Original Research Paper

Volume - 14 | Issue - 10 | October - 2024 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Radiology

RADIOFREQUENCY ABLATION AS A MINIMALLY INVASIVE TREATMENT FOR BENIGN THYROID NODULES: A CLINICAL STUDY

Dr. Jeffrey Ralph	Associate Professor, Annaii Medical College & Hospital, Tamilnadu
Dr. Karthik Palanisamy	Consultant Interventional Radiologist, Geri Care Hospital, Chennai, India
Dr Swarnalakshmi Sampath	Associate Professor, Sri Lalithambigai Medical College, Tamilnadu
Dr. Annamalai Vairavan*	Senior Resident, Sri Ramachandra Medical College, Tamilnadu *Corresponding Author

ABSTRACT **Background:** While benign thyroid nodules are often asymptomatic, they can cause cosmetic concerns and physical discomfort, leading to the need for treatment. Radiofrequency ablation (RFA) has gained attention as a non-surgical option to reduce nodule size and alleviate symptoms. This study investigates the effectiveness of RFA in treating benign thyroid nodules and its impact on nodule volume and related clinical symptoms. **Methods:** A total of 20 benign thyroid nodules in 15 patients were treated with RFA after obtaining informed consent. Patients were followed for six months' post-treatment. Inclusion criteria consisted of patients with unilateral or bilateral nodules that caused cosmetic or compressive symptoms, confirmed benignity via cytology twice, and those who either declined or were ineligible for surgery. Prior to ablation, cystic nodules were aspirated. RFA was performed using a STARMED RF generator. Nodule volume, symptom relief, and any complications were assessed before and after the procedure. **Results:** Significant reduction in nodule volume was observed, with a mean volume reduction ratio (VRR) of 42.6% at 1 month, 61.5% at 3 months, and 73.1% at 6 months ($p < 0.001$). Symptom resolution and cosmetic improvement were achieved in all patients, with no adverse effects on thyroid function. No serious complications were reported. **Conclusion:** Radiofrequency ablation proves to be a safe and effective treatment option for benign thyroid nodules, offering a minimally invasive alternative to surgery. The procedure demonstrated notable improvements in nodule size and patient symptoms, making it a valuable therapeutic approach. Further studies with extended follow-up will help define its long-term role in thyroid nodule management.

KEYWORDS : Radiology frequency ablation; thyroid nodule; benign nodules; thyroidectomy; minimally invasive.

INTRODUCTION

Management of thyroid nodules has, therefore, become challenging and highly sophisticated in modern medical practice. Advancing epidemiological reports on thyroid nodules, driven by the need to differentiate benign from malignant lesions, necessitate examination of newer advanced treatment modalities (1). This research essay addresses the specific topic of benign thyroid lesions and the focused inquiry into how effective RFA is as a therapeutic intervention.

Thyroid nodules are currently the most common health problem due to abnormal growths in the thyroid gland. Most being benign, thyroid nodules pose definite diagnostic dilemmas, and the necessity for such a treatment method as is both effective yet minimally invasive is of utmost importance. Of the medical applications of radiofrequency ablation, that technique that uses focused heat to ablate tissue, of interest has gained important ground: the treatment of thyroid nodules.

The primary purpose of the research is to outline a robust review of radiofrequency ablation in the treatment of benign thyroid lesions (3). It conducts detailed analysis and evaluation of patient results, hence bringing more relevant contributions to this shifting landscape of managing thyroid nodules. Since the medical community tries to deliver more effective care and therapy for the patients, the understanding of the potential of RFA in the context of benign thyroid lesions is not only relevant but promises advancement in more medical practice in delivering better patient welfare.

METHODOLOGY

Patient Selection:

Inclusion Criteria

All patients with clinically evident benign thyroid nodules, confirmed through ultrasound imaging and fine – needle aspiration cytology (FNAC) twice and having compressive symptoms and / or cosmetic problems.

Exclusion Criteria

Exclude patients with contraindications to RFA, pregnancy, or known thyroid malignancies.

Study Design

- Conduct a prospective cohort study to assess the thermal precision of RFA in the treatment of benign thyroid nodules.

Patient Preparation

The patient is clinically evaluated for compressive symptoms and cosmetic problems before the procedure. Screening ultrasound is done to assess the size and volume of the thyroid nodule, contents of the nodule- solid, cystic or complex. Laboratory values like baseline thyroid hormone levels were done. FNAC reports of the patients reviewed.

The volume of the thyroid nodule is assessed by measuring the three diameters (AP, TR, CC) of the nodule by ultrasound and calculating the volume by using the formula 0.52 x AP X TR X CC (AP – anteroposterior diameter, TR – transverse diameter & CC – craniocaudal diameter).Patients are made to rate their symptoms on a 10-point visual analog scale.

Cosmetic problems were assessed using a grading score consisting of grades 1 to 4, 1 – no palpable mass, 2-palpable mass, but no cosmetic problem, 3 – mild cosmetic problem, 4 – gross cosmetic problem.

Radio Frequency Ablation Procedure

All the patients underwent procedure on day care basis under conscious sedation and local anaesthesia. Single dose of intravenous cefotaxime 1g was given 1 hour before the procedure.The patients neck was cleaned and draped. Local anaesthesia was infiltrated at the puncture site. If the nodules contain cystic areas, first the cyst is aspirated before the ablation.

Thyroid gland is hydrodissected fully, to avoid thermal injury to the adjacent structures. Hydrodissection was then done using a mixture consisting of 1 part of 2% lignocaine and 3 parts of saline. Hydrodissection was performed under ultrasound guidance (3).

Starmed RF generator from TaeWoong Medical Company, USA is used for the procedure. The electrodes having active tip of 10mm were used.

After ensuring adequate hydrodissection, Radiofrequency electrode is then inserted through the isthmus in to the lateral aspect of the nodule under ultrasound guidance. The entire length of the electrode and target nodule must be clearly visible. Ablation was then performed using moving shot technique.

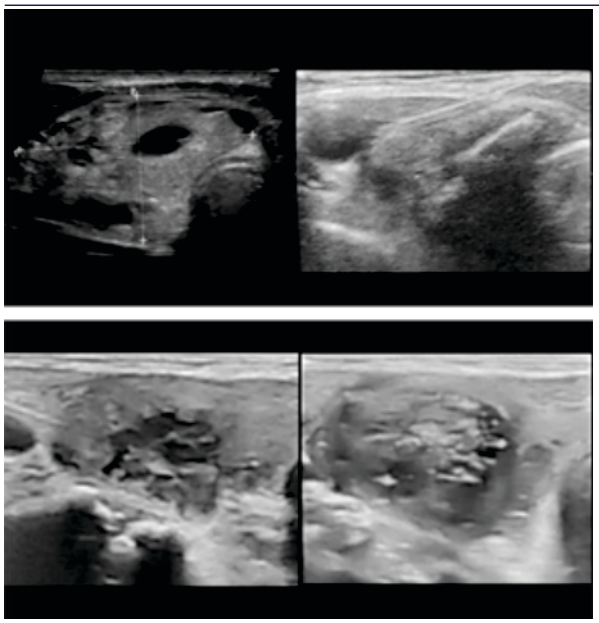

Figure 1: A- TIRADS – 2 lesion in right lobe of thyroid, B–Needle inserted in right side before hydrodissection,C – Image showing RFA needle ablating in moving shot technique ,D- Post procedure image showing echogenic storm cloud representing the ablation zone covering the lesion

First the ablation was started using 30W power and the tip was observed for formation of hyperechoic zone in 10s. If the tip doesn't show hyperechoic zone in 10s, then the power is increased by 10W. Once the tip shows hyperechoic zone, the electrode is moved to next untreated area.Ablation was done starting from the deepest portion of the nodule to the superficial area. The endpoint of the ablation is when all areas of the nodule becomes hyperechoic zones. The skin overlying the nodule is protected from the thermal injury by applying cold saline over the puncture site during the procedure. The average ablation time ranged from 20 to 30 minutes and power used 30 to 40W. Sterile mild compression dressing applied over the puncture site (3-5).

The patient is then observed in the recovery room for any voice changes or increased neck swelling. Then the patient is shifted to the ward after 2 to 3 hours. The patient is discharged later in the day with oral antibiotics and anti-inflammatory for a week.

The patient is then followed up and evaluated for compressive symptoms, cosmetic problems and ultrasound examination to measure the nodule volume at 1 month, 3 months and 6 months.

The volume reduction ratio is then calculated using the formula, (initial volume – final volume) x 100 / initial volume. If the response is unsatisfactory or partial after 6 months, then additional ablation was performed in the second sitting (6).

Post Procedural Care

Patients who had moderate sedation post-procedure are kept for 30 minutes, while patients who received general anaesthesia are kept for 2 hours. Monitoring involves pain scoring assessment of blood pressure, heart rate, and oxygen saturation. Effective pain management is ensured with ice packs and oral analgesic medication like acetaminophen as required. Majority of them get discharged without any prescription pain medication (4).

Complications and Safety

No major complications were encountered during or after the procedure. 7 patients did not develop any complications. 1 patient developed transient voice change which recovered spontaneously in 2 hours, 2 patients developed small bruises over the neck which was treated with thrombophob ointment (7,8).

DISCUSSION

RFA is a relatively new technique for the treatment of benign thyroid nodules, and this study has well proved a decrease in nodule volume and clinical symptoms associated with it (2). Results from this study are in alignment with the current literature reporting that RFA is a promising alternative for surgery in patients with benign thyroid nodules, mainly in patients unfit for the surgery or who refuse it (9). This study's inclusion criteria, such as established benignity and presence of cosmetic or compressive symptoms, are very well in line with earlier studies that aim at maximizing the selection of patients for RFA (7,8).

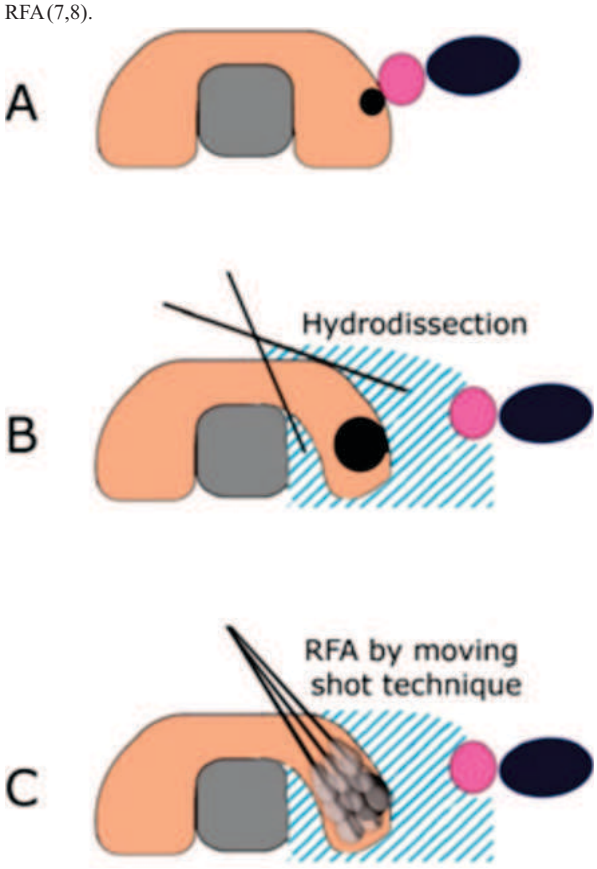

Figure 2: A – Small benign lesion in left lobe of thyroid, B – 23Gneedle inserted and hydrodissection done around the left lobe, C – Image showing RFA needle ablating in moving shot technique.

In terms of effectiveness, the volume reduction ratio observed in this study is well within statistical significance and in agreement with that reported in previous studies based on current literature. As instance, there have been various studies that have demonstrated similar volume reduction trends in which RFA appears to have a VRR of around 50-60% at a period of months subsequent to treatment while continuously demonstrating progressive reduction with time (5). The gradually steady volume reduction trend witnessed illustrates RFA's value as a long-term treatment option for benign thyroid lesions.

Of notable importance are the symptom resolution and cosmetic improvement seen in all patients, because in a clinical setting, the fear of nodules being malignant is not as critical as the physical discomfort or cosmetic issues they present. Earlier studies have demonstrated that RFA reduces not only the volume of the nodule but also the associated compressive symptoms and improves cosmetic results, thereby providing patients with significant quality-of-life improvement without surgery (9).

Most significantly, the study emphasized safety. This study showed no adverse effect on thyroid function, and no serious complications were noted (7,8). It is consistent with other studies that have brought out the safety profile of RFA, where complications were reported to be low in number and there were no adverse effects on thyroid function in the long term. This study supports the safety and minimally invasive nature of RFA for the treatment of benign nodules due to the absence of complications such as voice changes, infections, or damage to the surrounding tissues.

However, there are some limitations that need to be addressed with this study. The sample size is small at 20 nodules in 15 patients and results are not very generalizable. Larger, multi-center studies may further validate these findings in a more representative mix of the population.

Further, six months' follow-up period can demonstrate short-term efficacy but may not depict the complete long-term outcomes of RFA. Long-term follow-up would therefore be crucial to understand if the symptom relief is permanent or nodule regrows over time. Long-term follow-up studies would be required to definitively position RFA in the long-term treatment of benign thyroid nodules (10).

Another point of consideration is the comparison between RFA and other non-surgical methods, such as ethanol ablation or laser ablation. While RFA has gained significant attention due to its safety and efficacy, better volume reduction ratio compared to microwave ablation (11). Hence, Larger, multi-center studies may further validate these findings.

CONCLUSION

RFA of thyroid nodules is a safe, minimally invasive technique effective for treatment of benign thyroid nodules, including toxic nodules. Its use in primary small papillary thyroid cancers will most likely to expand. As we are moving forward toward the care of the patient with personalized approach, RFA will be an important tool for select cases of thyroid nodules. A careful selection of specific benign and certain malignant nodules in well selected patients will ensure a therapeutic response without complications and risk associated with surgical approaches. However, further research with larger sample sizes and longer follow-up periods is necessary to confirm its long-term effectiveness and refine its role in the broader management of thyroid nodules.

REFERENCES

1. Diana S. et al., Epidemiology of thyroid nodules, Best Practice & Research Clinical Endocrinology & Metabolism, Volume 22, Issue 6, 2008 (Pages 901-911). DOI - 10.1016/j.beem.2008.09.019
2. Shin JH, Baek JH, Ha EJ, Lee JH. Radiofrequency ablation of thyroid nodules: basic principles and clinical application. Int J Endocrinol. 2012;2012:919650. doi: 10.1155/2012/919650. Epub 2012 Oct 22. PMID: 23133449; PMCID: PMC3485526.
3. Ahmed M, Brace CL, Lee FT Jr, Goldberg SN. Principles of and advances in percutaneous ablation. Radiology. 2011 Feb;258(2):351-69. doi: 10.1148/radiol.10081634. PMID: 21273519; PMCID: PMC6939957.
4. Kim JH, Baek JH, Lim HK, Na DG. Summary of the 2017 thyroid radiofrequency ablation guideline and comparison with the 2012 guideline. Ultrasonography. 2019 Apr;38(2):125-134. doi: 10.14366/usg.18044. Epub 2018 Sep 27. PMID: 30458605; PMCID: PMC6443588.
5. Issa PP, Omar M, Issa CP, Buti Y, Hussein M, Aboueisha M, Abdelhady A, Shama M, Lee GS, Toraih E, Kandil E. Radiofrequency Ablation of Indeterminate Thyroid Nodules: The First North American Comparative Analysis. Int J Mol Sci. 2022 Sep 29;23(19):11493. doi: 10.3390/ijms231911493. PMID: 36232815; PMCID: PMC9569520.
6. Sinclair CF et al., General Principles for the Safe Performance, Training, and Adoption of Ablation Techniques for Benign Thyroid Nodules: An American Thyroid Association Statement. Thyroid. 2023 Oct;33(10):1150-1170. doi: 10.1089/thy.2023.0281. Epub 2023 Sep 14. PMID: 37642289; PMCID: PMC10611977.
7. Baek JH, Lee JH, Sung JY, Bae JI, Kim KT, Sim J, Baek SM, Kim YS, Shin JH, Park JS, Kim DW, Kim JH, Kim EK, Jung SL, Na DG; Korean Society of Thyroid Radiology. Complications encountered in the treatment of benign thyroid nodules with US-guided radiofrequency ablation: a multicenter study. Radiology. 2012 Jan;262(1):335-42. doi: 10.1148/radiol.11110416. Epub 2011 Oct 13. PMID: 21998044.
8. Chung, S. R., Baek, J. H., Choi, Y. J., & Lee, J. H. (2019). Management strategy for nerve damage during radiofrequency ablation of thyroid nodules. International Journal of Hyperthermia, 36(1), 203–209. https://doi.org/10.1080/02656736.2018.1554826
9. Bernardi S, Dobrinja C, Fabris B, Bazzocchi G, Sabato N, Ulcigrai V, Giacca M, Barro E, De Manzini N, Stacul F. Radiofrequency ablation compared to surgery for the treatment of benign thyroid nodules. Int J Endocrinol. 2014;2014:934595. doi: 10.1155/2014/934595. Epub 2014 Jun 22. PMID: 25045352; PMCID: PMC4090443.
10. Seo YK, Cho SW, Sim JS, Yang GE, Cho W. Radiofrequency Ablation of Papillary Thyroid Microcarcinoma: A 10-Year Follow-Up Study. Taehan Yongsang Uihakhoe Chi. 2021 Jul;82(4):914-922. doi: 10.3348/jksr.2020.0128. Epub 2021 Apr 14. PMID: 36238050; PMCID: PMC9514404.
11. Guo DM, Chen Z, Zhai YX, Su HH. Comparison of radiofrequency ablation and microwave ablation for benign thyroid nodules: A systematic review and meta-analysis. Clin Endocrinol (Oxf). 2021 Jul;95(1):187-196. doi: 10.1111/cen.14438. Epub 2021 Mar 2. PMID: 33556187.