Diffusion Weighted Magnetic Resonance Imaging in Differentiation of Benign and Malignant Thyroid Nodules

Thesis

Submitted for Partial Fulfillment of Master Degree in Radiodiagnosis

By

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2020

Acknowledgement

*I am grateful and thankful to **GOD** who makes all things possible. All praise is due to the Almighty. May Allah make our lives easier and grant.*

I am greatly honoured to express my deep gratitude and faithfulness to Professor Doctor/ Maha Abdel Meguid El-Shinnawy, Professor of Radio-diagnosis– Faculty of Medicine, Ain Shams University, for her wisdom, invaluable advice, support, encouragement and the sharing of her expertise.

I wish to express my gratitude and appreciation to Doctor/ Mona Ali Mohamed Ali Nagi, Lecturer of Radio-diagnosis, Faculty of Medicine, Ain Shams University, for her great help, faithful advice, kind support from the start and all through the work until its completion, and immense facilities she offered.

Special thanks to Radio-diagnosis Department of General Military Hospital for their support and encouragement.

Last, but certainly not least, I owe to the patients included in this study. May God alleviate their sufferings and may all our efforts be just for their own benefit.

Sherif Ali Ebrahim

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LIST OF ABBREVIATIONS

AACE	**:**	American Association of clinical Endocrinologists
ACR	:	American College of Radiology
ADC	:	Apparent Diffusion coefficient
Anti-Tg	:	Anti-thyroglobulin antibody
Anti-TPO	:	Antibody Anti-thyroglobulin antibody
AP	:	Antero-posterior
ATA	:	American Thyroid Association
AUS	:	Atypia of Undetermined Significance
BI-RADS	**:**	Breast Imaging, Reporting and Data System
BOLD	:	Blood Oxygenation Level Dependent
CA	:	Carcinoma
CT	:	Computed tomography
DKI	**:**	Diffusion Kurtosis Imaging
DWI	:	Diffusion Weighted Imaging
EPI	:	Echo Planar Imaging
FDG	:	Fluoro-deoxy-glucose
FLASH	:	Fast Low Angle Shot
FLUS	:	Follicular Lesion of Undetermined Significance
FNAB	:	Fine Needle Aspiration Biopsy
FNAC	:	Fine Needle Aspiration Cytology
FS	:	Frozen Section
FSE	:	Fast Spin Echo

HASTE	:	Half-fournier Acquisition Single-shot Turbo spin Echo
I	:	Iodine
ITN	:	Incidental Thyroid Nodule
KSThR	:	Korean Society of Thyroid Radiology
MRI	:	Magnetic resonance Imaging
NIFTP	:	Non Invasive Follicular Thyroid Neoplasm with Papillary-like nuclear features
NSCLC	:	Non-Small Cell Lung Carcinoma
PET	:	Positron Emission Tomography
RF	:	Radiofrequency
ROI	:	Region of Interest
SNR	:	Signal noise ratio
SSEPI	:	Single Shot EPI
SSFP	:	Steady State Free Precession
T	:	Tesla
TBSRTC	:	The Bethesda System for Reporting Thyroid Cytopathology
TE	:	Echo time
TI-RADS	:	Thyroid Imaging, Reporting and Data System
TRON	:	Tracking Only Navigation echo
TSH	:	Thyroid Stimulating Hormone
US	:	Ultrasonography

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Abstract

Background: Thyroid nodules are common; their clinical significance is mainly related to excluding malignancy. Regardless of the careful reporting of FNAC and frozen section biopsies, there is significant number of discordance with final histopathology reports, which leads to unnecessary thyroidectomies. DWI-MRI can help in the differentiation of benign and malignant thyroid nodules providing qualitative and quantitative information about the diffusion properties.

Objective: Is to determine the diagnostic accuracy of Diffusion-Weighted Imaging (DWI) and Apparent Diffusion Coefficient (ADC) mapping in differentiating benign from malignant thyroid nodules by taking histopathology as the gold standard.

Patient and methods: This study was performed on 32 cases who were diagnosed by ultrasonography to have thyroid nodules; in the General Naval Military Hospital. The patients were referred from the surgery department to the radiology department over a period of 18 months (January 2018– June 2018).

Results: In this study the sensitivity of DWI and ADC mapping in differentiating benign from malignant thyroid nodules reached 100%.

Conclusion: Quantitative DWI has a high sensitivity, and may be a reliable, non-invasive and non-radiative imaging modality for the detection of thyroid nodules. ADC values seem to be able to differentiate benign from malignant thyroid disease.

Key words: DWI-ADC mapping-Thyroid nodules

Introduction

Thyroid nodules, the most common pathology involving the thyroid gland, consist of discrete lesions within the thyroid gland that are often palpable and typically sonographically distinct from the surrounding thyroid parenchyma. Approximately 5 % of detected nodules are diagnosed as malignancies, a number that has more than doubled over the past 30 years **(*Noda et al., 2015*).** These nodules must be distinguished from benign thyroid nodules to correctly and efficaciously treat patients suffering from this pathology**.**

Because clinical findings do not provide a definitive diagnosis, several useful, non-invasive imaging tests such as ultrasonography (US) and radionuclide scintigraphy can be used to determine which nodules should be histopathologically evaluated to rule out the possibility of thyroid malignancy. US has been used as a first step in the assessment of these nodules, but no single US criterion has been demonstrated to accurately differentiate benign nodules from malignant nodules. Furthermore, the hazards associated with radiation exposure during radionuclide scintigraphy are unavoidable, and some functioning nodules (hot nodules) found on scintigraphy are malignant ***(Chen et al., 2016).***

Fine needle aspiration biopsy (FNAB) is regarded as the standard reference for diagnosis, but it has been reported before that FNAB results may mimic some other diseases ***(Wu et al., 2013).***

Routine T1- and T2- weighted MR imaging cannot differentiate benign from malignant nodules or assess the functional status of thyroid nodules, thus, its role in thyroid nodules evaluation is limited ***(Abdel-Rahman et al., 2016).***

Diffusion weighted MRI imaging (DWI) is an emerging technique for brain tumors. DWI is sensitive to changes in the microstructural organization of tissue that may affect water diffusion. It has been used to evaluate head and neck tumors. The Apparent diffusion coefficient (ADC) value is a quantitative parameter for distinguishing malignant from benign thyroid nodules ***(Abd El Aziz et al., 2015).***

Many studies have shown that DWI has the potential to differentiate benign from malignant thyroid nodules. However, the sample sizes of these studies were relatively small, and the findings have been inconclusive ***(Chen et al., 2016).***

Aim of the Work

The purpose of our study is to determine the diagnostic accuracy of Diffusion-Weighted Imaging (DWI) and Apparent Diffusion Coefficient (ADC) mapping in differentiating benign from malignant thyroid nodules by taking histopathology as the gold standard.

Chapter (1)

Historical Background

Thyroid is an important endocrine organ in human body. Its enlargement or goiter has been observed by ancient Greeks. The current understanding of its anatomy, function, and diseases are due to researchers of 17th to 20th centuries. The understanding of its anatomical relations and functional status is of paramount importance and a must for all medical personnel ***(Khatawkar and Awati, 2015).***

Thyroidolody, the study of the thyroid gland, is considered to be a relatively new field of endocrinology. However, references to the thyroid gland and its diseases can be seen in the literature of ancient Greek, Indian and Egyptian medicine. Goiter has always been a disease of immense interest of the general population due to its widespread prevalence. It is one of the most common medical problems portrayed in ancient paintings. Owing to the lack of awareness and poor nutritious habits of the people in that era, diseases such as iodine deficiency goiter were common. Physicians, healers and philosophers had been attempting time and again until the 19^{th} century to come up with explanations of the thyroid gland and provide a reasonable basis of its diseases. In spite of the discovery of thyroid gland, its structure, function and diseases has been accredited to modern scientists who presented their work mostly in the 19^{th} and 20^{th} century ***(Niazi et al., 2011).***

Chapter (2)

Embryology of Thyroid Gland

The primordial thyroid gland is one the earliest endocrine organs. It is detectable during the starting day 24 in the embryo. Throughout the 4th to 7th weeks of gestation, it slowly migrates to the final location. It is developed from pharyngeal endoderm cells and derived from the foramen caecum in the tongue base and also connected to the tongue base via thyroglossal duct until week 10. It consists of two lobes, and both lobes (lobus dexter and lobus sinister) are connected together with isthmus. There is a small lobe known as "the pyramidal lobe" mostly derived from the left lobe of the thyroid and attached to the hyoid bone. Calcitonin-secreting para-follicular thyroid ("C") cells are derived from a combination of cells migrating from the neural crest and a fifth pharyngeal pouch structure ***(Binboga et al., 2019).***