ScienceDirect

Surgery

Volume 175, Issue 1, January 2024, Pages 139-145

Innovation/Technology

Radiofrequency ablation of benign thyroid nodules: A prospective, multi-institutional North American experience

Jonathon O. Russell MD [a], Dipan D. Desai MD [a], Julia E. Noel MD [b], Mohammad Hussein MD, MSc [c], Eman Toraih MD, PhD, MSc [c d], Stefanie Seo BS [a], Samantha Wolfe MD [e], Mahmoud Omar MD [c], Peter Issa BS [c], Lisa A. Orloff MD [b], Ralph P. Tufano MD, MBA [f], Emad Kandil MD, MBA [c]

Show more

https://doi.org/10.1016/j.surg.2023.07.046

Abstract

Background

Radiofrequency ablation for benign thyroid nodules aims to achieve a volume reduction rate of ≥50%. However, factors that predict treatment success have not been defined in a large-scale study.

Methods

A prospective cohort study of biopsy-proven benign thyroid nodules treated with radiofrequency ablation at 3 institutions was performed. Patient demographics, nodule sonographic features, procedural data, and nodule volume reduction were evaluated. Binary logistic regression analysis was performed to identify features associated with treatment response.

Results

A total of 620 nodules were analyzed. The pooled median volume reduction rate at 12 months was 70.9% (interquartile range 52.9–86.6). At 1 year follow-up, 78.4% of nodules reached treatment success with a volume reduction rate ≥50%. The overall complication rate was 3.2% and included temporary voice changes (n= 14), vasovagal episodes (n= 5), nodule rupture (n= 3), and lightheadedness (n= 2). No permanent voice changes occurred. Four patients developed postprocedural hypothyroidism. Large baseline nodule volume (>20 mL) was associated with a lower rate of successful volume reduction (odds ratio 0.60 [0.37–0.976]). Large nodules achieved treatment success by 12-month follow-up at a rate of 64.5%, compared with 81.4% for small nodules and 87.2% for medium nodules.

Conclusion

To our knowledge, this is the largest North American cohort of patients with benign thyroid nodules treated with radiofrequency ablation. Overall, radiofrequency ablation was an effective treatment option with a low risk of procedural complications. Large volume nodules (>20 mL) may be associated with a lower rate of successful reduction with radiofrequency ablation treatment.

Introduction

Thyroid nodules represent an increasingly common diagnosis with a reported incidence of 20% to 68% in otherwise healthy adults.[1] Although thyroid nodules are associated with a relatively low risk of malignancy, a subset of benign nodules will eventually become symptomatic, resulting in compressive symptoms or cosmetic deformity. Historically, treatment of symptomatic, benign thyroid nodules has required surgical resection with either a partial or total thyroidectomy. Even in experienced hands, thyroidectomy carries meaningful risks, including recurrent laryngeal nerve injury, hypoparathyroidism,

iatrogenic hypothyroidism, scarring, and hematoma formation.[2,3] These potential morbidities have prompted the development of minimally invasive treatments, including ultrasound-guided percutaneous ablation techniques.

Among these, radiofrequency ablation (RFA) has gained acceptance as an alternative treatment for benign thyroid nodules. Radiofrequency ablation treatment is an outpatient procedure that uses the application of thermal energy from an alternating current with frequencies ranging from 200 to 1200 kHz.[4] This generates temperatures up to 100°C, resulting in coagulative necrosis of the treated nodular tissue. After being pioneered in Asia and Europe in the early 21st century,4, 5, 6 RFA was first used to treat benign thyroid nodules in North America in 2013.[7] Subsequent studies have demonstrated a track record of efficacy, safety, and cost-effectiveness.[5,]8, 9, 10, 11 A recent systematic review reported published volume reduction rates (VRR) ranging from 56% to 93% at 1-year follow-up.[10] Given this growing body of evidence, an international consensus statement published in 2022 recommended RFA as a first-line alternative to surgery for eligible patients with benign thyroid nodules.[12] Additional international guidelines have described its utility for autonomously functioning nodules, cytologically indeterminate behavior nodules, and even carefully selected primary and recurrent malignancies.[13,14]

However, most currently available data describe outcomes in retrospective cohorts of Asian and European populations. As the adoption of RFA technology continues in North America, there is a specific need for additional prospective research focused on this patient population. Here, we report our outcomes from a multi-institutional cohort in the United States. We aimed to elucidate the degree of total volume reduction variables predictive of treatment success.

Section snippets

Study design

After approval by the Institutional Review Board of each of the 3 participating institutions, we reviewed prospectively collected data from each institution. Across institutions, follow-up data was gathered at 1, 3, 6, and 12 months. Thyroid function testing was completed 1 month after the procedure, and post-treatment ultrasounds were performed at the 3, 6, and 12-month marks. Follow-up beyond 12 months was performed on an as-needed basis. …

Cohort selection

The cohort consisted of consecutive patients from July …

Characteristics of the study population

A total of 620 nodules were evaluated, including 75, 102, and 443 nodules from JHU, SU, and TU, respectively. The mean participant age was 58.7 ± 13.1 years. 77.1% (n = 478) of participants were female, and 39.1% (n = 231) were Black. The mean body mass index was 29.7 ± 7.3 kg/m^2, and the TU cohort had a significantly greater proportion of patients with obesity (P < .001). Additionally, 9.0% (n = 56) of participants had been diagnosed with Hashimoto's thyroiditis. The mean age of the TU cohort …

Discussion

Since its initial FDA approval in 2018, RFA treatment of benign thyroid nodules has been increasingly adopted in the United States.[18] A recent systematic review evaluated 35 studies of RFA treatment for solid, benign nodules and demonstrated international evidence supporting its efficacy and safety.[19] However, of the included studies, the vast majority included exclusively European or Asian patient populations, and only 4 studies included 200 or more nodules. Within the United States, previous …

Funding/Support

Dr. Russell reports consultation fees from Baxter Scientific and research funding from Eli Lilly as a Site PI for an advanced thyroid cancer pharmaceutical trial. He is also a co-recipient of an NIH SBIR R44 with Optosurgical. Dr. Noel disclosed consultation fees from Pulse Biosciences. Dr. Kandil reported speaking fees from STARMed. Dr. Tufano reported consultation fees from Medtronic, Stryker, Pulse Biosciences, and RGS Healthcare. All other authors reported no biomedical financial interests …

Conflict of interest/Disclosure

Dr. Russell reports consultation fees from Baxter Scientific and research funding from Eli Lilly as a Site PI for an advanced thyroid cancer pharmaceutical trial. He is also a co-recipient of an NIH SBIR R44 with Optosurgical. Dr. Noel disclosed consultation fees from Pulse Biosciences. Dr. Kandil reported speaking fees from STARMed. Dr. Tufano reported consultation fees from Medtronic, Stryker, Pulse Biosciences, and RGS Healthcare. All other authors reported no biomedical financial interests …

Special issue articles Recommended articles

References (28)

O. Hamidi *et al.*
Outcomes of radiofrequency ablation therapy for large benign thyroid nodules: a Mayo Clinic case series
Mayo Clin Proc (2018)

E.J. Kuo *et al.*
If the price is right: cost-effectiveness of radiofrequency ablation versus thyroidectomy in the treatment of benign thyroid nodules
Surgery (2023)

E.G. Grant *et al.*
Thyroid ultrasound reporting lexicon: white paper of the ACR Thyroid Imaging, Reporting and Data System (TIRADS) committee
J Am Coll Radiol (2015)

B.R. Haugen *et al.*

2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer
Thyroid (2016)

E. Kandil *et al.*
Hemithyroidectomy: a meta-analysis of postoperative need for hormone replacement and complications
ORL J Otorhinolaryngol Relat Spec (2013)

S.J. Stoll *et al.*
Thyroid hormone replacement after thyroid lobectomy
Surgery (2009)

J.H. Baek *et al.*
Thermal ablation for benign thyroid nodules: radiofrequency and laser
Korean J Radiol (2011)

S. Spiezia *et al.*
Thyroid nodules and related symptoms are stably controlled two years after radiofrequency thermal ablation
Thyroid (2009)

H. Dobnig *et al.*
Monopolar radiofrequency ablation of thyroid nodules: a prospective Austrian single-center study
Thyroid (2018)

J.R. Miller *et al.*
Cost comparison between open thyroid lobectomy and radiofrequency ablation for management of thyroid nodules
Head Neck (2023)

View more references

Cited by (15)

Radiofrequency ablation of Bethesda category III thyroid nodules with benign molecular testing: Preliminary findings from a single institution

2025, American Journal of Surgery

> *Citation Excerpt :*
>
> …Combined with the data from Fuggazzola et al. this provides some early evidence that RFA may be a safe alternative to thyroid lobectomy or active surveillance of these indeterminate nodules, however, longer follow-up both in Europe and the United States is still needed. In a prospective, multicenter study on RFA including 620 benign thyroid nodules, the median VRR at 12 months after RFA was 70.9 %; however, nodules with a volume >20 mL tended to exhibit a VRR <50 %.31 The efficacy of RFA was markedly reduced in nodules with pronounced stiffness and enhanced vascularity on shear wave elastography compared to nodules that were less stiff with minimal vascularity.32…

Show abstract

Thermal Ablation of Thyroid Nodules, From the AJR "How We Do It" Special Series ↗

2025, American Journal of Roentgenology

The Influence of Impedance on the Efficacy of Radiofrequency Ablation for Benign Thyroid Nodules ↗

2024, Laryngoscope

Treatment outcomes in patients with papillary thyroid cancer undergoing radiofrequency ablation of metastatic lymph nodes ↗

2024, Gland Surgery

Microwave ablation: a technical and clinical comparison to other thermal ablation modalities to treat benign and malignant thyroid nodules ↗

2024, Gland Surgery

A novel guided approach to radiofrequency ablation of thyroid nodules: the Toronto Sunnybrook experience ↗

2024, Frontiers in Endocrinology

View all citing articles on Scopus ↗

Jonathon O. Russell and Dipan D. Desai contributed equally to this project as co-first authors.

View full text