

Role Of Elastasonography In Diagnosis Of Thyroid Lesions

Essay Submitted by

Islam Mustafa Ahmed EL Dahshan

M.B.B.CH

*A protocol submitted in partial fulfillment of the requirements for
degree of M.sc. in radiodiagnosis*

Supervised by

Prof. Dr.

Aida Mohamed El Shibiny

*Professor of Radiodiagnosis
Faculty of Medicine-Ain Shams University*

Dr.

Lobna Abd El Monem Habib

*Lecture of Radiodiagnosis
Faculty of Medicine- Ain Shams University*

*Radiology Department
Faculty of Medicine
Ain Shams University*

٢٠١٢

ACKNOWLEDGMENT

First and foremost, thanks are due to **ALLAH**, the most beneficent and merciful.

I would like to express my deepest appreciation and gratitude to

Prof. Dr. Aida Mohamed El Shibiny.

Professor of Radiodiagnosis, Ain Shams University .

for her precious advice, continuous encouragement and guidance through out this work.

I am deeply grateful to

Dr. Lobna Abd El Monem Habib.

lecturer of Radiodiagnosis, Ain Shams University .

for her patience, guidance, sincere help and meticulous comments that enlightened my way through out this work.

Finally I cannot forget to extend my deepest thanks and gratitude to my **family** for their great help and kind support.

ABSTRACT

Thyroid nodules are common in general population, their prevalence is being dramatically increased in iodine-deficient areas. The great majority of nodules are benign, less than 5% of them are malignant.

Ultrasound elastography is a newly developed technology that has been used in assessment of thyroid nodules. It can measure the degree of tissue stiffness as pathological tissues are usually harder than normal tissues. This can be represented through a colored map ranging between red and blue colors.

US elastography is non-stressful for patients, easy to perform, and requires not more than a few minutes of additional examination time.

Key words:

Elastography – Ultrasound – Thyroid gland – Nodules.

CONTENTS

Title	Page No.
List of abbreviations	I
List of figures	II
List of tables	III
Introduction	IV
Aim of work	V
Anatomy of the thyroid gland	VI
Pathogenesis of thyroid nodule	VII
Ultrasonography of the thyroid nodules	VIII
Principles of US elastography	IX
Technique of examination	X
Elastographic evaluation of thyroid nodules	XI
Assessment of cervical lymph nodes	XII
Summary	XIII
References	XIV
Arabic summary	

LIST OF ABBREVIATIONS

ARFI	Acoustic Radiation Force Impulse
BC	Before Christ
BGR	Blue-Green-Red
CCA	Common carotid artery
CT	Computed tomography
ES	Elastographic Score
FNAC	Fine Needle Aspiration Cytology
kPa	Kilo Pascal
MEN	Multiple endocrinal neoplasia
MHZ	Mega Hertz
M/S	Meters Per Second
MTC	Medullary Thyroid Carcinoma
NHT	Nodular Hashimoto's thyroiditis
P₁₋₄	Pattern 1-4
RF	Radio-Frequency
ROI	Region Of Interest
RTE	Real Time Elastography
SD	Standard Deviation
SEG	Sono -Elastography
SI	Stiffness Index
SR	Strain Ratio
TG	Thyroglobulin
TSH	Thyroid Stimulating Hormone
TSHR	Thyroid Stimulating Hormone Receptor
US	Ultrasound
US-E	Ultrasound Elastography

LIST OF FIGURES

No.	Figure	Page
١	Transverse section of the thyroid gland anatomy.	٦
٢	Relations of the thyroid gland.	٨
٣	Schema of cervical lymph nodes.	١٠
٤	Normal thyroid ultrasound in transverse view.	١٢
٥	Sonogram, papillary cancer.	٣٥
٦	Sonogram, hypoechoic solid nodule with irregular borders.	٣٧
٧	Sonogram, colloid nodule.	٣٨
٨	Two types of calcifications in thyroid nodules	٣٩
٩	Color Doppler US Benign follicular adenoma.	٤١
١٠	Color Doppler US, Perinodular flow signals.	٤١
١١	Color Doppler US, Intranodular flow signals.	٤١
١٢	Estimating strain from tissue insonified	٤٢
١٣	Estimating strain from tissue displacement.	٤٥
١٤	Major categories of elastography approaches.	٤٦
١٥	Sono-elasticity setup.	٤٨
١٦	Experimental setup of elastography.	٤٩
١٧	Transient elastography imaging	٥٠
١٨	Ultrasound stimulated vibro-Acoustography.	٥٥
١٩	Operation of elastography probe in thyroid.	٥٧
٢٠	US elastography of a thyroid nodule..	٥٨
٢١	Shear Wave Elastography of Thyroid papillary carcinoma.	٦٠
٢٢	(ROI) to compute thyroid stiffness index within a nodule.	٦٣
٢٣	Us elatosography in acromegaly.	٦٤
٢٤	Conventional ultrasonographic and elastography in acromegaly.	٦٥
٢٥	Elastography patterns of thyroid nodules of Fukunari ٢٠٠٧	٦٦
٢٦	Pattern ١ Adenomatous goiter.	٦٧
٢٧	Pattern ٢ follicular cancer.	٦٨
٢٨	Pattern ٣ thyroid papillary cancer.	٦٩
٢٩	Pattern ٤ Intracystic papillary cancer.	٧٠
٣٠	Elastography patterns according to Raggiunti et al. ٢٠١١.	٧١
٣١	Pattern ١ and ٢ of thyroid nodules.	٧٢
٣٢	Pattern ٣a and ٣b of thyroid nodules.	٧٣
٣٣	Pattern ٤ of thyroid nodules.	٧٣
٣٤	Soft benign nodule by Shear Wave Elastography.	٧٤
٣٥	Thyroid cyst showing blue-green and red pattern.	٧٦
٣٦	Acoustic Radiation Force Impulse Imaging.	٨٠
٣٧	Elastography patterns of lymph nodes.	٨١
٣٨	US elastography of a metastatic cervical lymph node.	٨٢

LIST OF TABLES

No.	Table	Page
١	Relative proportion of different primary thyroid cancer subtypes. (<i>Jossart et al, ١٩٩٤</i>).	٢٥
٢	Reported sensitivities and specificities of sonographic features for detection of thyroid cancer (<i>Kim et al, ٢٠٠٢</i>).	٣٤
٣	Elasticity score (<i>Rago et al, ٢٠٠٧</i>).	٦٢
٤	Elastography patterns in thyroid nodules (<i>Fukunari ٢٠٠٧</i>).	٦٧
٥	Elastography patterns in thyroid nodules (<i>Raggiunti et al, ٢٠١١</i>).	٧٤
٦	ARFI velocities in thyroid gland (<i>Friedrich-Rust et al, ٢٠١٠</i>).	٧٨
٧	Elastography Patterns of lymph nodes on Findings (<i>Alam et al, ٢٠٠٨</i>).	٨٢

INTRODUCTION

US elastography is a newly developed dynamic technique that evaluates the degree of distortion of a tissue under the application of an external force. Because softer parts of tissue deform more readily than the stiffer parts, this technique enables objective evaluation of tissue stiffness from the deformation rate (*Kagoya et al, 2007*).

Ultrasound elastography provides an interesting contribution to the differentiation of malignant and benign thyroid nodules. Particularly worthy of mention is that an entirely elastic nodule pattern was observed only in relation to benign nodules, a result which would suggest that immediate recourse to FNAB might be avoided (*Rago et al, 2009*).

Real-time Elastosonography may be a useful adjunct to conventional US in the evaluation and characterization of thyroid nodules allowing identification of patients at high risk of malignancy for whom tissue diagnosis and/or close follow-up is required (*Tranquart et al, 2008*).

Thyroid nodules are common in people living in iodine sufficient areas, their prevalence being dramatically increased in iodine-deficient areas (*Alam et al, 2007*).

The prevalence of thyroid nodules is about 2%-4% in the general population and is greater than 10% after age 40 years. The number of thyroid nodules being detected has increased because of improvements in medical imaging. Studies indicate a 5%-15% prevalence of malignancy for thyroid nodules (*Utiger 2007*).

In the assessment of thyroid nodules, clinical evaluation is also very important. In particular, as reported by recent consensus, a firm or hard consistency is associated with an increased risk of malignancy. However, this clinical parameter is highly subjective and dependent on the experience of the examiner (*Rago et al, 2009*).

In many cases, despite the difference in stiffness between the lesion and the surrounding normal tissue, the small size of a pathological lesion and/or its location deep in the body make its detection and evaluation by palpation difficult or impossible (*Ophir et al, 2000*).

Thyroid cancer is the most common type of endocrine malignancy and accounts for the most of deaths due to endocrine cancers (*Robbins et al, 2002*).

The great majority of nodules are benign, less than 5% of them being malignant. Cytological examination of material obtained by fine needle aspiration (FNA), due to its high sensitivity and specificity, is the best single test for differentiating malignant from benign thyroid lesions. Yet, a substantial proportion of nodules are not correctly diagnosed before surgical treatment, and histological examination is required (*Rago et al, 2009*). It is also an invasive procedure and is subject to sampling errors. Approximately 10 to 20 % of nodules yield an inadequate or non diagnostic cytology (*Chow et al, 2000*).

Ultrasonographic (US) examination is an accurate method for detecting thyroid nodules, but its use in differentiating between benign and malignant thyroid nodules is relatively low (*Takashima et al, 2000*).

Due to the accessibility of the thyroid gland, external deformation of the thyroid using the ultrasound transducer has been utilized by several groups. Deformations introduced from pulsations due to blood flow through the carotid artery has also been utilized as a deformation source (*Bae et al, 2007*).

The combination of highly specific elastography with highly sensitive conventional B-mode Sonography has the potential to further improve the diagnosis of metastatic enlarged cervical lymph nodes (*Alam et al, 2007*).

US elastography is non stressful for patients, easy to perform, and requires not more than a few minutes of additional examination time and is a very useful examination to avoid unnecessary procedures (*Cooper et al, 2007*).

AIM OF WORK

The aim of this work is to review the role of ultrasound elastography in assessment of thyroid gland nodules and differentiation between benign and malignant conditions.

ANATOMY OF THE THYROID GLAND

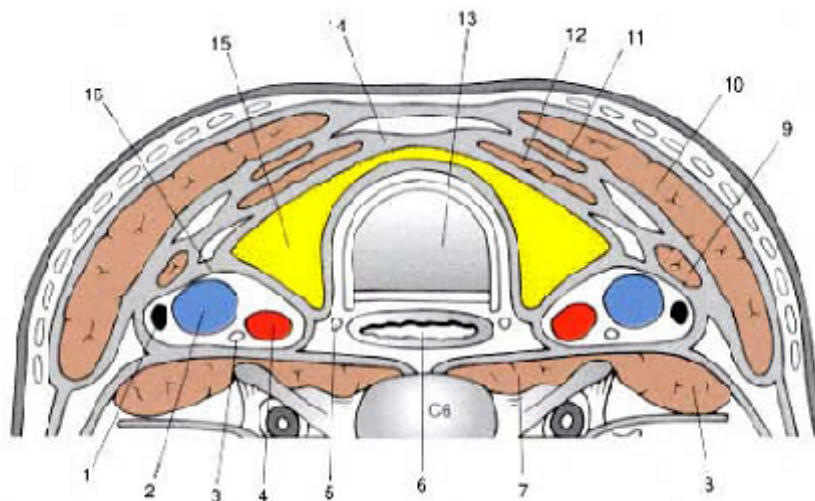
The normal thyroid gland is located in the anterior neck at the level of the thoracic inlet. The majority of the gland consists of two lateral lobes connected anteriorly by the isthmus. Approximately 10% of people have a pyramidal lobe, which is a remnant of the distal end of the thyroglossal duct(*Amdur & Mazzaferri 2002*).

The location of the thyroid gland relative to important structures in the neck explains the presenting symptoms of locally advanced thyroid cancer, potential surgical complications, and the complexity of planning external beam radiotherapy. The main structures of interest are the recurrent laryngeal nerve, the trachea, the esophagus, the sympathetic trunk, the vagus and phrenic nerves and the carotid arteries. The parathyroid glands lie close to the posterior surface of the thyroid and vary in number and exact location(*Bliss et al, 2000*).

The spinal cord is located in the midline, approximately 4 cm posterior to the thyroid gland. This distance, and the intervening muscles of the floor of the neck and bone of the vertebral column, makes it so that tumor rarely spreads directly from the thyroid area to the spinal canal. The proximity of the thyroid gland to the spinal cord is a major factor when planning external beam radiotherapy(*Amdur & Mazzaferri 2002*).

RELATIONS OF THE LOBES:

Superficially: Strap muscles (sternothyroid & sternohyoid) and Sternocleidomastoid, **posterolaterally:** Carotid sheath containing common carotid artery, internal jugular vein and vagus nerve, **medially:** Larynx, trachea and esophagus and **posteriorly:** Longuscolli muscle and recurrent laryngeal nerve as shown in (Fig. 1) ***(Ahuja & Evans 2000)***

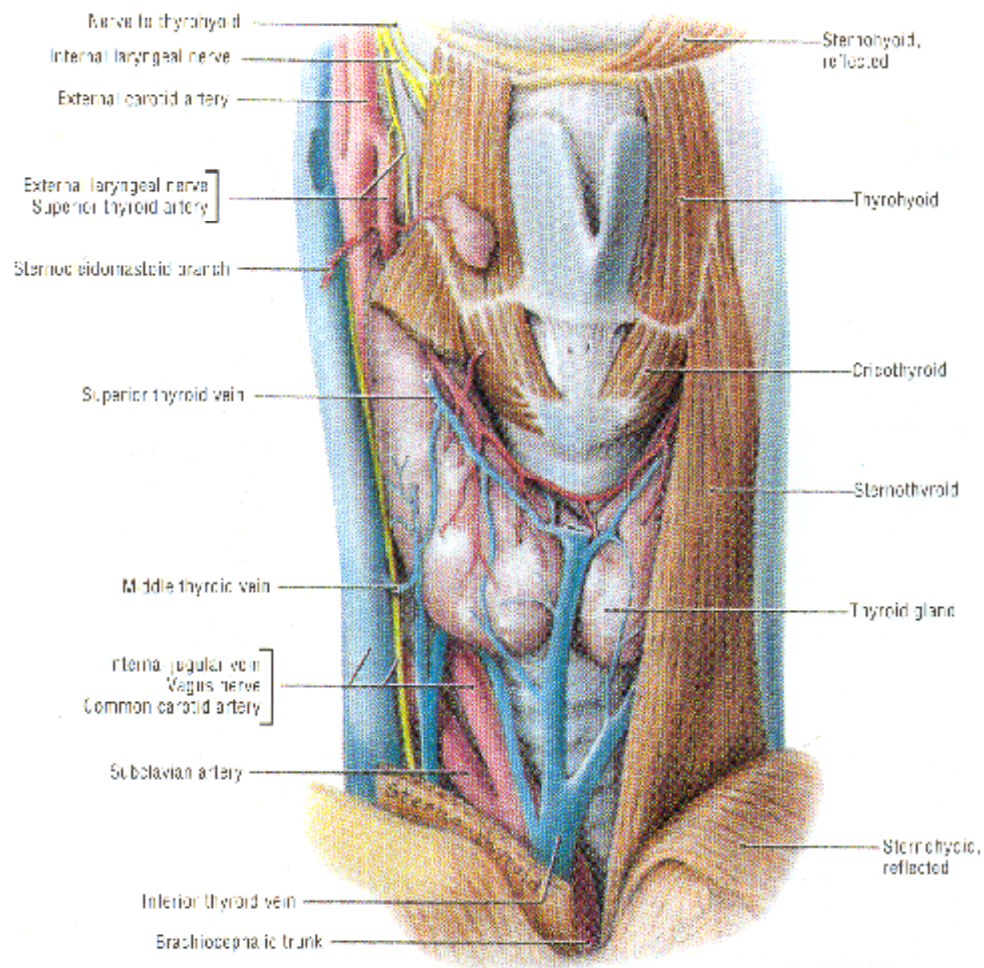


Fig(1) Transverse section at the level of C₆ showing anatomy of the thyroid. 1.cervical lymph node 2.internal jugular vein 3.vagus nerve 4.common carotid artery 5.recurrent laryngeal nerve 6.oesophagus 7.longus colli 8.Scalenus anterior muscle 9.Omohyoid muscle 10.Sternocleidomastoid 11.sternohyoid 12.sternothyroid 13.trachea 14.Paratracheal fascia 15.thyroid gland 16.Carotid sheath ***Quoted from(Ahuja & Evans 2000).***

ARTERIAL SUPPLY:

Superior thyroid artery: Arises as the first branch from the anterior aspect of the external carotid artery supplies the upper thyroid pole. It lies on the outer surface of the inferior constrictor muscle of the larynx, with the superior laryngeal nerve situated only a little higher up. So this nerve may be included in ligation of the superior thyroid artery unless care is exercised and **Inferior thyroid artery:** Arises from the subclavian artery by way of the thyrocervical trunk, most of its branches penetrate the posterior aspect of lateral thyroid lobe, closely associated with the recurrent laryngeal nerve as listed in (Fig. 7)(*McVay& Anson 1944*).

Anatomy of the thyroid gland



Fig(9)Thyroid arteries & veins *Quoted from (Young et al, 2011).*