بسم الله الرحمن الرحيم

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Role of Ultrasonography and Color Doppler Imaging in Identification of Thyroid Nodules Suspicious of Malignancy for Fine Needle Aspiration

Thesis

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قَالُوا

سبحانك لا علم لنا

إلا ما علمتنا إنك أنت

العليم الحكيم

صدق الله العظيم

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Ahmed Mohamed Hussein

List of Contents

List of Abbreviations

Abb.	Full term
ACR	American College of Radiology
Ant. Strap m	Anterior strap muscle
ATA	American Thyroid Association
CCA	Common carotid artery
CFD	Color flow Doppler
ETE	Extrathyroidal extension
FMTC	Familial medullary thyroid carcinomas
FNA	Fine Needle Aspiration
FTC	Follicular Thyroid carcinoma
HCC	Hürthle or oncocytic cell cancer
IJV	Internal jugular vein
IQR	Inter-quartile range
MEN	Multiple endocrine neoplasia
MTC	Medullary thyroid carcinoma
NPV	Negative predictive value
PD	Power Doppler
PDTC	Poorly differentiated thyroid carcinoma
PI	Pulsatility index
PPV	Positive predictive value
PRF	Pulse repetition frequency
PSV	Peak Systolic Velocity
PTC	Papillary thyroid carcinoma
RI	Resistive index
ROC	Receiver operating characteristic curve
SCM	Sternocleidomastoid muscle
SPSS	Statistical Package for Social Science
TIRADS	Thyroid Imaging, Reporting, and Data System
TSH	Thyroid-stimulating hormone
US	Ultrasonography
WHO	World Health Organization

List of Tables

Table No.	Title	Page No.

List of Figures

List of Figures Cont...

List of Figures Cont...

List of Figures Cont...

INTRODUCTION

Ultrasonography (US) is one of the most widely used imaging technologies in medicine. It is portable, free of radiation risk, and relatively inexpensive when compared with other imaging modalities, such as magnetic resonance and computed tomography the images can be acquired in "real time," thus providing instantaneous visual guidance for many interventional procedures including those for regional anesthesia and pain management *(Chan & Perlas, 2011).*

Thyroid nodules are exceedingly common, with a reported prevalence of up to 68% in adults on high-resolution US *(Tessler et al., 2017).*

Certain features of thyroid nodules on US are consistently predictive of malignancy and are used as criteria for Fine Needle Aspiration (FNA). These criteria have various sensitivity and specificity, but unfortunately none of them alone is sufficient to discard or detect malignancy efficiently *(Russ et al., 2017).*

FNA of the thyroid is the single most useful diagnostic test for evaluating the patients with thyroid nodules who should undergo surgery *(Renshaw et al., 2020).*

Medical professional societies such as the American Thyroid Association (ATA) and American Association of Clinical Endocrinologists have suggested that the initial

cytological diagnosis can be postponed until growth of a nodule or a change in its US features is observed. Repeated FNA of nodules with an initial benign cytological diagnosis leads to a final diagnosis of cancer in approximately 2% of cases *(Maino et al., 2021)*.

The pattern of vascularity and intra-nodular peak systolic velocity can be used as color and spectral Doppler parameters to differentiate benign from malignant thyroid nodules. Intranodular flow is strongest predictor for diagnosing malignancy among color Doppler parameters *(Bhatt et al., 2017)*.

Since about 90% of thyroid nodules are benign, it is crucial to correctly stratify the malignancy risk of the nodules to avoid a huge number of unnecessary invasive procedures and/or surgery, as an improper use of FNA has the risk of increasing healthcare expenditures and even of inappropriately referring patients to surgery in case of indeterminate cytology *(Pantano et al., 2018)*.

AIM OF THE WORK

The aim of the study is to investigate the performance of US imaging and color flow mapping in identification of thyroid nodules indicated for FNA to predict thyroid cancer to avoid unnecessary interventions.

Chapter 1

ANATOMY OF THE THYROID GLAND

Thyroid gland is the largest endocrine gland. It is situated opposite C5- C7 and T1 vertebra embracing anterolateral part of trachea. The gland is related medially to trachea and esophagus and carotid sheath laterally. The gland is covered anterolaterally by sternocleidomastoid and three ribbon muscles, sternohyoid, sternothyroid and superior belly of omohyoid muscles *(Singh, 2020).*
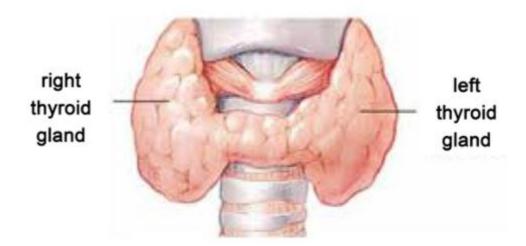

Figure (1): The thyroid gland *(Quoted from Arrangoiz et al., 2018).*

The shape of the thyroid gland varies from an H to a U shape and is formed by two lateral lobes with superior and inferior poles connected by a median isthmus **(Figure 1)**, with an average height of 12 to 15 mm, overlying the second to fourth tracheal rings. Each of the lateral thyroid lobes measures an average of 50 to 60 mm (8 to 10 ml in volume), with the