

# Short-term Outcomes of Benign Thyroid Nodule Ablation Using Radiofrequency: A Study at a Tier-1 Hospital in Vietnam

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DOI: <https://doi.org/10.52403/ijhsr.20250219>

## ABSTRACT

Thyroid nodules are a frequent clinical condition, traditionally managed with surgery or levothyroxine therapy. Radiofrequency ablation (RFA) has been introduced as a treatment option for thyroid nodules at the Thong Nhat Hospital (Ho Chi Minh City, Vietnam). A retrospective longitudinal case series was conducted at the Thong Nhat Hospital from November 2022 to June 2024. Patients diagnosed with benign thyroid nodules based on ultrasound and fine-needle aspiration were treated using RFA. Follow-up ultrasounds were performed one month post-treatment to measure nodule volume reduction and identify any complications. Statistical analysis using univariate and multivariate linear regression explored factors influencing volume reduction. The study included 125 patients (113 females, 12 males) with an average age of  $43 \pm 12$  years. Patients presented with 1 to 4 nodules each (mean: 1.7), and the average initial nodule volume was  $9.87 \pm 8.65$  mL. The RFA procedure lasted an average of  $15 \pm 12$  minutes. Mean nodule volume reductions were  $49.6 \pm 17.7\%$  after one month and  $65.5 \pm 15.2\%$  after three months. Minor self-limiting complications occurred in 2 cases (1.6%), with no major complications reported. Regression analysis revealed an inverse relationship between initial nodule solidity and volume reduction. These findings suggest that RFA is a safe and effective treatment for benign thyroid nodules, offering a viable alternative for broader clinical application.

**Keywords:** thyroid nodule, radiofrequency ablation, efficacy, safety.

## INTRODUCTION

Nodular goiter is a common clinical issue, with a prevalence ranging from 20% to 76% in the general population [6]. Although most nodular goiters are benign, they still carry the potential for malignancy [1] and may cause compression-related symptoms in the neck, such as hoarseness or difficulty swallowing, which necessitate treatment in certain cases [10]. In Vietnam, the primary treatment methods for nodular goiters include surgery and levothyroxine hormone therapy, both of which have limitations.

Surgical methods, including open and endoscopic surgery, require general anesthesia and may result in complications such as surgical site issues, voice changes, and postoperative hypothyroidism [8]. Meanwhile, levothyroxine therapy can lead to symptoms of hyperthyroidism and demonstrates limited therapeutic efficacy [5].

In recent years, ultrasound-guided, non-surgical ablation techniques for nodular goiter treatment have gained popularity in developed countries. These methods include

RFA, laser ablation (LA), and ethanol injection. Among these, ethanol injection is less recommended due to complications such as voice changes and direct damage to nerves and tissues near the thyroid caused by ethanol leakage [2]. Both RFA and LA have shown efficacy and safety in treating benign nodular goiters. However, recent evidence suggests that LA causes a broader area of tissue damage around the intervention site compared to RFA [11], even though RFA is superior in reducing thyroid nodule volume and has a similar complication rate to LA [7]. Consequently, RFA has become more widely adopted than LA.

The technique of RFA for treating benign thyroid nodules has been implemented at the Thong Nhat Hospital (Ho Chi Minh City), since November 2016. We have developed and refined the procedural and post-intervention follow-up protocols. Assessing the efficacy and safety of this method is crucial. Therefore, we conducted this study to evaluate the effectiveness and safety of RFA in treating benign thyroid nodules at 1 and 3 months post-intervention.

## **MATERIALS & METHODS**

### **Study Design**

This is a longitudinal case series study conducted at the Thong Nhat Hospital (Ho Chi Minh City), from November 2022 to June 2024.

### **Study Subjects**

We included all patients diagnosed with benign thyroid nodules and treated with RFA at the Thong Nhat Hospital (Ho Chi Minh City). Diagnosis of benign thyroid nodules was confirmed through clinical examination, ultrasound findings suggesting a low suspicion of malignancy, and benign results from fine-needle aspiration. All patients were thoroughly informed about their condition, available treatment options, and agreed to undergo RFA by signing a consent form.

### **RFA Intervention Protocol**

Patients were positioned supine with the neck extended. Local anesthesia was administered with 2% lidocaine (2 mL) at the cervical skin. Under ultrasound guidance, the thyroid capsule was anesthetized using 20 mL of diluted 1% lidocaine. The electrode was inserted from the contralateral side, passing through the isthmus and targeting the thyroid nodule. The entire length of the electrode was visualized under ultrasound, maintaining a minimum safety margin to the “danger triangle” (including the recurrent laryngeal nerve and esophagus). Ablation began at the deepest and most distal part of the nodule and proceeded in a stepwise, pull-back manner to avoid image interference caused by bubbling during ablation. The RF energy ranged from 50 to 70 W, depending on the electrode tip size and the nodule's characteristics.

### **Patient Monitoring**

All patients were monitored in the hospital for 30 minutes to 1 hour post-procedure to evaluate complications and their overall condition. Patients were discharged the same day if vital signs were stable and they reported no or minimal pain. Follow-up visits were scheduled at 1 week, 1 month, and 3 months post-intervention to identify complications and to measure the size of the treated nodule using ultrasound to calculate the reduction rate.

### **STATISTICAL ANALYSIS**

The primary outcome variables were the reduction rate in thyroid nodule volume at 1 month and 3 months post-intervention (efficacy) and the total complications observed immediately post-intervention up to 1 month and 3 months later (safety). These outcomes, along with patient and intervention characteristics, were reported using frequency and percentages for categorical variables and means with standard deviations for continuous variables. Univariate and multivariate linear regression analyses were performed to

identify factors associated with the volume reduction rate at 3 months post-intervention. Regression results were presented with regression coefficients and p-values, with statistical significance defined as  $p < 0.05$ . All statistical analyses were performed using R software version 3.3.2.

## RESULT

After 7 months of implementing the RFA method for treating benign thyroid nodules

at the Thong Nhat Hospital (Ho Chi Minh City), we performed the procedure on 134 patients. Among them, 125 patients met the inclusion criteria for this study. The patients had an average age of 43 years, with a majority being female (113 out of 125). Each patient had between 1 to 4 thyroid nodules confirmed by ultrasound, with an average nodule volume of 9.87 mL. Patient characteristics and intervention details are summarized in Tables 1 and 2.

**Table 1- Patient characteristics**

Clinical Characteristics		Frequency (Percentage)	Mean
Gender	Male	12 (9.6%)	
	Female	113 (90.4%)	
Age			43 ± 12
Disease detection characteristics	Known to have a thyroid nodule	65 (52.0%)	
	Incidentally discovered	13 (10.4%)	
Clinical symptoms	Compression symptoms	98 (78.4%)	
	Aesthetic concerns	12 (9.6%)	
	Voice change	0 (0.0%)	
Thyroid function	Euthyroid	117 (93.6%)	
	Hyperthyroidism (due to medication)	8 (6.4%)	
	Hypothyroidism	0 (0.0%)	
Ultrasound imaging characteristics	Largest diameter (cm)		3.48 ± 1.13
	Thyroid nodule volume (mL)		9.87 ± 8.65
	Number of thyroid nodules		1.7
	Solid component ratio (%)		69.3 ± 34,5

**Table 2- Treatment characteristics**

Intervention characteristics	Mean
Radiofrequency ablation duration (seconds)	15 ± 12 (12 – 30)
Radiofrequency energy applied (Watt)	50 – 70

The treatment outcomes at 1 month and 3 months post-intervention showed average thyroid nodule volume reduction rates of 47.6% and 65.5%, respectively. There were two cases of minor complications following the procedure:

- One patient experienced temporary hoarseness, which resolved spontaneously after 3 weeks.
- Another patient developed a hematoma, which resolved on its own after 1 week.

**Table 3- Results after one month of treatment**

Treatment outcomes	Frequency (Percentage)	Mean
Percentage Volume Reduction After 1 Month		47.6 ± 17.5
Percentage Volume Reduction After 3 Months		65.5 ± 15.2
Mild Complications	2 (1.6%)	
Voice change (self-recovering)	1 (0.8%)	
Hematoma	1 (0.8%)	
Skin burn	0 (0.0%)	
Nodule rupture	0 (0.0%)	
Severe Complications	0 (0.0%)	

Univariate and multivariate analyses revealed that the solid component ratio of the thyroid nodule prior to intervention was strongly associated with the volume reduction rate at 3 months post-intervention.

Specifically, after adjusting for other factors, each 10% increase in the solid component ratio resulted in a 3.5% decrease in the volume reduction rate of the thyroid nodule at 1 month post-intervention.

**Table 4- Factors associated with volume reduction rate after 3 months**

Factors	Univariate analysis		Multivariate analysis	
	Coefficient	p-value	Coefficient	p-value
Gender	3,3	0,534	3,7	0,457
Age	0,1	0,368	-0,3	0,243
Nodule volume before treatment	-0,3	0,335	-0,4	0,078
Number of nodules	-2,3	0,144	-1,9	0,145
Solid component ratio	<b>-3,0</b>	<b>&lt;0,001</b>	<b>-3,5</b>	<b>&lt;0,001</b>

## DISCUSSION

After 3 months of follow-up for 125 patients with benign thyroid nodules treated with RFA at the Thong Nhat Hospital (Ho Chi Minh City), our findings demonstrate that RFA is a safe and effective treatment method. It achieved an average nodule volume reduction of approximately half the initial volume at 1 month and two-thirds at 3 months post-intervention. Aside from one patient who experienced hoarseness due to vocal cord paralysis after the procedure, no other severe complications were observed. The average procedure duration per patient was  $15 \pm 12$  minutes, significantly shorter than surgical treatment. All patients were discharged the same day without the need for hospitalization.

RFA for benign thyroid nodules has been utilized in developed countries such as South Korea, Italy, and Germany for over 15 years. Multiple reports on volume reduction rates over time have shown a 33–58% reduction at 1 month, 51–92% at 6 months, and 75–95% at 12 months post-intervention [4]. Our study yielded similar results, with a volume reduction rate of nearly 50% at 1 month and 65.5% at 3 months. Based on these trends, we expect the nodules to achieve an average volume reduction of over 90% at 12 months post-intervention.

Clinicians are continually refining intervention techniques to enhance the efficacy of RFA in treating benign thyroid nodules and improve long-term volume

reduction rates. Simultaneously, research is being conducted to identify factors influencing volume reduction. A study in South Korea involving 111 patients with RFA-treated thyroid nodules over a 4-year follow-up identified two factors related to volume reduction: pre-treatment nodule volume and the solid component ratio. Larger nodule volumes and higher solid component ratios were associated with lower post-treatment volume reduction rates [9].

Our univariate and multivariate analyses yielded similar results. Although pre-intervention nodule volume did not show a statistically significant association ( $p = 0.055$ ), it still negatively correlated with the post-intervention volume reduction rate. The solid component ratio strongly influenced this outcome. A lower solid component ratio indicates a higher fluid content in the nodule, which is typically aspirated during the procedure, leaving only the solid portion for ablation. This process results in a significant reduction in nodule volume.

While RFA does not provide the immediate, definitive results of surgery, it has a much lower complication rate. A multicenter study in South Korea involving 1,459 patients reported a severe complication rate of 1.4%, with the most common being voice changes (1.02%), followed by thyroid rupture (0.14%), thyroid rupture with abscess (0.07%), hypothyroidism (0.07%), and brachial plexus injury (0.07%). Less

severe complications occurred at a rate of 1.92%, including hematoma (1.02%), vomiting (0.62%), and skin burns (0.27%) [3]. In our study, there were only two cases of minor complications: one case of voice changes (0.8%) that resolved within 3 weeks and one case of hematoma at the intervention site (0.8%) that resolved within 1 week. With such a low complication rate, RFA is undoubtedly a safe treatment for patients with benign thyroid nodules.

This study has several limitations, including a small sample size (125 cases), short follow-up duration (3 months), and reliance on medical records, which may introduce bias due to subjective evaluations by clinicians and imaging diagnoses. However, the study's strength lies in the standardized and synchronized diagnostic, intervention, and follow-up procedures at the Thong Nhat Hospital (Ho Chi Minh City). All patients were consistently followed up at 1 and 3 months post-intervention.

As a preliminary finding, our study indicates that RFA is an effective and safe treatment method for benign thyroid nodules. Future research should include larger sample sizes and longer follow-up periods to further evaluate the efficacy and safety of this treatment. Additionally, further studies should investigate factors associated with nodule volume reduction to enhance the effectiveness of RFA in treating benign thyroid nodules.

## CONCLUSION

A study of 125 patients with benign thyroid nodules treated with RFA at the Thong Nhat Hospital (Ho Chi Minh City), revealed an average nodule volume reduction rate of 47.6% at 1 month and 65.5% at 3 months post-intervention. There were two cases of mild, self-limiting complications, and no severe complications were reported. RFA for benign thyroid nodules has the potential to be widely implemented and become a routine treatment method for patients with benign thyroid nodules.

## Declaration by Authors

**Ethical Approval:** Approved

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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How to cite this article: Cuong Chi Le. Short-term outcomes of benign thyroid nodule ablation using radiofrequency: a study at a Tier-1 Hospital in Vietnam. *Int J Health Sci Res*. 2025; 15(2):145-150. DOI: <https://doi.org/10.52403/ijhsr.20250219>

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