an easy simple way to diagnose nodules we use ultrasound, but its ability to differentiate benign from possible malignant nodules was an obstacle.

The introduction of elastography technique to the ultrasound enabled it to differentiate benign from possibly malignant ones.

As we currently use FNA cytology for these Suspicious nodules, The principle of ultrasound elastography (USE) is to acquire two ultrasonographic images (before and after tissue compression used by the probe) and to pick up tissue displacement by assessing the propagation of the US beam by a special software. The US elastogram was displayed over the gray scale image in a color coded scale that ranged from red, for components with greatest elastic strain (i.e. softer components), to blue for those with no strain (i.e. harder components) ***(Rago et al., 1998).***

American College of Radiology (ACR) proposed TI-RADS which is a reporting system for thyroid nodules giving recommendations for when to use fine needle aspiration (FNA) with ultrasound follow-up of suspicious nodules, and when to safely leave alone nodules that are benign/not suspicious ***(Greg and Derek, 2018).***

TI-RADS is a reporting system for thyroid nodules on ultrasound proposed by the American College of Radiology (ACR). The ultrasound features in the ACR TI-RADS are categorized as benign, minimally suspicious, moderately suspicious, or highly suspicious for malignancy. Points are given for all the ultrasound features in a nodule, with more suspicious features being awarded additional points ***(Tessler et al., 2017).***

Scoring is determined from five categories of ultrasound findings (composition, echogenicity, shape, margin and presence of echogenic foci). The higher the cumulative score, the higher the TI-RADS level and likelihood of malignancy ***(Grant et al., 2015).***

The total point determines the nodule's ACR TI-RADS level, which ranges from TR1 (benign) to TR5 (high suspicion of malignancy) ***(Park et al., 2016).***

AIM OF THE WORK

The objective of this study is to quantify the sensitivity & the specifity of ultrasound elastography and TIRAADS in evaluation of thyroid nodules among study population in Ain Shams university hospitals

Chapter One

NORMAL THGYROID GLAND ANATOMY

The thyroid is a highly vascular, brownish-red gland located anteriorly in the lower neck at the level of the thoracic inlet, extending from the level of the fifth cervical vertebra down to the first thoracic vertebra ***(Dominique, 2017).***

The gland varies from an H to a U shape and is formed by 2 elongated lateral lobes with superior and inferior poles connected by a median isthmus, with an average height of 12-15 mm, overlying the second to fourth tracheal rings. (Figure 1) ***(Dominique, 2017).***

Each lobe is approximately 4 cm in length, 2 cm in width, and 2 to 3 cm in thickness. The isthmus measures about 2 cm in width, 2 cm in height, and 2 to 6 mm in thickness ***(Lai et al., 2005).***

Occasionally, the isthmus is absent, and the gland exists as two distinct lobes ***(Dominique, 2017).***

Although thyroid weight varies, it averages 25-30 grams in adults (it is slightly heavier in women). The gland enlarges during menstruation and pregnancy ***(Dominique, 2017).***

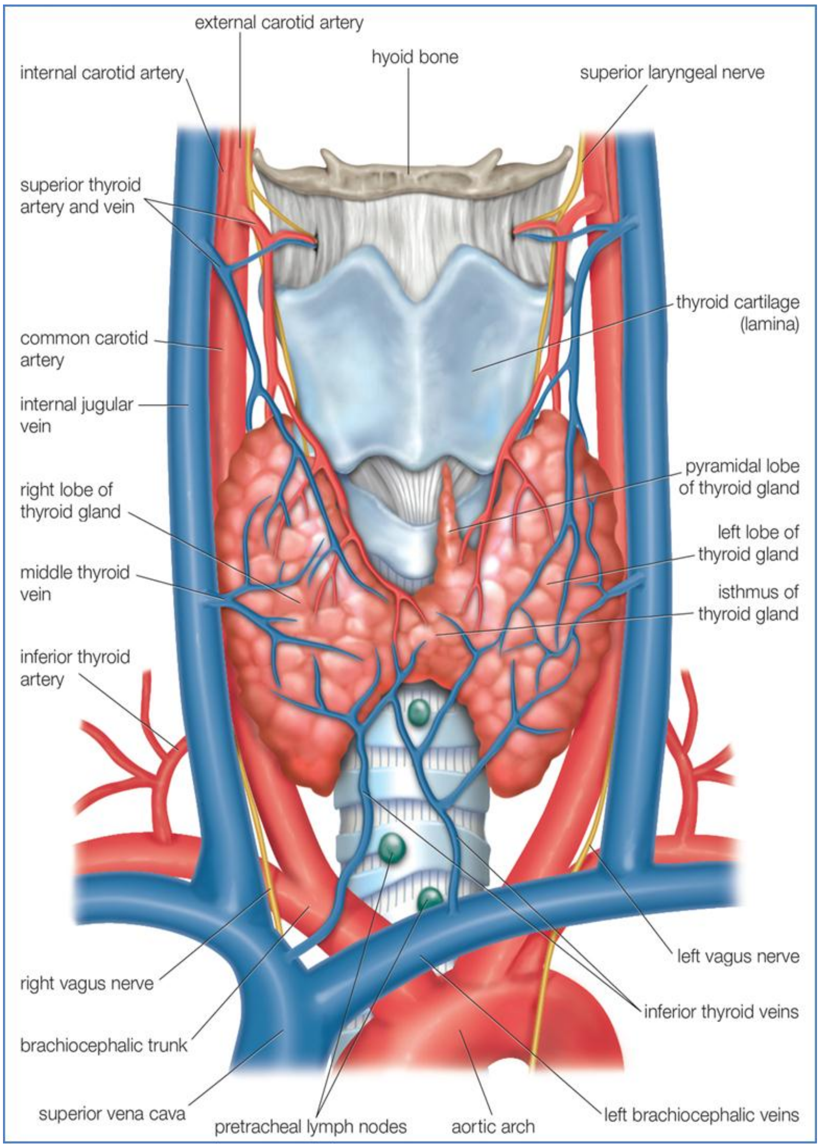

Figure (1): Thyroid gland anatomy ***(Dumont et al., 2015)***.

The thyroid gland lies around the circumference of the trachea, most posterior aspects of the lateral lobes may touch the oesophagus. The anterior surface of the thyroid is deep to the strap muscles of the neck, superiorly the lateral lobes of the thyroid usually extend to level of the middle of the thyroid cartilage and inferiorly the thyroid usually extends to the level of the sixth tracheal ring ***(Robert and Ernst, 2005)***.

The thyroid gland is ensheathed by the visceral fascia, a division of the middle layer of deep cervical fascia, which attaches it firmly to the laryngeal skeleton. The anterior suspensory ligament extends from the superio-medial aspect of each thyroid lobe to the cricoid and thyroid cartilage. The posteromedial aspect of the gland is attached to the side of the cricoid cartilage, first and second tracheal ring, by the posterior suspensory ligament (Berry ligament). This firm attachment of the gland to the laryngeal skeleton is responsible for movement of the thyroid gland and related structures during swallowing ***(Dominique, 2017).***

The parathyroid glands are usually lying on the posterior aspect of the thyroid lobes; there are usually 4 parathyroid glands; a superior and inferior on either side, though the numbers vary from 2 to 6. 90% are in close relationship to the thyroid, while 10% almost invariably the inferior glands are aberrant ***(Ellis, 2003).***

Relations of the Lobes *(Ahuja and Evans, 2000)* (Figure 2)

Anteriore Relationships:

- Strap muscles (sternothyroid and sternohyoid muscles)
- Sternocleidomastoid.

Posterolateral relationships:

- Carotid sheath containing common carotid artery, internal jugular vein and vagus nerve.

Medial relationships:

- Larynx.
- Trachea.
- Oesophagus.

Posterior relationships:

- Parathyroid glands.
- Longus coli muscle.
- Recurrent laryngeal nerve ***(Ahuja and Evans, 2000).***

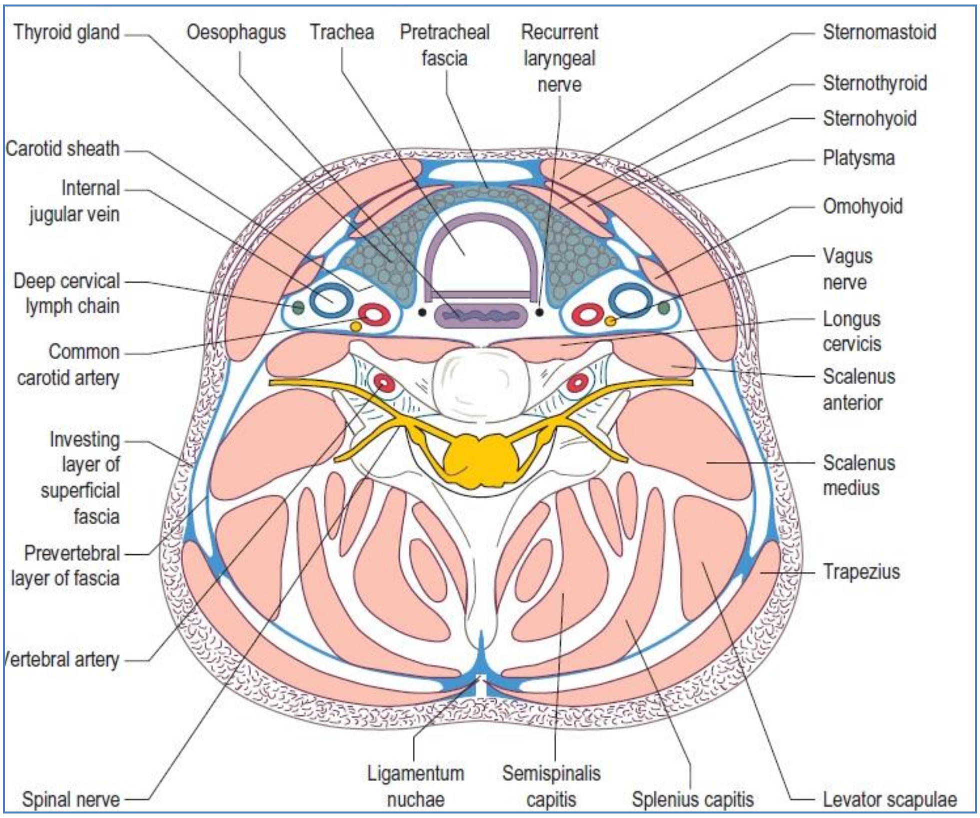

Figure (2): Transverse section of the neck at the level of C6 showing relationships of the thyroid gland ***(Ahuja and Evans, 2000).***

ARTERIAL SUPPLY:

Thyroid gland is supplied by the superior thyroid artery which arises from the external carotid and passes to the upper pole, the inferior thyroid artery arises from the thyrocervical trunk of the first part of the subclavian artery and passes behind the carotid sheath to the posterior aspect of the gland and the thyroid ima artery is small and inconstant; when present, it arise from the aortic arch or the brachiocephalic artery. **(Figure3)** ***(Ellis, 2003).***

The superior thyroid artery is the first branch of the external carotid artery and courses inferiorly to the upper pole of the thyroid gland. It enters the upper pole of the thyroid on its anterosuperior surface. The inferior thyroid artery usually arises from the thyrocervical trunk and passes upward in front of the vertebral artery and Longus colli to the lower pole of the thyroid gland. Before entering the thyroid, the artery usually divides into 2–3 branches ***(Yeo-Kyu et al., 2014).***

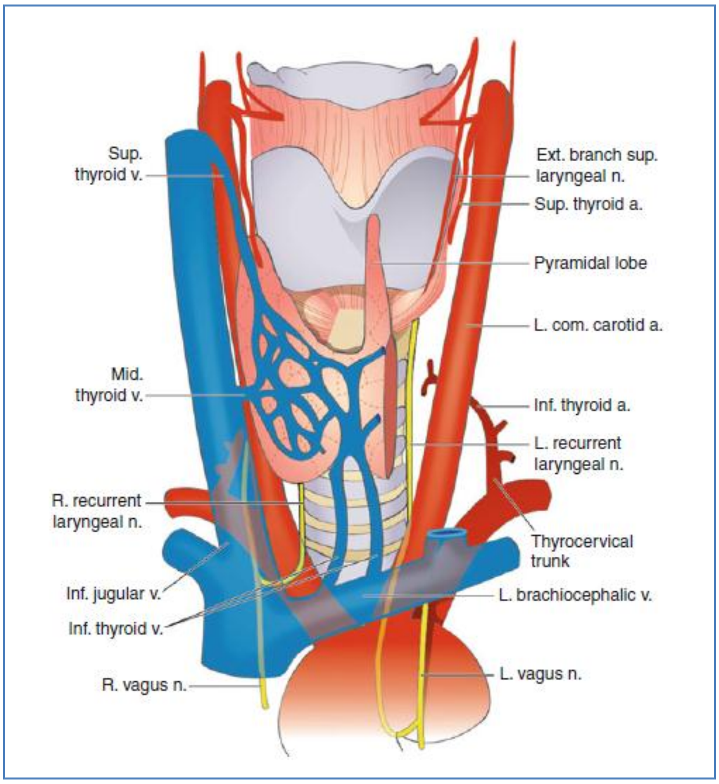

Figure (3): Blood supply and venous drainage of the thyroid gland ***(Yeo-Kyu et al., 2014).***

Venous drainage:

Three pairs of veins provide venous drainage for the thyroid gland. The superior thyroid vein drains the upper pole to the internal jugular vein, the middle thyroid vein drains from the lateral side of the gland to the internal jugular and the inferior thyroid veins (there are often several) drain the lower pole to the brachiocephalic veins **(Figure 3)**. Occasionally, both inferior veins form a common trunk called the thyroid ima vein, which empties into the left brachiocephalic vein ***(Ellis, 2003).***

Nerve supply:

Principal innervation of the thyroid gland derives from the autonomic nervous system. Parasympathetic fibers come from the vagus nerves, and sympathetic fibers are distributed from the superior, middle, and inferior ganglia of the sympathetic trunk. These small nerves enter the gland along with the blood vessels. Autonomic nervous regulation of the glandular secretion is not clearly understood, but most of the effect is postulated to be on blood vessels, hence the perfusion rates of the glands. **(Figure 4)** ***(Dominique, 2017).***

The relationship of the thyroid gland to the recurrent laryngeal nerve and to the external branch of the superior laryngeal nerve is of major surgical significance because damage to these nerves leads to disability in phonation and/or to difficulty breathing **(Figure 4)**. Both nerves are branches of the vagus nerve ***(Abadin et al., 2010).***

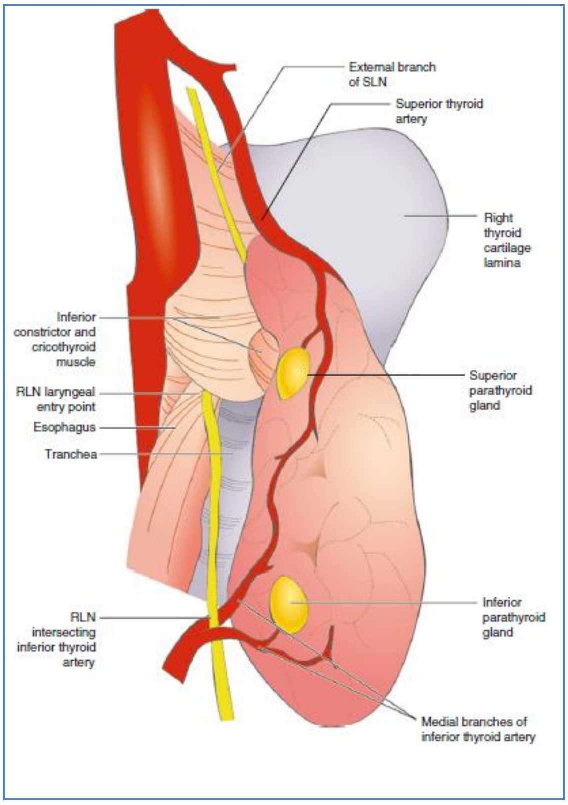

Figure (4): Nerve supply of the thyroid gland **SLN**: Superior Laryngeal Nerve **RLN**: Recurrent Laryngeal Nerve ***(Yeo-Kyu et al., 2014).***

Recurrent Laryngeal Nerve (RLN): *(Yeo-Kyu et al., 2014)*

Recurrent laryngeal nerves ascend toward the middle of the thyroid gland. They are intimately associated with the inferior thyroid artery. Multiple variations have been described in the relationship of the nerve to the inferior thyroid artery and its branches. The 3 basic configurations include: nerve anterior to the artery, nerve between branches of the artery (found in about 50%

of patients on the right), and nerve posterior to the artery (found about 50% of patients on the left) ***(Yeo-Kyu et al., 2014).***

Lymphatic drainage

Lymphatic drainage of the thyroid gland is multidirectional. Capsular lymph channels, draining the intraglandular capillaries, may cross communicate with the isthmus and opposite lobe. Therefore, it is difficult to predict lymphatic drainage of the thyroid gland.

In the first place, immediate lymphatic drainage is to the periglandular nodes and it courses to prelaryngeal, pretracheal, and paratracheal lymph nodes; these lymph node groups are called as the central neck compartment. The superior boundary of the central neck compartment is the hyoid bone; the inferior boundary is the suprasternal notch, and the lateral boundaries are the medial border of common carotid artery ***(Youn et al., 2014).***

The second part of lymphatic drainage is the lateral neck region; lymphatic drainage of the superior poles of the thyroid gland can flow directly into the lateral neck nodes, while lymphatic drainage of the other parts flows initially to the central neck nodes. Lateral neck compartment can be subdivided and grouped into several levels. As there exist many classifications of grouping neck lymph nodes, the American Academy of Otolaryngology Head and Neck Surgery Dissection Classification describes six different levels in the central (level IA, IB, and VI) and lateral (IIA, IIB, III, IV, VA, VB) neck **(Figure 5)** ***(Youn et al., 2014).***

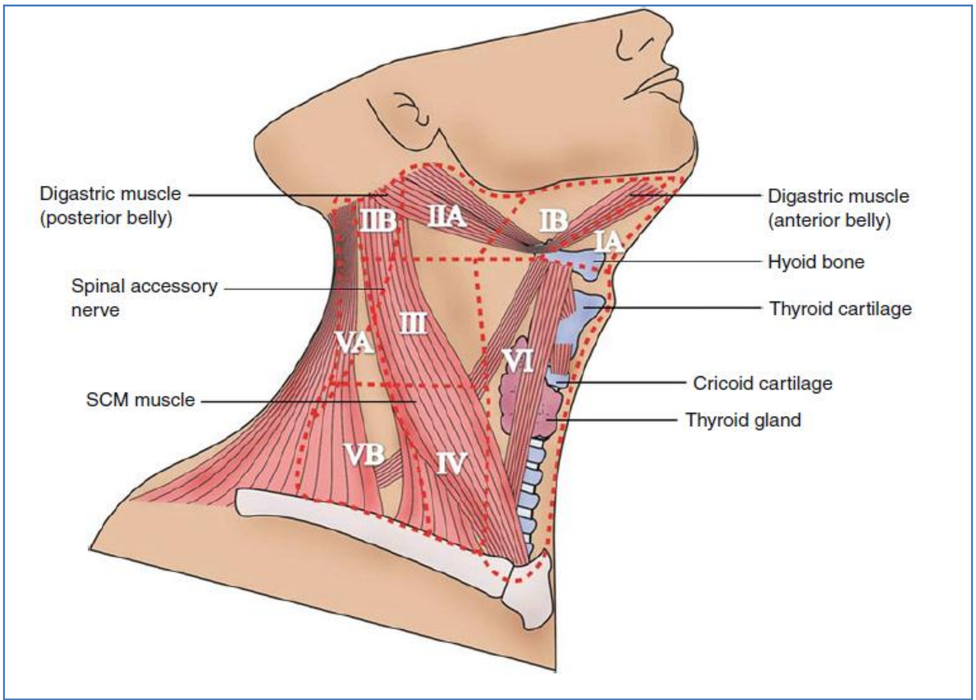

Figure (5): Classification of neck lymph nodes ***(Youn et al., 2014).***

The first nodal metastases from thyroid cancer are the nodes of the central compartment of the neck, the nodes of the superior mediastinum, and the lateral cervical nodes. The central compartment nodes are level VI, which is bounded by the hyoid bone superiorly, the suprasternal notch inferiorly, and the carotid arteries laterally. The specific nodal groups that drain the thyroid in the level VI compartment are the paralaryngeal, paratracheal, and prelaryngeal nodes **(Figure 6)**. The level VII nodes are those of the superior mediastinum that lie superior to the innominate vein. The lateral cervical nodes include nodes in both level III and IV ***(Lu and Brandy, 2008).***

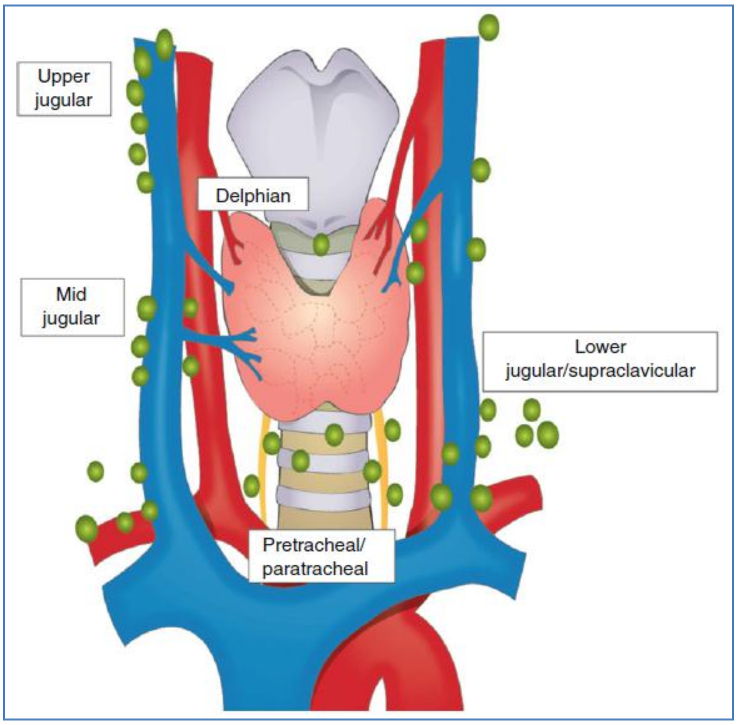

Figure (6): Lymph nodes of importance in thyroid carcinoma ***(Yeo-Kyu et al., 2014).***

Chapter Two

SONOGRAPHIC ANATOMY OF THYROID GLAND

The thyroid gland is examined with 7.5 MHz linear transducer. With the head slightly extended, transverse sections of the entire gland.

The thyroid gland is a butterfly shaped organ located in the midline of the anterior neck. It has two elongated lateral lobes (right and left), and is connected by the isthmus **(Figure 7)** ***(Khati et al., 2003).***

The parenchymal echogenicity of a normal thyroid gland is homogeneous and higher than the overlying strap muscles of the neck ***(Choi et al., 2014).***

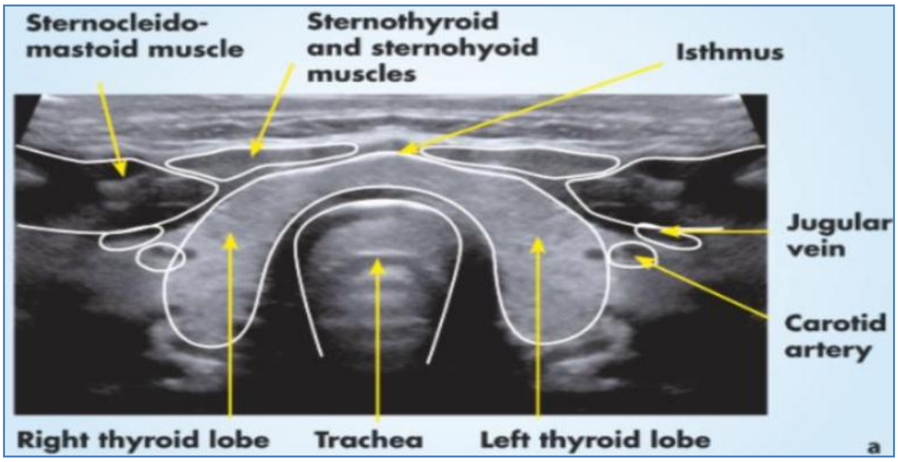

Figure (7): Normal thyroid ultrasound in transverse view ***(Hofer, 2013).***