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# Percutaneous Ablation of Benign Thyroid Nodules as Safe Alternative for Surgery: A Single-Center Experience

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## Abstract

**Purpose** The increasing prevalence of thyroid nodules, coupled with the desire to minimize the invasiveness and potential complications associated with surgical interventions, underscores the critical need for exploring alternative therapeutic strategies.

**Objectives** To evaluate the role of percutaneous radiofrequency ablation in the management of benign thyroid nodules.

**Methods** Forty-five consecutive patients who presented with evidence of symptomatic benign thyroid nodules and were categorized under TIRADS 1 or 2 and BETHESDA II scoring were selected for percutaneous ablation.

**Results** About 86.7% were women with a mean (±standard deviation [SD]) age being 44.4 (± 5.4) years. Radiofrequency ablation was done for 45 patients with solid or predominantly solid thyroid nodules. Majority of them (79.66%) reported a reduction in symptom score after ablation. The mean (± SD) volume of the nodules at baseline was 35.03 (± 17.2) mL, which significantly ($p = 0.05$) dropped to 7.44 (± 4.1) mL at 1 year of follow-up. The average volume reduction rate was 79.66% at 1 year, with the maximum rate of volume reduction observed at the first month of follow-up.

**Conclusion** Percutaneous radiofrequency ablation is a safer and an effective alternative to surgery for managing benign thyroid nodules.

**Keywords**

- minimally invasive surgical procedures
- radiofrequency ablation
- thyroid nodule
- ultrasound

## Introduction

Thyroid nodules represent a common clinical concern, affecting a substantial proportion of the global population. The prevalence of clinically palpable thyroid swellings among Indian adults ranges from 3.3 to 33.6%.[1,2] However, the prevalence increases to 20 to 76% when ultrasound is used for detection.[3] While the majority of thyroid nodules are benign and asymptomatic, a significant subset necessitates intervention due to symptoms such as compression of adjacent structures or the suspicion of malignancy.

Pharmacotherapy with levothyroxine as well as surgical resections have been employed as treatment options for benign thyroid nodules. Surgery has certain risks that may outweigh the benefits of treating the benign nodules. Thyroidectomy, in partial or total, has the risk of bleeding, scarring, hypocalcemia, and recurrent laryngeal nerve injury. Hence, less invasive procedures are of scientific interest.[4]

Among the various therapeutic modalities available, percutaneous radiofrequency ablation (RFA) has emerged as promising techniques for the management of thyroid nodules.[5–9] These minimally invasive procedures offer alternatives to traditional surgical approaches, providing patients with a less invasive and potentially more accessible option for the treatment of thyroid nodules.

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This study seeks to highlight the experiences and outcomes associated with RFA as a treatment for symptomatic thyroid nodules in a specific Indian cohort.

## Materials and Methods

This retrospective study was conducted in the department of radiology in a tertiary care institute. Forty-five patients who consecutively presented to the study setting with symptoms of neck swelling, difficulty in swallowing, or changes in voice were thoroughly assessed with ultrasonography and those with TIRADS 1 or 2 (solid, solid-cystic) and BETHESDA II scoring were selected for percutaneous ablation. TIRADS scoring system has demonstrated 75% sensitivity and 67% specificity, as compared with other similar systems in prediction of malignant thyroid nodules.[10] Those nodules with features suggestive of malignancy were excluded. The purpose of the study was explained to the study participants, and informed written consent was obtained from them before the start of the procedure.

The size, characteristics, proportion of solid component, and internal vascularity of each nodule were evaluated. Three orthogonal nodule diameters, including the largest diameter, were measured by ultrasound to assess volume of the nodule using the equation $V = \pi abc/6$, where V was the volume, a was the largest diameter, whereas b and c were the other two perpendicular diameters.

Solid-cystic or completely solid nodules were offered RFA. In this technique, an 18- to 19-gauge monopolar radiofrequency electrode (STARmed, South Korea) was used based on the size and volume of the thyroid nodule and area of ablation zone required. A transisthmic approach was deployed in all the patients under ultrasound guidance after achieving good hydro dissection to avoid charring of the adjacent tissue and skin burns (►**Fig. 1**). Ablation was done at 30 to 40 W using "moving-shot technique" displacing the electrode toward more superficial areas as the deeper zones were necrotized. Good ablation zone was demonstrated by the appearance of transient hyperechogenic segments and changes in tissue impedance. The average ablation time required was 18 to 20 minutes. The total time of the procedure was dependent on the volume of the nodule ranging from 45 minutes to 1 hour.

Preliminary evaluation with coagulation profile was done for all the study subjects and the procedures were performed on a day care basis. A visual analog scale was used for patient-reported assessment of symptoms and its reduction. Patients were discharged on the same day and were called for follow-up ultrasound evaluation at 1, 3, 6, and 12-month postprocedure to evaluate rate of volume reduction. Rate of volume reduction (VRR) was calculated by using the following formula: VRR = initial volume (mL) − final volume (mL) × 100/initial volume (mL).

Descriptive statistics using frequency and percentages was attempted. Volume of the nodule as well as rate of volume reduction were expressed in mean and standard deviation (SD). Wilcoxon signed-rank test was performed to check for any significant reduction in mean volume during the follow-up period, as the variable followed a nonparametric distribution. Paired *t*-test was done to check for any significant rate of volume reduction during the follow-up period.

## Results

Totally 45 patients with thyroid nodules with a minimum follow-up of 6 months were included in the research during our study period of 1 year. Of them, 39 (86.7%) were women. The mean (± SD]) age of the patients was 44.4 (± 5.4) years. The most common presenting symptom was neck swelling (95.6%) followed by change in voice (82.2%) and difficulty in deglutition (80.0%). Of the 45 patients who presented with thyroid nodules, 45 were solid (86.7%) or predominantly solid (13.3%), as represented in ►**Table 1**.

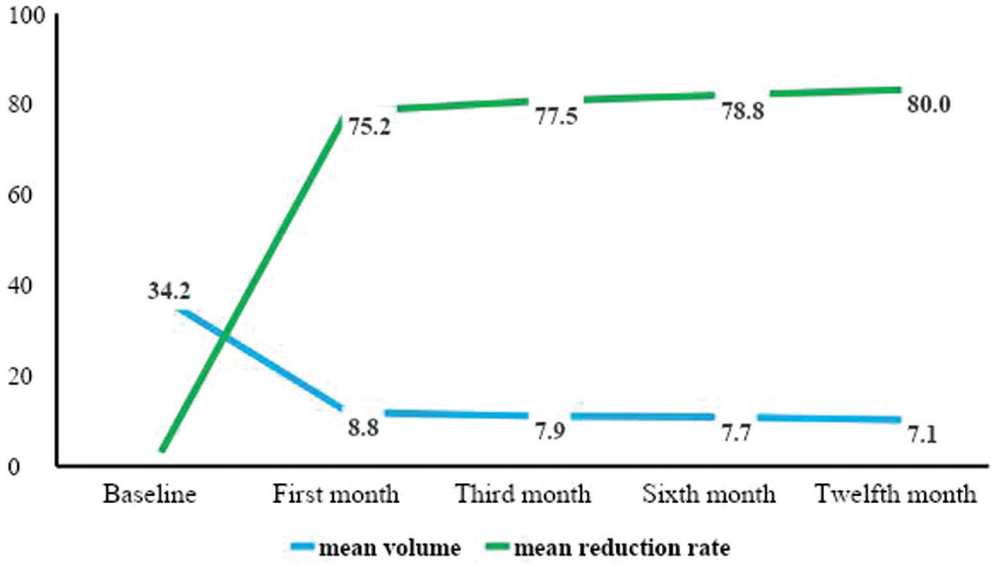


**Fig. 1** Graph showing trends of mean volume and mean reduction volume during follow-up. Trends of mean volume and mean reduction volume during follow-up period.

 

**Table 1** Baseline characteristics of study participants ($n = 50$)

| Variable | | Frequency | % |
|---|---|---|---|
| Age category (y) | 35–40 | 16 | 35.6 |
| | 41–45 | 10 | 22.2 |
| | 46–50 | 16 | 35.6 |
| | 51–55 | 3 | 6.7 |
| Gender | Male | 6 | 13.3 |
| | Female | 39 | 86.7 |
| Presenting symptoms | Neck swelling | 43 | 95.6 |
| | Change in voice | 8 | 17.8 |
| | Difficulty in deglutition | 36 | 80.0 |
| Type of nodule | Cystic | 5 | 10.0 |
| | Predominantly solid | 6 | 13.3 |
| | Solid | 39 | 86.7 |

RFA (90.0%) was done for 45 patients with solid or predominantly solid thyroid nodules. Only four (8.8%) patients reported complications postprocedure, two of them had hematoma, one had fever, while one had a change of voice. More than three-fourth of the patients reported reduction in their symptoms with 43 (86.0%) patients reporting a symptom reduction score of 1 or 2.

The mean (±SD) volume of the nodules at baseline was 35.03 (±17.2) mL that significantly ($p = 0.05$) dropped to 9.32 (±5.7) mL at first month of follow-up; 8.37 (±5.0) mL at third month; 8.0 (±4.8) mL at sixth month and 7.44 (±4.1) mL at 1 year of follow-up (►**Table 2**). There has been significant mean volume reduction ($p = 0.05$) of the thyroid nodules ranging from 74.32 at first month of follow-up, 78.66 at 1 year of follow-up (►**Table 3**). This significant reduction in volume as well as percentage reduction are illustrated in ►**Fig. 1**. Ultrasound-guided hydrodissection, preablation, and postablation at 3 months of follow-up are illustrated in ►**Figs. 2** and **3**, respectively.

## Discussion

Although most thyroid nodules are euthyroid, some may necessitate surgical removal due to cosmetic reasons or compressive symptoms. Surgery inherently is associated with risks and complications. The need for thyroid hormone supplementation after the surgery depends upon the extent of the resection (total thyroidectomy vs. thyroid lobectomy) and ranges from 28 to 100%.[11] Hence, less invasive procedures are of interest to the patients as well as the physicians.

Thermal ablation techniques are being deployed to treat tumors in various organs such as kidney, lungs, and liver.[12–14] With the advancement of science, these methods are being tested and proved effective in treating benign thyroid nodules.[15] Such modalities also help in overcoming cosmetic problems and compression symptoms.[16] The present study was performed to understand the role of RFA in an Indian cohort.

Most of our study subjects were women, with an average (±SD) age of 44.4 (±5.4) years. A similar finding was observed by authors in their studies elsewhere.[17,18] However, Mauri et al observed a higher mean age of 55.6 (±14.1)

**Table 2** Distribution of study subjects by volume of thyroid nodules during follow-up

| Volume | Frequency | Mean | Standard deviation | *p*-Value[a] |
|---|---|---|---|---|
| Baseline | 45 | 35.03 | 17.2 | – |
| 1st month | 45 | 9.32 | 5.79 | <0.05 |
| 3rd month | 45 | 8.37 | 5.11 | <0.05 |
| 6th month | 45 | 8.00 | 4.92 | <0.05 |
| 12th month | 45 | 7.44 | 4.14 | <0.05 |

[a]Wilcoxon signed-rank test.

**Table 3** Distribution of study subjects by rate of volume reduction of thyroid nodules during follow-up

| Reduction rate | Frequency | Mean | Standard deviation | *p*-Value[a] |
|---|---|---|---|---|
| 1st month | 45 | 74.32 | 5.38 | <0.05 |
| 3rd month | 45 | 76.75 | 4.04 | <0.05 |
| 6th month | 45 | 78.37 | 4.09 | <0.05 |
| 12th month | 45 | 79.66 | 4.33 | <0.05 |

[a]Paired sample *t*-test.

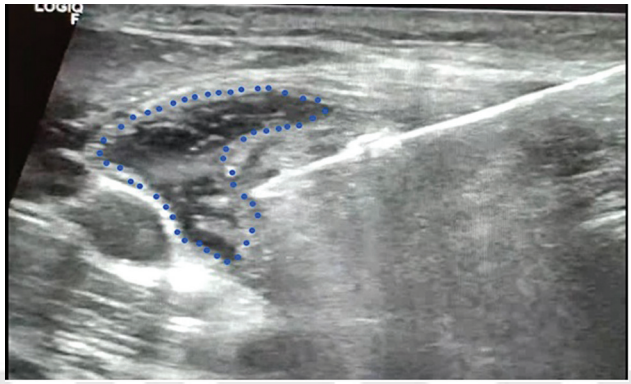

**Fig. 2** Ultrasound image showing hydrodissection. *Adequate hydrodissection between the nodule and major neck vessels prevents damage to surrounding structures.

**Fig. 3** Preablation and postablation at third-month follow-up.

 

years, whereas Basu et al observed a lower mean age of 29.78 ($\pm$ 8.76) years.[18,19] This may be attributed to the sampling differences across these studies.

We observed a significant drop in the average volume of the nodules from 35.3 mL at baseline to 7.44 mL at 1 year of follow-up, with a reduction rate of 79.66%. Literature shows that the volume reduction rate in the 6th to 18th month after percutaneous ablation ranges from 50 to 88%.[20] Navin et al considered therapeutic success to be a volume reduction rate greater than 50% at 1-year postintervention.[4]

In their study on comparing the efficacy of two thermal ablation techniques namely RFA and microwave ablation in the treatment of benign thyroid nodules, Cerit et al documented significantly ($p < 0.00001$) higher volume reduction rates in the RFA group ($77.9 \pm 10.3$) than those in the microwave ablation group ($65.0 \pm 11.3$).[21] A meta-analysis showed a pooled volume reduction rate of 63% ($I^2 = 24\%$, $p < 0.00001$) at 1-year postablation.[22]

An important reason for a high reduction rate in the present study could be attributed to the low baseline volume of the nodule. Nodules less than 30 mL have demonstrated a volume reduction rate of above 75% at 1 year as compared with 63% among nodules with volume greater than 30 mL.[4] Previous research have documented that macrocystic echotexture, spongiform pattern, and intense peripheral vascularity were predictive of a positive response, whereas a large pretreatment nodule volume and increased echogenicity in solid nodules were identified as negative predictors.[23–25]

Less than 10% of our patients reported complications postprocedure, and most of the subjects reported symptom reduction scores of one or two in the present study. A study done in Turkey could not demonstrate any significant difference ($p = 0.88$) in the incidence of complications between those patients who underwent RFA (5.4%) against those who underwent microwave ablation (4.6%).[21] Basu et al could not observe any major complications such as intra-cyst hemorrhage, infection, or perithyroidal ethanol leakage during the treatment of cystic thyroid nodules by percutaneous ethanol ablation.[19]

The noninvasive treatment for benign thyroid nodules offers several advantages over traditional surgical approaches. As a nonsurgical, day care procedure, it does not require hospitalization or leave behind a visible scar. It selectively destroys the nodules while preserving the surrounding healthy thyroid tissue, allowing normal thyroid function to continue without lifelong medication. With its low complication rate along with the lack of scarring and preserved thyroid function, this procedure improves patients' quality of life compared with more invasive surgical options that could damage the thyroid.

While the noninvasive treatment has several advantages, there are some potential drawbacks to consider. Large-volume nodules may require multiple treatment sessions to fully resolve. There are also rare chances of complications like skin burns, hematoma formation, or voice changes/hoarseness from injury to the recurrent laryngeal nerve. However, when performed by a skilled practitioner, these risks remain negligible.

Percutaneous RFA is safe and effective in the treatment of benign thyroid solid, solid-cystic nodules with improvement in compressive and aesthetic symptoms. Single-session percutaneous RFA is a promising outpatient minimally invasive treatment of benign thyroid nodules. Overall, this noninvasive approach maximizes treatment benefits while minimizing risks and lifestyle disruptions.

## Conclusion

In conclusion, our research endeavors to enhance our understanding of the role of percutaneous RFA in the armamentarium of thyroid nodule therapies. We aspire to contribute valuable knowledge that can guide clinicians in selecting the most suitable intervention for individual patients, ultimately improving the overall quality of care in thyroid nodule management, especially considering for an Indian cohort.

### Ethical Approval

Ethical approval was not required for this retrospective study as per institutional guidelines.

### Conflict of Interest

None declared.

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