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The Role of Ultrasound Guided Radio-Frequency Ablation in Reduction of Benign Thyroid Nodular Volume

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Abstract

Background: The reported prevalence of thyroid nodules in adults using high-resolution ultrasound is as high as 68 per cent. Radiofrequency ablation (RFA) has been utilised to treat benign thyroid nodules as a secure alternative to surgery. RFA is a minimally invasive technique.

Aim and objectives: To assess the role of ultrasound-guided radio-frequency ablation in reducing benign thyroid nodular volume.

Patients and methods: This single-arm interventional research was performed on 30 individuals referred mainly to the Sayed Galal University Hospital interventional radiology unit from May 2022 to February 2023.

Results: A statistically significant variance was noted regarding the volume (ml) of benign thyroid nodules between pre and after 1m and pre and after 3m. The non-significant variance was observed among echo structure and volume pre-, after a month and after three months. Our study showed that the solid (33.4%), cystic (23.3%) and complex (43.3%) textures and the most common complications were Haematoma or swelling in 3.3%, followed by Transient voice changes (fully recovered) in 3.3%, then Skin burn (first degree) in 3.3%.

Conclusion: In patients with elevated risks or those who are more apprehensive about undergoing surgery, ultrasound-guided radio-frequency ablation is a viable alternative that offers greater patient satisfaction and fewer complications, according to the current research findings. Who refuse surgery. Moreover, it is a safe modality with satisfactory short-term efficacy for benign thyroid nodules.

Keywords: Radiofrequency ablation (RFA); Benign thyroid nodules; Ultrasound

1. Introduction

Although thyroid nodules are generally benign, if their proliferation gives rise to signs associated with the nodules, such as dysphagia, cosmetic issues, or malignant transformation, the only treatment option thus far has been surgical intervention. Not only is the curative operation invasive, but it also causes patients discomfort and aesthetic flaws. Furthermore, the detrimental impact on thyroid function resulting from surgical procedures should not be disregarded, and it is often necessary to administer thyroid hormone therapy on an ongoing basis. Non-surgical approaches are necessary when various surgical limitations and contraindications exist, including patient refusal and compromised

medical conditions. Radiofrequency ablation (RFA), a minimally invasive modality, has been employed as a safe substitute for surgery to manage benign thyroid nodules. ¹

It has been reported that RFA is an effective treatment for thyroid nodules, including those predominantly solid or predominantly cystic. RFA has been utilized to eliminate a variety of tumours. Applying RFA led to a considerably more pronounced reduction in the size of cystic nodules compared to other nodule types one and three months following ablation. However, the disparity did not reach statistical significance at six months. ²

The reported prevalence of thyroid nodules in adults using high-resolution ultrasound is as high as 68 per cent. ³

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The American Thyroid Association (ATA) established the terminology for thyroid nodules as “discrete lesions within the thyroid gland, radiologically distinct from the surrounding thyroid parenchyma”.⁴

There are numerous clinically significant reasons why thyroid nodules exist. They have the potential to induce thyroid dysfunction, compressive symptoms, and cosmetic problems in patients.⁵

The work aimed to assess the role of ultrasound-guided radio-frequency ablation in reducing benign thyroid nodular volume.

2. Patients and methods

This was a single-arm interventional research study that was performed on 30 patients referred mainly to the interventional radiology unit at the Sayed Galal University Hospital from May 2022 to February 2023.

Inclusion criteria: Benign nodule proved by FNA, autonomously functioning thyroid nodule, the existence of subjective signs (e.g., discomfort otherwise a pain in the neck, a compressive sign), cosmetic issues, unsuitability for surgery, or refusal to undertake the procedure, Nodule size > 2 cm and increase in size and single nodule or asymptomatic nodules associated.

Exclusion criteria: Absence of symptoms, Allergy to local anaesthetics, On fine needle aspiration cytology (FNAC), a nodule that meets the sonographic criteria for malignancy (tall to wide, marked hypoechoic, microcalcifications, ill-defined margins) indicates a follicular neoplasm otherwise malignancy. Taking a treatment with anti-coagulant or double anti-platelet, contralateral laryngeal paralysis in a nodule, nodule in contact with the recurrent laryngeal nerve, patient refusal or pregnancy and breastfeeding women.

Ethical Considerations: Oral consent that was well-informed and detailed regarding the procedure was obtained from each individual. The research complied with the regulations set forth by the scientific and ethical committee at ASU.

Before the scanning procedure, comprehensive history-taking was performed on all patients.

Individuals are followed up with at one and three months.

Benign nodules were then classified according to the Echo structure, Macrocalcifications and Vascularization.

Procedure

With the neck extended, the individual was positioned in the supine position. A local anaesthetic was applied.

Five per cent dextrose was added to a local anaesthetic mixed with HCO₃ prior to hydrogenation, and an ultrasound guided the insertion of a specialized RFA electrode. RFA of the nodule commenced and was continuously monitored via ultrasound. To avert superfluous scar development, no incision was made in the epidermis. Under US guidance, an electrode was introduced into the thyroid nodule along its short axis.

Until a transient hyperechoic zone appeared at the electrode tip within ten seconds, the power was progressively increased by five to 10 W, with a maximum increase of seventy W. The electrode point was retracted when a transient hyperechoic zone appeared at the periphery of the nodule, which typically occurred within five to ten seconds. Following this, each nodule was individually treated utilizing the moving shot technique. Twenty minutes should not pass during the ablation to prevent patient discomfort. The ablative process was concluded when every unit of the nodule transitioned to transient hyperechoic zones. Prescribed following ablation were oral analgesics (acetaminophen).

Trans-isthmic approach and moving shot technique: Full visualization of the entire length of the electrode was allowed, and then an alteration in the position of the electrode tip during swallowing was prevented. Care for the dangerous triangle because recurrent laryngeal nerves are present in it.

Moving Shot technique: The ablation was monitored in real-time as the ablated region became hyperechoic (white bubbles) within seconds. This technique involved many mini-ablations in order. The electrode tip was retracted when a transient hyperechoic zone emerged at the periphery of the nodule (typically within 5–10s) to prevent heat transfer to the perithyroidal tissue.

Statistical analysis: Recorded data were analyzed utilizing the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage. The following tests were done: Paired sample t-test, A one-way analysis of variance (ANOVA), and a Post Hoc test; the confidence interval was set to ninety-five per cent, and the margin of error accepted was set to five per cent. So, the p-value was regarded as significant as the following: Probability (P-value); P-value <0.05 was considered significant, P-value <0.001 was regarded as highly significant and P-value >0.05 was regarded insignificant.

3. Results

Table 1. The age of the studied patients (n = 30)

AGE	RANGE	MEAN ± SD
	18 - 64	45.947 ± 8.13

This research was performed on thirty individuals with the mean age was 45.947 years, ranged between 18 to 64 years as in [Table 1](#).

Table 2. Sex distribution among 30 patients in our study (n= 30)

SEX	N	%
MALE	4	13.3%
FEMALE	26	86.7%
TOTAL	30	100%

[Table 2](#) demonstrated that, there were female predominance with 86.7% of the studied patients were female and 13.3% were males.

Table 3. Complications among 30 patients included in our study

TYPE	N	%
HAEMATOMA OR SWELLING	1	3.3%
TRANSIENT VOICE CHANGES (FULLY RECOVERED)	1	3.3%
SKIN BURN (FIRST DEGREE)	1	3.3%
THYROIDITIS	0	0%
ABSCESS FORMATION	0	0%

[Table 3](#) showed that the most common complications was Haematoma or swelling in 3.3%, followed by Transient voice changes (fully recovered) in 3.3%, then Skin burn (first degree) in 3.3%.

Table 6. Comparison between Echo-structure according to volume (ml)

VOLUME (ML)	ISOECHOIC		HYPERECHOIC		HYPOECHOIC		ANOVA	
	Mean	±SD	Mean	±SD	Mean	±SD	F	p-value
PRE	20.32	5.46	21.85	5.13	18.34	3.24	0.357	0.575
AFTER 1 MONTH	13.46	3.14	10.72	3.42	10.68	2.15	0.631	0.564
AFTER 3 MONTHS	8.63	3.31	7.14	3.62	7.11	1.45	0.667	0.478

p-value>0.05 NS; *p-value <0.05 S;

This table demonstrated that was observed non-significant difference in among Echo-structure and volume pre, after a month and after 3 months.

Illustrative Case

In the following cases, each nodule underwent FNA and proved to be benign by pathology, received treatment by RFA starting with hydrodissection by local anesthesia mixed with NaHCO₃ then dextrose 5% injected for isolation & to decrease thermal conduction to the surrounding important structures and decrease thermal conduction to the surroundings, then RF ablation of the thyroid nodule by moving shot technique under US guidance was done.

Case: A 53-year-old female patient with multinodular goiter with large right lobe benign thyroid nodule complaining of compressive symptoms & readily observable cosmetic problem with volume 28 ml.

Table 4. The extent of the variance over the periods through volume (ml) in the research group

VOLUME (ML)	RANGE	MEAN ± SD	PAIRED SAMPLE T-TEST		
			Mean Diff.	t-test	p-value
PRE	9.5-35	19.15±4.21			
AFTER 1 MONTH	5.1-15.32	10.72±3.23	8.43±0.98	7.74	<0.001**
AFTER 3 MONTHS	3.5-11.46	7.52±2.36	11.63±1.85	8.31	<0.001**

Comparison between After 1m and after 3m (mean diff. 3.2; t=9.74; p-value <0.001**)

p-value>0.05 NS; *p-value <0.05 S; **p-value <0.001 HS

This table demonstrated statistically significant difference regarding the volume (ml) of benign thyroid nodules among pre and after 1m and also pre and after 3m.

Table 5. Distribution of the texture of the thyroid nodule by US (n=30)

TEXTURE	TOTAL (N=30)
SOLID	10 (33.4%)
CYSTIC	7 (23.3%)
COMPLEX	13 (43.3%)

This table showed that the solid (33.4%), cystic (23.3%) and complex (43.3%) of texture.

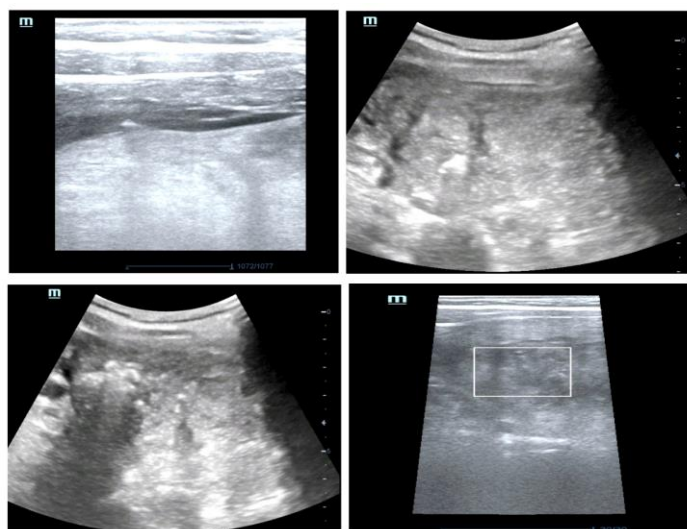


Figure 1. Ultrasound Guided Radio-Frequency Outcome: Patient symptoms visual analog scale score pre-treatment was (8), to become (5) 1 month after the procedure and (4) 3 months after the procedure. Cosmetic score pre-treatment was (4) to become (3) one month after the procedure and remains (2) 3 months after the procedure. Starting

volume was 28ml, to become 17.4 ml one month after the procedure and 12.6ml 3 months after the procedure.

4. Discussion

Although benign thyroid nodules are relatively common in the general population, the incidence of malignant cases has increased significantly over the past few decades. Thyroid nodules are exceedingly prevalent among the general populace, affecting 20–67% of the population and around fifty per cent of those aged forty and older. The majority of these nodules are hyperplastic and lack clinical significance as neoplasms.⁶

The most frequently utilised imaging modality for evaluating thyroid nodular lesions, devising patient evaluations, and directing minimally invasive therapies is ultrasound (US). Six For managing thyroid nodules, non-surgical, minimally invasive, US-guided techniques have been proposed over the past two decades.⁷

Concerning the demographic data, the mean age was 45.947 years, ranging between 18 to 64 years and female predominance with 86.7% of the studied patients female and 13.3% were males, which coincides with Jawad et al.⁸ who found that there were thirty-nine females & seven males, with a mean age of 50.9 & a range of 30–83.

Abd El-Galil et al.⁹ analysed 40 individuals, of which twelve (30.0%) were males, and twenty-eight (70.0%) were females, with a mean age \pm standard deviation of 47.28 ± 13.79 years and a range of 21–80 years.

The most common complications were Hematoma or swelling, Transient voice changes (fully recovered), and Skin burn (first-degree) in each case. This is consistent with Kim et al.¹⁰ who found that the most common complications in their studied cases were Hematoma, ipsilateral vocal cord palsy, and I-grade burn in each case.

Also, in the study done by Thomas et al.⁷, One participant presented with adverse events of moderate severity, involving pain both while following the procedure in addition to oedema at the location of needle insertion.

Regarding nodule volume pre-radio-frequency ablation, it was 19.15 ± 4.21 ml and ranged between 9.5 and 35. This agreed with Aysan et al.¹¹ who found that the nodular volume pre-radio-frequency ablation was 16.8 ml. Also, in the study done by Sung et al.¹² they found that the nodular volume pre-radio-frequency ablation was 18.5 ± 1.30 ml. Another Korkusuz et al.¹³ study found that the nodular volume pre-radio-frequency ablation was 18 ± 4.24 ml. Jawad et al.⁸ the average (SD) nodule volume was determined to be 25.9 (27.7) ml, ranging from

0.7 to 130.8 ml at baseline. Thomas et al.⁷ It was further specified that the index thyroid nodule exhibited a basal volume ranging from 5.51 to 28.22 mL. Also, in the study done by Sim et al.,¹⁴ mean (SD) nodule volume was 14.0 ± 12.7 ml, with a range from 3.1 to 56.6 ml at baseline. Abd El-Galil et al.⁹ observed that the mean nodule volume at baseline was 15 (8.5–39.5) ml.

As regards the distribution of the texture of the thyroid nodule, the solid was in 10 (33.4%), cystic in 7 (23.3%) and complex in 13 (43.3%) of texture and that near to the results in the research done by Aysan et al.¹¹ who found that 51 solid, 35 mixed; and 14 cystic. In another study by Kohlhase et al.¹⁵, they found two cystic, 10 complex, and eight solid. Jawad et al.⁸ also discovered that twenty-two treated nodules were solid, three were cystic, and twenty-five were mixed solid-cystic. In the study done by Sim et al.¹⁴ they found that 38 were solid, 11 were mixed, and five cystic Abd El-Galil et al.⁹ found that there were 27 (60.0%) solid, 16 (35.6%) were complex, and 2 (4.4%) were cystic.

Concerning Echo-structure and volume, there was a non-significant difference in echo Echo-structure volume pre, after a month and after three months, which agrees with Cesareo et al.¹⁶ It has been stated that the volumetric decrease of the thyroid remains constant regardless of sonographic characteristics. Furthermore, Abd El-Galil et al.⁹ uncovered no statistically significant correlation between the volume decrease ratio of thyroid nodules at one, three, or six months of the echotexture of the nodule.

Jeong et al.¹⁷ found that cystic nodules exhibited the greatest reduction in size compared to the other varieties at the 1- and 3-month follow-up periods ($P = 0.000$ & 0.007 , respectively). However, no statistically significant distinction was observed among the nodule types at the six-month follow-up period ($P = 0.621$). The nodules that required an additional session to attain the desired decrease in volume are the larger nodules (those with a solid component exceeding fifty millilitres in volume), thyroid nodules located in both thyroid lobes and thyroid nodules extending retrosternally.

4. Conclusion

The present research concluded that In addition to being a viable substitute for surgery, ultrasound-guided radio-frequency ablation offers the benefit of reduced complications and increased patient satisfaction, particularly in individuals who are at high risk or decline surgical intervention. It exhibits satisfactory short-term efficiency and is a safe modality for benign thyroid nodules. Additionally, it exhibits efficacy in diminishing the dimensions of benign thyroid nodules, managing compressive symptoms

associated with nodules, and addressing cosmetic concerns. No significant complications arose, and none of the complications or sequelae were life-threatening.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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