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Radiofrequency ablation for benign thyroid nodule treatment: New solution in our center

Monica Bellynda [a], Muhammad Rizki Kamil [a], Kristanto Yuli Yarso [b,*]

[a] Surgery Department, Sebelas Maret University, Indonesia
[b] Surgical Oncology Division, Surgery Department, Sebelas Maret University, Indonesia

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ABSTRACT

Introduction and importance: Thyroid nodules are one of the most common thyroid disorders and are estimated at 4–7 % in the general population. Although it is estimated that 95 % of thyroid nodules are benign and only 4.0–6.5 % malignant, a combined assessment of clinical data, ultrasound imaging, and FNAB is needed to estimate the risk of malignancy. Several minimally invasive nonsurgical modalities have been developed to treat thyroid nodules, including ethanol ablation (EA), laser ablation (LA), microwave ablation (MWA), and radiofrequency ablation (RFA). Since 2006, this method had been used to treat thyroid nodules and reported to have good efficacy and safety for treating benign thyroid nodules and recurrent thyroid cancer. This paper aims to provide the efficacy and safety of the RFA procedure in benign thyroid lesions.

Case presentations: Here we report 34 cases of patients with thyroid nodules who underwent RFA procedures. After the procedure, patients were followed up in the first, third, sixth, and twelfth months. The ratio of decreasing volume in the first, third, sixth, and twelfth months was as follows 81.6 %; 76.89 %; 63.48 %, 60.11 %.

Clinical discussion: Factors that are thought to predict RFA response include small volume nodule (<12 ml), the presence of a fluid component and well-defined margins, the absence of vascularization, and nonfunctioning status. However, RFA has several limitations, including the procedure that is highly operator dependent to maximize its efficacy, the possibility of persistent lesions, and the lack of a final histological diagnosis that does not completely exclude aggressive histological variants.

Conclusion: The RFA procedure has minimal side effects, is highly effective, and is short in procedure time.

1. Introduction

Thyroid nodules are one of the most common thyroid disorders and are estimated at 4–7 % in the general population [1]. Although it is estimated that 95 % of thyroid nodules are benign and only 4.0–6.5 % malignant, a combined assessment of clinical data, ultrasound imaging, and fine-needle aspiration biopsy (FNAB) is needed to estimate the risk of malignancy [2,3]. In the diagnosis of thyroid nodules, we use physical examination, ultrasound, and FNAB. The combination of the three tools has high accuracy [4]. In general, most benign thyroid nodules are asymptomatic. Only about 10–15 % came with the chief complaint of a lump in the neck, leading to symptoms or cosmetic problems [5]. Open thyroidectomy is still the first choice in the treatment of thyroid nodules with complications such as voice changes, surgical scars, and subclinical to permanent hypothyroidism [6].

Several minimally invasive nonsurgical modalities have been developed to treat thyroid nodules, including ethanol ablation (EA), laser ablation (LA), microwave ablation (MWA), and radiofrequency ablation (RFA). EA is remarkably successful in the treatment of cystic or predominantly cystic nodules. In the last decade, it has not been used in the treatment of solid thyroid nodules. LA can reduce thyroid nodule volume by 40–80 % with satisfactory outcome [7]. MWA is the newest procedure for the management of thyroid nodules and gives satisfactory results in other organs such as lungs, kidneys, and liver [8]. RFA is a method of using heat energy to induce tissue necrosis. Initially, it was used to treat hepatomas. Since 2006, this method has been used to treat thyroid nodules and reported to have good efficacy and safety for treating benign thyroid nodules and recurrent thyroid cancer [9,10]. Radiofrequency ablation (RFA) is a minimally invasive method that is feasible, safe and has up to 80 % efficacy [11].

* Corresponding author at: dr. Muwardi street no 4, Surakarta.
E-mail address: yarsaonko@gmail.com (K.Y. Yarso).

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Fig. 1. This procedure was performed by an operator (an oncology surgeon) and two assistants.

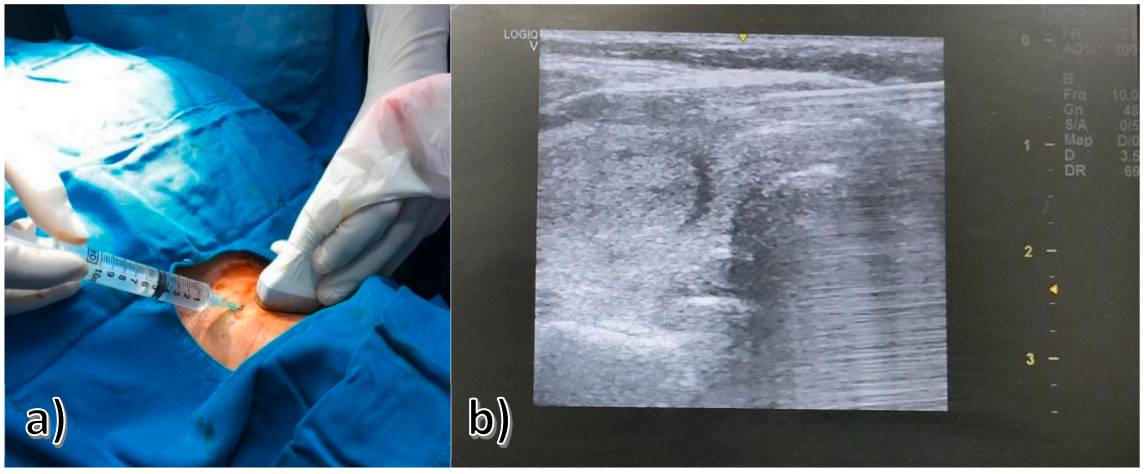

Fig. 2. a) Anesthesia procedure under local anesthesia using 2 % lidocaine, b) ultrasound during anesthesia procedure.

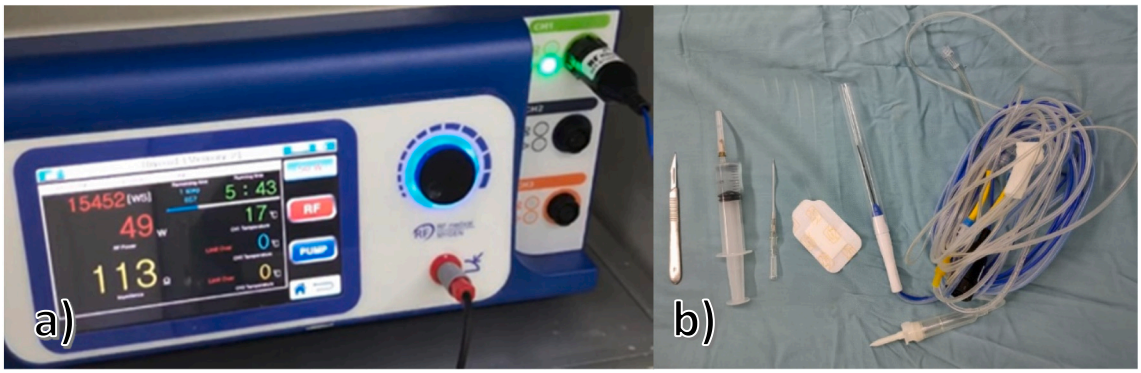

Fig. 3. a) RF Generator type M3004, b) Electrode Ref RFTP 0710, 7 cm long and 10 mm exposure, 18 G in size.

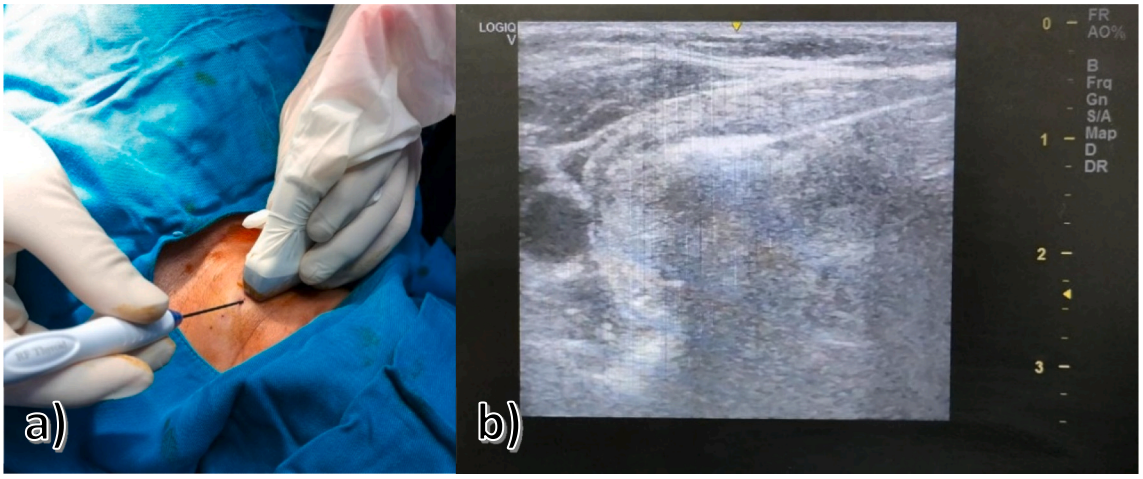

Fig. 4. a) Ablation procedure using moving-shot technique, b) ultrasound during ablation procedure.

Currently, we often use the RFA procedure because of its advantages. The reasons patients choose the RFA procedure are the use of local anesthesia, better cosmetic results, one-day care, and minimal complications. This paper aims to provide the efficacy and safety of the RFA procedure in benign thyroid lesions.

2. Method

Patients who come to the surgical oncology poly at Indriati Hospital or Kasih Ibu Hospital in Solo city have the main complaint of a lump in the neck. This procedure was performed by an operator (An oncology surgeon) and two assistants. They underwent an ultrasound examination of the neck and FNAB revealed a benign and malignant thyroid lesion (solid, cystic). They underwent RFA and/or EA procedures and were followed up in the first, third, sixth, and twelfth months. This research has been approved by the Research Ethics Committee Faculty of Medicine Sebelas Maret University (ID: 01/02/02/2022/07).

We performed this procedure in two hospitals but by the same operator and procedure. This procedure was performed by an operator (An oncology surgeon) and two assistants (1 operator assistant, 1 circulator) in a standard operating room (Fig. 1). An anesthesia procedure under local anesthesia using 2 % lidocaine was injected in the transisthmic access area (Fig. 2). The patient was in the supine position with the neck extended. The RFA was performed by ultrasound-guided and generator RF Generator type M3004, RF Medical Co Ltd., Seoul Korea (Fig. 3a). The electrodes used are Electrode Ref RFTP 0710, 7 cm long and 10 mm exposure, 18 G in size with a power of 45–50 W (Fig. 3b). The moving shot technique is the most used method today. The electrode was inserted into the deepest part of the nodule; then, it moved towards the center and surface of the nodule to divide the nodule and was withdrawn and repositioned in a different area of the nodule. The nodule was divided into multiple, small, and conceptual ablation units, and the ablation was performed unit-by-unit by moving the electrode tip continuously (Fig. 4). The ablation procedure was terminated after the whole nodule became transient hyperechoic zones. If the patients feel pain during the procedure, then the power is turned off for several minutes or they are given a lidocaine injection. The duration of the procedure ranges from 45 to 90 min depending on the size of the thyroid nodule. Complications that occur during and immediately after the procedure were considered to assess the safety of the procedure. After the procedure, the patients were observed for 1 to 2 h in the hospital. The patients were not given antibiotics before or after ablation. This report has been reported in line with the SCARE 2020 criteria [12].

Table 1
Baseline characteristics.

Characteristics	n (%)
Age (year)	
<30	7 (20.6 %)
≥30	27 (79.4 %)
Gender	
Male	4 (88.2 %)
Female	30 (11.8 %)
TIRADS Score	
TIRADS 1	1 (2.9 %)
TIRADS 2	8 (23.5 %)
TIRADS 3	12 (35.3 %)
TIRADS 4	12 (35.3 %)
TIRADS 5	1(2.9 %)
Nodule type	
Solid nodule	27 (79.4 %)
Cystic nodule	1(2.9 %)
Cystic + solid nodule	6 (17.6 %)
Bethesda classification	
I	0 (0 %)
II	25 (73.5 %)
III	0 (0 %)
IV	8 (23.5 %)
V	1 (2.9 %)
VI	0 (0 %)

TIRADS, Thyroid Imaging Reporting and Data System.

Table 2
Intraoperative characteristics.

Characteristics	Details
Volume	
Mean	85 cm^3
Median	87.5 cm^3
Duration	
Mean	50 min
Median	80 min
Procedure	
RFA	27 (79.4 %)
EA	1 (2.9 %)
RFA + EA	6 (17.6 %)
Complication	
Pain	34 (100 %)
Recurrent laryngeal nerve injury	1 (2.9 %)

RFA: radiofrequency ablation; EA: ethanol ablation.

Fig. 5. a) 35 years old women with thyroid nodule since 6 months ago, b) Postoperative RFA procedure, c) 1 month after the procedure, d) 6 months after the procedure, e) 12 months after the procedure.

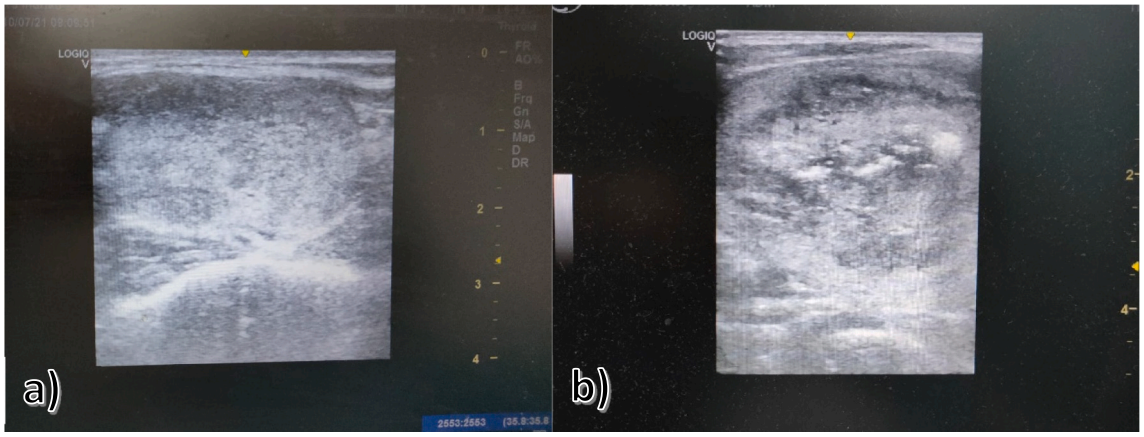

Fig. 6. a) Ultrasonography examination Pre-RFA, b) ultrasonography examination Post-RFA.

Table 3
Volume Reduction Ratio in the first, third, sixth, and tweltfh months.

Follow up	1 month	3 months	6 months	12 months
VRR (%)	81.6	76.89	63.48	61.12

3. Result

Here we report 34 patient cases with thyroid nodules who underwent RFA procedures. Data on patient characteristics in this study are shown in Table 1. Thirty-four consecutive patients gave informed written consent to have their data analyzed in this study. Most of the patients in this study were women aged over 30 years. From the ultrasound examination, 1 patient had TIRADS 1 (2.9 %), 8 patients had TIRADS 2 (23.5 %), 12 patients had TIRADS 3 (35.3 %), 12 patients had TIRADS 4 (35.3 %), and 1 patient had TIRADS 5 (2.9 %). There were 27 patients with solid nodules (79.4 %), 1 patient with cystic nodules (2.9 %), and 6 patients with solid-cystic nodules (17.6 %). FNAB examination showed 25 patients with Bethesda II (73.5 %), 8 patients with Bethesda IV (23.5 %), and 1 patient with Bethesda V (2.9 %) (Table 1).

Intraoperative characteristic data are described in Table 2. The minimum volume of nodules measuring 5 cm^3 requires a procedure time of 10 min while the maximum volume of 170 cm^3 takes 150 min. We performed 27 RFA procedures (79.4 %), 1 EA procedure (2.9 %), and 6 RFA + EA procedures (17.6 %). All patients experienced postoperative pain, and only 1 patient (2.9 %) had recurrent laryngeal nerve injury that resolved in the first 10 days without further treatment (Table 2).

After the procedure, the patients were followed up in the first, third, sixth, and twelfth months (Fig. 5). All patients were clinically evaluated, and their thyroid nodule volumes were measured using ultrasound (Fig. 6). The complications found were that there was pain on the first day after the procedure (VAS 5–7) and reduced on the third day after the procedure (VAS 3–4) and one patient had recurrent laryngeal nerve injury. In our report, the ratio of decreasing volume in the first, third, sixth, and twelfth months was as follows 81.6 %; 76.89 %; 63.48 %, 60.11 % (Table 3 and Fig. 7).

4. Discussions

When performing ablation, we use the most widely used method today, namely the moving-shot technique. This method has minimal heat exposure in the danger triangle and can visualize the entire electrode with transverse ultrasound view [7]. This method is also safer and is the main choice in the treatment of recurrent thyroid cancer [10]. Another approach method that is most often used is the trans-isthmus approach. This method is performed by inserting the electrode through the isthmus, in a midline to lateral direction. The advantage of this method is that the operator can monitor the electrodes, laryngeal nerves, and target nodules in the “danger triangle”. Other advantages are that it prevents leakage of hot ablation fluid into the perithyroidal area and has a stable electrode position [13].

Vuong et al. reported in a study of 184 patients who underwent the RFA procedure that the volume reduction ratio (VRR) at 3, 6, and 12 months was 66.8, 74.3, and 81% [14]. In addition, the study by Cappelli et al. in 43 patients who underwent the RFA procedure found that the VRR at 1, 3, and 12 months was 40.6 ± 20.8, 61.9 ± 15.6, and 66.7 ± 16.6% [15]. In our report, the ratio of decreasing volume in the first, third, sixth, and twelfth months was as follows 81.6 %; 76.89 %; 63.48 %, 60.11 %. The conventional open thyroidectomy procedure takes an average of 120 minutes [16], whereas the RFA procedure in our current report takes an average of 50 min. Our recent report, with RFA procedure takes an average 30 min with average smaller nodule size and with EA procedure also takes an average 30 min with cystic nodule [17,18]. MWA procedure takes average 30 min each nodule and average ablation time was 6.97 ± 5.13 min [19].

There are many publications regarding the use of RFA for benign thyroid nodules and recurrent thyroid cancer, including follicular neoplasms. Due to the high rate of false-negative follicular neoplasms, size <2 cm and the absence of neck metastases were predictive factors [20]. In our study, we performed the RFA procedure on Bethesda IV and showed good results, whereas in Bethesda V we only performed fluid aspiration.

A multicenter study by Baek et al. reported that only 48 (3.3 %) of the 1543 patients with thyroid nodules that underwent RFA had complications. Major complications that occur include voice changes, brachial plexus injury, tumor rupture, and permanent hypothyroidism while minor complications include hematoma, skin burn, and vomiting [21]. The comparative study between RFA and surgery found complications of 1 % versus 6% [22]. The complications of other non-invasive methods such as LA, EA, and MWA are as follows. LA has 0.5 % major complications of voice changes due to vocal cord palsy, with complete recovery after 3 months. And 0,5 % minor complications including subcapsular or perithyroidal hematoma and skin burn. Pain was the most frequent side effect of LA and was recorded as mild or moderate, respectively, in 10.6 % and 1.6 % of patients [23]. The complications that can occur due to ethanol ablation such as localized pain and hematoma in the puncture site, facial flushing, drunken sense, hoarseness, dyspnea, temporary hyperthyroidism, and fibrosis [17]. Morelli et al.

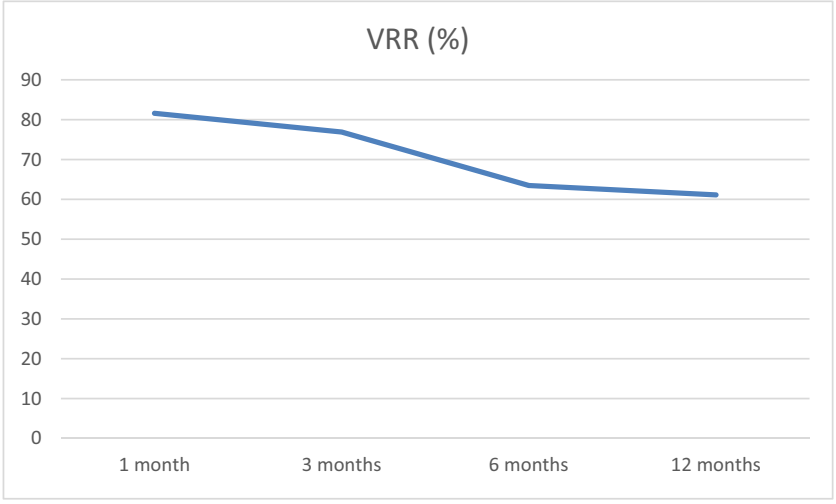

Fig. 7. Volume Reduction Ratio during follow-up period.

reported MWA has several minor complications such as heat sensation in the neck, slight pain, first-degree burns, and hematoma without active bleeding in the ablated site. There were no major complications such as esophageal perforation and tracheal injury [8].

Factors that are thought to predict RFA response include small volume nodule (<12 ml), the presence of a fluid component and well-defined margins, the absence of vascularization, and nonfunctioning status [24]. However, RFA has several limitations, including the procedure that is highly operator dependent to maximize its efficacy, the possibility of persistent lesions, and the lack of a final histological diagnosis that does not completely exclude aggressive histological variants [25]. RFA is the most widely used of the non-invasive treatment options for thyroid nodules due to its high efficacy and safety. In addition, it has been recommended in several guidelines [26]. In the management of thyroid nodules, various factors must be considered including serum TSH, assessment of clinical risk factors, nodule size, ultrasound characteristics, biopsy results, and patient preferences [17].

Limitations in this study include the lack of sample size and variety, and lack of further diagnostic examination data. Strengths of this study include being a new method used in our center, discussing factors that influence the success of the RFA procedure, and comparing it with other minimally invasive methods.

5. Conclusion

The RFA procedure is the most widely accepted because it has very minimal side effects, is highly effective, and is short in procedure time. Further studies can be carried out with more samples, more complete additional examinations, and comparisons with other methods.

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Ethical approval

This research has been approved by the Research Ethics Committee Faculty of Medicine Sebelas Maret University (ID: 01/02/02/2022/07).

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

CRediT authorship contribution statement

Monica Bellynda, Kristanto Yuli Yarso: Surgical therapy for this patient and data collection.

Muhammad Rizki Kamil, Monica Bellynda, Yuli Yarso: Writing Original draft preparation and study concept.

Kristanto Yuli Yarso: Senior author and the manuscript reviewer.

Monica Bellynda, Muhammad Rizki Kamil: Editing – Writing. All authors read and approved the final manuscript.

Research registration

Not applicable. This is not a clinical trial or 'First in Man' study.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Guarantor

Kristanto Yuli Yarso

Declaration of competing interest

The authors declare no conflict of interest.

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