



□ □ □

تم رفع هذه الرسالة بواسطة / حسام الدين محمد مغربي

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى

مسئولية عن محتوى هذه الرسالة.

### ملاحظات:

ملاحظات:



# **Efficacy and safety of ultrasound (US)-guided radiofrequency ablation of benign thyroid nodules**

*A Thesis*

*Submitted for Partial Fulfillment of M.D Degree in  
Radiology*

*Presented by*

**Mai Shaaban Abdelgalil Mabrouk**

*M.B.B.Ch., M.Sc. Radiology*

*Under Supervision of*

**Prof. Osama Mohamed Abdelhamid Hetta**

*Professor of Radiology*

*Faculty of Medicine – Ain Shams University*

**Prof. Raef Malak Botros**

*Professor of Internal Medicine and Endocrinology*

*Faculty of Medicine – Ain Shams University*

**Dr. Yasser Ibrahim Abdelkhaleq**

*Assistant Professor of Radiology*

*Faculty of Medicine – Ain Shams University*

**Dr. Ali Hagag Ali**

*Lecturer of Radiology*

*Faculty of Medicine – Ain Shams University*

*Faculty of Medicine*

*Ain Shams University*

*2021*

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# قَالَ

سَبَّحَانَكَ لَا إِلَهَ إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ  
الْعَلِيمُ الْعَظِيمُ

صدق الله العظيم

سورة البقرة الآية: ٣٢

# Acknowledgment

*First, I thank **God** for blessing me more than i deserve and for helping me reach this stage in my life.*

*I would like to thank my family especially my dear father and mother for being there for me along the road, and for whom I owe everything I am, and will ever be.*

*I would like to express my deepest appreciation and gratitude to **Prof. Dr. Osama Hetta** for supporting me and trusting my abilities.*

*I would also like to thank **Prof. Dr. Raef Malak, Dr. Yasser Abdelkhaleq and Dr. Ali Hagag** for their patience and meticulous remarks which have helped me keep this thesis structured, organized and concise.*

*Last but not least I thank my friends and colleagues in the Radiology department of Ain Shams University for helping me in many ways throughout my work.*

# *List of Contents*

Title	Page No.
List of Abbreviations.....	i
List of Tables .....	ii
List of Figures .....	iii
Introduction .....	1
Aim of the Work.....	3
Review of Literature	
Anatomy of the Thyroid Gland.....	4
Pathophysiology .....	14
Diagnosis and Management of Benign Thyroid Nodules .....	19
Technique of Radiofrequency Ablation of Benign Thyroid Nodules.....	33
Patients and Methods.....	49
Results .....	57
Illustrative Cases .....	71
Discussion .....	102
Summary and Conclusion.....	105
References .....	107
Arabic Summary .....	—

## *List of Abbreviations*

Abb.	Full term
AFTN .....	Autonomously functioning thyroid nodule
BMR.....	Basal metabolic rate
FNA .....	Fine needle aspiration
IQR .....	Interquartile range
MNG .....	Multi-nodular goiter
PTC.....	Papillary thyroid carcinoma
RFA.....	Radiofrequency ablation
SIR.....	Society of Interventional Radiology
T3.....	Triiodothyronine
T4.....	Thyroxine
TRH .....	Thyrotropin releasing hormone
TSH.....	Thyroid stimulating hormone
US .....	Ultrasound
VRR .....	Volume reduction ratio

# *List of Tables*

Table No.	Title	Page No.
<b>Table (1):</b>	Anatomical relations of the thyroid gland.....	8
<b>Table (2):</b>	The 2017 Bethesda system .....	28
<b>Table (3):</b>	Complications observed following surgery versus RFA .....	48
<b>Table (4):</b>	Inclusion and Exclusion criteria.....	52
<b>Table (5):</b>	Main Characteristics and baseline clinical data of the 40 patients .....	58
<b>Table (6):</b>	Main characteristics of the 45 thyroid nodules of the 40 patients .....	59
<b>Table (7):</b>	Summary of the follow up of the thyroid nodule volume, patients symptoms and the thyroid hormone level during follow up.....	63
<b>Table (8):</b>	The correlation between the texture of the thyroid nodule by US and the power of RF ablation.....	64
<b>Table (9):</b>	The relation between the composition of the thyroid nodules and the volume percentage of the remnant thyroid nodule during follow up .....	66
<b>Table (10):</b>	Demonstration of complications happened in the 40 patients, no sustained or life threatening complications .....	69

# *List of Figures*

Fig. No.	Title	Page No.
<b>Fig. (1-1):</b>	Anatomy of the thyroid gland.....	4
<b>Fig. (1-2):</b>	Fibrous capsule and fascia covering the thyroid gland .....	5
<b>Fig. (1-3):</b>	Related structures to the thyroid gland.....	6
<b>Fig. (1-4):</b>	US picture of the thyroid gland .....	7
<b>Fig. (1-5):</b>	The anatomical relations of the thyroid gland.....	9
<b>Fig. (1-6):</b>	The arterial supply and venous drainage of the thyroid gland .....	10
<b>Fig. (1-7):</b>	Thyroid pyramidal lobe.....	12
<b>Fig. (1-8):</b>	The two basic cell types of the follicles of the thyroid gland (Follicular and parafollicular cells) .....	13
<b>Fig. (2-1):</b>	Regulation of the thyroid hormone production and release.....	15
<b>Fig. (2-2):</b>	Thyroid hormone effects on different tissues .....	17
<b>Fig. (3-1):</b>	Pemberton's sign .....	20
<b>Fig. (3-2):</b>	Malignant features of thyroid nodules in US .....	23
<b>Fig. (3-3):</b>	Benign features of thyroid nodule in US .....	23
<b>Fig. (3-4):</b>	TIRADS Scoring .....	24
<b>Fig. (3-5):</b>	US elastography of a soft thyroid nodule .....	25
<b>Fig. (3-6):</b>	CT scan of the neck shows a retrosternal extension of nodular thyroid goiter .....	26
<b>Fig. (3-7):</b>	MRI scan of the neck. (A) T2 blade sequence. (B) T2 blade sequence with contrast enhancement.....	26



## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (3-8):</b>	Cold nodule vs hot nodule in thyroid scan imaging.....	29
<b>Fig. (4-1):</b>	Mygen (M-3004) RF generator.....	35
<b>Fig. (4-2):</b>	Different active tip's length of RF electrode used in RFA of thyroid nodules.....	36
<b>Fig. (4-3):</b>	Trans-isthmic approach during RFA of thyroid nodule.....	37
<b>Fig. (4-4):</b>	Moving shot technique.....	38
<b>Fig. (4-5):</b>	Ionic agitation and formation of friction heat.....	39
<b>Fig. (4-6):</b>	Heat propagation through target tumor.....	39
<b>Fig. (4-7):</b>	Ablation size.....	40
<b>Fig. (4-8):</b>	Trachea-esophageal groove.....	40
<b>Fig. (4-9):</b>	Voice change resulting from hemorrhage in a 46-year-old woman. US of the left thyroid nodule (A) before and (B) after insertion of the electrode show a hypo-echoic hemorrhage (arrowheads) between the trachea (T) and left thyroid nodule.....	42
<b>Fig. (4-10):</b>	Abscess formation and ablated nodule rupture in a 46-year-old man.....	43
<b>Fig. (4-11):</b>	US picture of 42-year-old woman shows a large sub-capsular hematoma that developed during electrode insertion.....	45
<b>Fig. (4-12):</b>	Neck of a 47-year-old woman shows first-degree skin burn at the electrode puncture site immediately after RF ablation.....	46
<b>Fig. (6-1):</b>	Reduction of the thyroid nodules volume during follow up at 1, 3 and 6 months.....	60
<b>Fig. (6-2):</b>	Volume reduction ratio changes during the follow up.....	60

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (6-3):</b>	Reduction of the compressive symptoms scoring during follow up .....	62
<b>Fig. (6-4):</b>	Reduction of the cosmetic problem scoring at 1, 3 and 6 months .....	62
<b>Fig. (6-5):</b>	The more cystic component of the nodule the more RF ablation power needed .....	65
<b>Fig. (6-6):</b>	No significant relation between the composition of the thyroid nodules and the volume of the remnant thyroid nodule .....	66
<b>Fig. (6-7):</b>	Graph demonstrates the percentage of the patients with no complications compared the percentage of the patients with major and minor complications.....	68
<b>Fig. (6-8):</b>	Summary of complications .....	69
<b>Fig. (6-9):</b>	Fate of complications.....	70
<b>Fig. (7-1):</b>	A 21-year-old female with right sided neck bulging .....	71
<b>Fig. (7-2):</b>	US picture shows a right thyroid lobe complex nodule with a nodule volume = 29ml.....	71
<b>Fig. (7-3):</b>	RF ablation of a 21-year-old female's right thyroid complex nodule.....	72
<b>Fig. (7-4):</b>	Neck of a 21-year-old female shows post ablation puncture site .....	72
<b>Fig. (7-5):</b>	Reduction of the size of a 21-year-old female's nodule after 1-month duration post RF ablation .....	73
<b>Fig. (7-6):</b>	Disappearance of the neck bulging of a 21-year-old female after 1 month duration post RF ablation .....	73

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (7-7):</b>	Reduction of the nodule size of a 21-year-old female (A) Preprocedural nodule's volume 29ml. (B) Nodule's volume on 1-month follow-up "3.2ml". (C) Nodule's volume on 3-month follow-up "1.7ml".....	74
<b>Fig. (7-8):</b>	Neck of a 21-year-old female (A) Preprocedural. (B) On 1-month follow up. (C) On 3-month follow up .....	75
<b>Fig. (7-9):</b>	Reduction of the nodule size of a 21-year-old female (A) Preprocedural nodule's volume 29ml. (B) Nodule's volume on 1-month follow-up "3.2ml". (C) Nodule's volume on 3-month follow-up "1.7ml" (D) Nodule's volume on 6-month follow up "0.5ml" .....	76
<b>Fig. (7-10):</b>	Neck of a 21-year-old female (A) Preprocedural. (B) On 1-month follow up. (C) On 3-month follow up. (D) On 6-month follow up .....	77
<b>Fig. (7-11):</b>	A 55-year-old female with a midline neck bulging.....	78
<b>Fig. (7-12):</b>	US picture of the two 55-year-old female's nodules (A) An isthmic nodule with a nodule's size 1ml. (B) A left thyroid lobe nodule with a nodule's size 2.3ml.....	79
<b>Fig. (7-13):</b>	Neck of a 55-year-old female (A) Preprocedural. (B) After 6 months.....	79
<b>Fig. (7-14):</b>	A 43-year-old female with huge neck bulging.....	80
<b>Fig. (7-15):</b>	US picture shows a left thyroid lobe cystic nodule with a nodule volume = 99ml.....	80

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (7-16):</b>	Aspiration of a 43-year-old female's cystic nodule. (A) US picture shows the needle inside the nodule during aspiration. (B) The aspirated fluid.....	81
<b>Fig. (7-17):</b>	RF ablation of a 43-year-old female's left thyroid lobe collapsed nodule after aspiration of its cystic component .....	81
<b>Fig. (7-18):</b>	Reduction of a 43-year-old female's nodule size after 1-month duration post RF ablation.....	82
<b>Fig. (7-19):</b>	Disappearance of the neck bulging of a 43-year-old female after 1 month duration post RF ablation .....	82
<b>Fig. (7-20):</b>	US picture of a re-accumulated cystic component of a 43-year-old female's thyroid nodule on 3-month follow up.....	83
<b>Fig. (7-21):</b>	The aspirated fluid of a re-accumulated cystic component of a 43-year-old female's thyroid nodule on 3-month follow up.....	83
<b>Fig. (7-22):</b>	A 50-year-old female with a midline neck bulging .....	84
<b>Fig. (7-23):</b>	US picture of the two 50-year-old female's nodules (A) A right lobe nodule with a nodule's size 13.7ml. (B) A right lobe-isthmus nodule with a nodule's size 8.9ml.....	85
<b>Fig. (7-24):</b>	US picture of the two 50-year-old female's nodules after 6 months (A) A right lobe nodule with a nodule's size 2.5ml. (B) A right lobe-isthmus nodule with a nodule's size 1.2ml .....	85
<b>Fig. (7-25):</b>	Neck of a 50-year-old female (A) Preprocedural. (B) After 6 months .....	86

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (7-26):</b>	A 37-year-old male with a left sided neck bulging .....	87
<b>Fig. (7-27):</b>	US picture shows a left thyroid lobe mainly solid nodule with a nodule volume = 10ml .....	87
<b>Fig. (7-28):</b>	US picture shows left vocal cord compression by a left thyroid lobe solid nodule .....	88
<b>Fig. (7-29):</b>	RF ablation of a 37-year-old male's left thyroid solid nodule .....	88
<b>Fig. (7-30):</b>	Neck of a 37-year-old male (A) Preprocedural. (B) After 6 months .....	89
<b>Fig. (7-31):</b>	A 48-year-old female with a right sided and midline neck bulging .....	90
<b>Fig. (7-32):</b>	US picture shows a right sided and isthmic nodule with a nodule volume = 9.7ml .....	90
<b>Fig. (7-33):</b>	RF ablation of a 48-year-old female's right thyroid lobe and isthmic solid nodule .....	91
<b>Fig. (7-34):</b>	Neck of a 48-year-old female with a blister of first degree burn at the electrode puncture site happened during RF ablation .....	92
<b>Fig. (7-35):</b>	Neck of a 48-year-old female during the follow up of the first-degree burn treated with topical treatment .....	92
<b>Fig. (7-36):</b>	Neck of a 48-year-old female after about 1-month post RF ablation with complete resolution of the first-degree burn .....	93
<b>Fig. (7-37):</b>	Reduction of the size of a 48-year-old female's nodule after 6-month duration post RF ablation .....	93
<b>Fig. (7-38):</b>	A 48-year-old male with a huge right sided neck bulging .....	94

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (7-39):</b>	US picture shows a right thyroid lobe solid nodule with a nodule volume = 126ml.....	94
<b>Fig. (7-40):</b>	Reduction of the size of a 42-year-old male's nodule after 1-month duration post RF ablation .....	95
<b>Fig. (7-41):</b>	Partial resolution of the neck bulging of a 42-year-old male after 1 month duration post RF ablation .....	96
<b>Fig. (7-42):</b>	Neck of a 42-year-old male (A) Preprocedural. (B) On 1-month follow up. (C) On 1-month follow up after the second session.....	96
<b>Fig. (7-43):</b>	A 49-year-old male with left sided recurrent neck bulging.....	97
<b>Fig. (7-44):</b>	US picture shows a left thyroid lobe solid nodule with a nodule volume = 62.5ml .....	97
<b>Fig. (7-45):</b>	Reduction of the size of a 49-year-old male's nodule after 6-month duration post RF ablation .....	98
<b>Fig. (7-46):</b>	Disappearance of the neck bulging of a 49-year-old male after 6 months duration post RF ablation .....	98
<b>Fig. (7-47):</b>	Marked regression of the right sided neck bulging of a 80-year-old male after 6 months duration post RF ablation. (A) Neck of the patient pre-procedural. (B) Neck of the patient on 6-month follow-up .....	99
<b>Fig. (7-48):</b>	Marked regression of the right sided and midline neck bulging of a 70-year-old female after 6 months duration post RF ablation.....	100

## *List of Figures Cont...*

Fig. No.	Title	Page No.
<b>Fig. (7-49):</b>	Marked regression of the right sided neck bulging of a 36-year-old female after 6 months duration post RF ablation. (A)	
	Neck of the patient pre-procedural. (B)	
	Neck of the patient on 6-month follow-up .....	101