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# From ablation to operation: Unraveling the surgical outcomes and complications of thyroidectomy after radiofrequency ablation

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ABSTRACT

*Background:* Radiofrequency ablation is a minimally invasive treatment for thyroid nodules; however, concerns exist regarding its impact on subsequent thyroid surgery. We compared surgical outcomes and complications between patients undergoing thyroidectomy after radiofrequency ablation (post-radiofrequency ablation thyroidectomy group) and those without prior radiofrequency ablation (non-radiofrequency ablation thyroidectomy group).

*Methods:* We retrospectively analyzed thyroidectomy patients, comparing post-radiofrequency ablation thyroidectomy and non-radiofrequency ablation thyroidectomy groups, examining demographics, nodule characteristics, surgical techniques, and complications.

*Results:* The study included 96 patients (73 in the non-radiofrequency ablation thyroidectomy group and 23 in the post-radiofrequency ablation thyroidectomy group). The mean age was 53.3 ± 14.4 years, with 78.1% female patients and 36.5% African American patients. Median operative time was similar between the post-radiofrequency ablation thyroidectomy (110 minutes) and the non-radiofrequency ablation thyroidectomy (92 minutes) cohorts ($P = .40$). Complications were reported in 13 patients, without significant differences between groups ($P = .54$). No permanent complications, including nerve injury or hypoparathyroidism, were reported in either cohort. Prior radiofrequency ablation treatment did not increase the risk of complications (odds ratio = 3.48, 95% confidence interval = 0.70–17.43, $P = .16$).

*Conclusion:* Our work found no differences in outcomes or safety in patients undergoing thyroidectomy with or without previous radiofrequency ablation treatment, potentiating the post-radiofrequency ablation thyroidectomy group as a safe management option. Accordingly, this may reassure both clinicians and patients of the safety of radiofrequency ablation in treating patients with thyroid nodules.



## Introduction

Thyroid nodules, a ubiquitous and salient concern in the realm of endocrinology, exhibit a strikingly high incidence, afflicting as many as two-thirds of the general population.[1] Despite their ubiquity, most of these nodules are benign, accounting for approximately 90% of all cases, and the overwhelming majority, roughly 95%, remain asymptomatic.[2] This benign and asymptomatic nature of most thyroid nodules, however, does not negate the necessity for targeted and effective management strategies, particularly for the subset of patients with benign or low-risk nodules who may benefit from less invasive treatment options. Radiofrequency ablation (RFA), a minimally invasive procedure performed under ultrasound guidance, has emerged as a viable treatment modality.[3] Radiofrequency ablation, in addition to being minimally invasive, boasts an impressive safety profile and is, accordingly, a preferable choice for many clinicians and patients alike.[4] Furthermore, numerous studies have demonstrated significant reductions in nodular volume by 60% to 100% with RFA.[3,5,6]

Nonetheless, akin to all therapeutic interventions, a fraction of patients may exhibit a suboptimal response to RFA, which can

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manifest as minimal volume reduction rates (VRRs), persistent compressive symptoms, or nodule regrowth.[7,8] These complications necessitate further intervention, typically involving repeat ablation or thyroidectomy.[7,8] This raises a pivotal question regarding the impact of RFA-induced coagulative necrosis on subsequent thyroidectomy outcomes. One concern regarding the potential deleterious effects of RFA-induced necrosis is the potential to complicate thyroidectomy and possibly compromise patient outcomes.[9,10] Despite these concerns, no works have previously investigated the safety of thyroidectomy after RFA. Specifically, no previous studies have investigated the outcomes in patients with post-RFA thyroidectomy (PRT) and compared them with those who underwent thyroidectomy without prior RFA (non-RFA thyroidectomy, NRT).

In response to this notable research gap, our study endeavored to break new ground as the first to evaluate the safety and outcomes of PRT with NRT in non-malignant thyroid nodules. Our findings may serve as a catalyst for further exploration of the topic, sparking invigorating discourse and inspiring additional investigations into the broader implications of RFA on thyroid surgery, patient outcomes, and cost-effectiveness. Ultimately, this study sought not only to address a critical knowledge gap but also to contribute to the optimization of thyroid nodule management and the enhancement of patient care. Our specific objective was to delineate the perioperative outcomes of patients undergoing PRT compared to NRT.

**Table I**
Baseline characteristics of the study population

| Characteristics | Study population ($N = 96$) |
|---|---|
| Demographics | |
| Age, mean ± SD, y | 53.3 ± 14.4 |
| Female sex, *n* (%) | 75 (78.1) |
| Black race, *n* (%) | 35 (36.5) |
| BMI, median (IQR), kg/m$^2$ | 31.2 ± 7.2 |
| Comorbidities, *n* (%) | |
| Comorbidities, yes | 30 (31.3) |
| Type of comorbidities | 20 (20.8) |
| Diabetes | 13 (13.5) |
| Cardiovascular | |
| Pulmonary | 9 (9.4) |
| Preoperative work-up | |
| Pre-TSH, median (IQR), mU/L | 1.7 (0.8–2.6) |
| Toxic nodules, *n* (%), yes | 10 (28.6) |
| Nodule size, median (IQR), cm | 2.3 (1.3–.3.8) |
| Procedure, *n* (%) | |
| Type of surgery | |
| Lobectomy | 74 (77.1) |
| Total thyroidectomy | 22 (22.9) |
| Hospital length of stay | |
| Outpatient | 18 (18.7) |
| Stay overnight | 78 (81.3) |

Data are reported in mean and SD, median and IQR or frequency (percentage).
*TSH*, thyroid-stimulating hormone.

## Methodology

### *Ethical considerations*

This retrospective study received approval from Tulane University's Institutional Review Board (#2023–452) and involved operations performed by 2 endocrine surgeons (M.S. and E.K.).

### *Study cohort*

Our study identified a total of 522 cases that underwent RFA for benign disease from 2020 to 2022. Of these, 23 cases (4.4%) did not achieve the expected outcome and required subsequent thyroidectomy (either lobectomy or total thyroidectomy). This cohort was compared against a control group of 73 adult patients (≥21 years of age) who underwent thyroidectomy for benign thyroid disease without prior RFA during the same study period. Exclusion criteria included patients who had neck dissection, remote-access surgeries (including trans-axillary, retro-auricular, and trans-oral thyroidectomy), previous head/neck radiation, or a history of head and neck cancer or surgery.

### *Clinical assessment*

Data collected included patient demographics (including age, sex, and race), sonographic features, and biochemical parameters before surgical interventions. Data regarding RFA procedural details and thyroidectomy-related aspects, including operative time and complications, were collected.

### *RFA procedure*

All patients underwent comprehensive neck ultrasound assessment using a 15-MHz linear transducer and subsequent fine-needle aspiration. Comprehensive assessment of nodules included an evaluation of the ultrasonographic features of the nodule, such as echogenicity, composition, echogenic foci, margins, elastography, and vascularity, as well as the determination of the 3-dimensional measurements and volume of the nodule. All nodules treated by RFA included in this cohort were classified as benign nodules.

### *Thyroidectomy procedure*

All patients underwent conventional thyroidectomy with the cervical approach. Robotic and remote-access thyroid surgeries were excluded. All cases used intermittent intraoperative nerve integrity monitoring systems to periodically assess laryngeal nerve functionality. Only cases of thyroid lobectomy or total thyroidectomy were included, and cases that required central or neck dissections were excluded. Surgical techniques included the creation of a transverse cervical incision, formation of subplatysmal flaps, subsequent strap muscle retraction (or excision when indicated), upper thyroid pole pedicle dissection and distal ligation, middle and inferior thyroid pedicle dissection and ligation, parathyroid identification and preservation, as well recurrent laryngeal nerve (RLN) identification and preservation. Postoperative flexible laryngoscopy was conducted on all patients to assess vocal cord mobility. All surgical specimens were pathologically examined to confirm the benign nature of the disease.

### *Statistical analysis*

Statistical analyses were performed using SPSS version 27.0 (IBM SPSS, Inc, Armonk, NY). The descriptive characteristics between the PRT and NRT groups were summarized. Continuous variables were expressed as a mean and SD or median and IQR. Categorical data were expressed as a count and its corresponding percentage. Two-sided $\chi^2$ analysis, Fisher exact tests, and Mann-Whitney *U* tests were used as appropriate. Multivariate binary logistic regression was used to identify predictor risk factors for complications, and odds ratios and CIs were reported. The authors initially intended to conduct a propensity score analysis to match the 2 study groups. However, upon performing univariate analysis, it was observed that the groups were comparable, negating the need for further analysis.

**Table II**
RFA procedure details and outcomes of thyroid nodules according to final postoperative diagnosis ($N = 23$)

| Characteristic | Value ($N = 23$) |
|---|---|
| Operative time, median (IQR), min | 110 (81–142) |
| Amplitude, median (IQR), J/W | 15 (15–25) |
| Impedance, median (IQR), ohms | 200 (200–300) |
| Probe size, *n* (%), cm | |
| 5 | 11 (47.8) |
| 7 | 10 (43.5) |
| No. of RFA sessions, *n* (%) | |
| 1 | 21 (91.4) |
| 2 | 2 (8.6) |
| Max volume reduction rate, median (IQR), % | 48 (12–74) |
| Latency to thyroidectomy, median (IQR), mo | 6.7 (3.5–13.4) |

Data are reported in median and IQR or frequency (percentage).
*RFA*, radiofrequency ablation.

## Results

### *Characteristics of the study population*

The current study encompasses a cohort of 96 patients, subdivided into 73 NRT cases and 23 PRT cases. The collective demographic profile of the patients revealed a mean age of 53.3 ± 14.4 years, with female patients constituting a significant majority (75 patients, 78.1%). Moreover, 35 patients (36.5%) were of African-American descent. The patients' body mass index (BMI) was 31.2 ± 7.2 kg/m$^2$. Data regarding the study population can be found in Table I.

The study also assessed the comorbidity status of the patients. Almost one-third of patients (30, or 31.3%) had at least 1 comorbidity. Diabetes was present in 20 patients (20.8%), whereas cardiovascular diseases and pulmonary comorbidities were noted in 13 (13.5%) and 9 (9.4%) patients, respectively. The preoperative profile of the patients was evaluated. The median thyroid-stimulating hormone (TSH) level, as per the preoperative workup, was 1.7 mU/L (0.8–2.6). The median size of the thyroid nodules was 2.3 cm (1.3–3.8).

### *Characteristics of patients requiring RFA and its procedure*

The study scrutinized a subset of 23 patients who underwent RFA before thyroidectomy. The mean age of this cohort was 62.5 ± 11.7 years, and the average BMI was 30.0 ± 6.2 kg/m$^2$. Female sex constituted the majority of patients, accounting for 16 individuals (69.6%), with 8 patients (34.8%) of African-American descent.

The median thyroid nodule size was 2.5 cm (IQR: 1.3–6.2). The details and outcomes of the RFA procedures are outlined in Table II. The median operative time was 110 minutes (IQR: 81–142). The median latency to thyroidectomy post-RFA was 6.7 months (IQR: 3.5–13.4).

Indications for thyroidectomy after RFA are depicted in Figure 1. A common indication for thyroidectomy after RFA included a suboptimal VRR or nodule regrowth, which occurred in 9 patients (39.1%). Patient preference and a persistent toxic nodule were the indications in 1 (4.3%) and 3 (13%) cases, respectively. The most common indication for thyroidectomy post-RFA was positive molecular testing, which was noted in 10 cases (43.5%), detected by Afirma (Veracyte) or Interpace Diagnostics gene testing, which was performed at the time of the RFA. We routinely perform a second fine-needle aspiration at the time of the RFA procedure.

### *Comparative analysis for characteristics of post-RFA thyroidectomy and non-RFA thyroidectomy patients*

The specific indications for thyroid surgery among the NRT cohort are shown in Figure 2. The most common indication for surgical intervention was the positive result from molecular testing, which accounted for 46.60% of cases. The presence of a large goiter or a nodule exceeding 4 cm accounted for 11% of cases and patient preference for 20.5% of cases. Compressive symptoms led to 19.20% of the surgical interventions. The least common indication for surgery, observed in 2.70% of the cases, was a hyperfunctioning thyroid nodule.

Demographic and clinical characteristics of both groups are shown in Table III. Apart from age, both cohorts were matched in their characteristics. The mean age of the PRT group (62.5 ± 11.7 years) was significantly higher than the NRT group (50.5 ± 14.1 years) ($P < .001$). The proportion of female patients (NRT: 80.8% vs PRT: 69.6%) was similar between the 2 groups ($P = .25$). African American representation in both groups was similar (37% in NRT vs 34.8% in PRT; $P = .06$). Median BMI was similar between the 2 cohorts (31.6 ± 7.5 kg/m$^2$ in NRT vs 30.0 ± 6.2 kg/m$^2$ in PRT, $P = .35$).

The prevalence of comorbidities was similar between the 2 groups ($P = .22$), at 51.2% in the PRT cohort and 24.7% in the NRT cohort. Comorbidities, including cardiovascular diseases ($P = .44$), diabetes ($P = .06$), and pulmonary diseases ($P = .49$) showed no significant differences between the 2 groups. The preoperative TSH

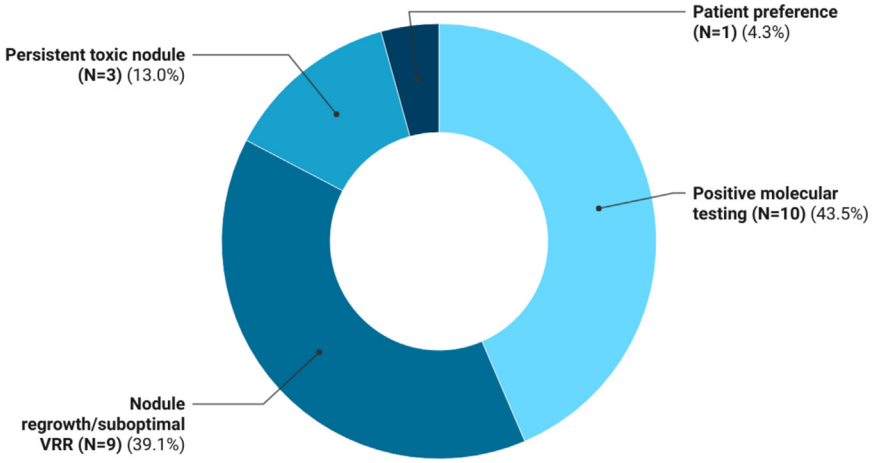


**Figure 1.** Indications of thyroid surgery after radiofrequency ablation according to the final postoperative diagnosis. Data are reported as percentages. *VRR*, volume reduction rate.

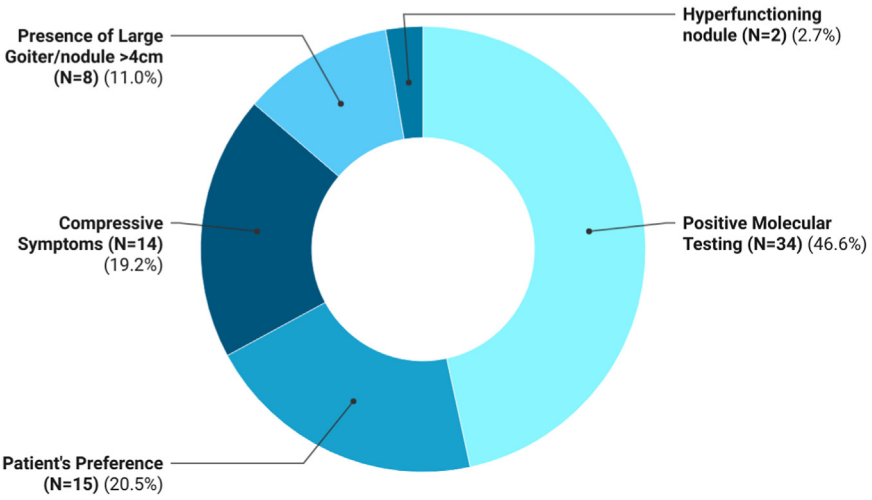


**Figure 2.** Indications of thyroid surgery in the non–radiofrequency ablation thyroidectomy patients. Data are reported as percentages.

levels ($P = .13$) and nodule sizes ($P = .21$) were similar in both groups. Regarding the surgical intervention, there were similar proportions ($P = .26$) of patients undergoing thyroid lobectomy (74% in NRT vs 87% in PRT) and total thyroidectomy (26% in NRT vs 13% in PRT). Regarding hospital stay, most patients in both groups (81.3%) stayed overnight after the procedure, without statistical difference between the 2 groups ($P = .16$).

*Operative outcomes after thyroidectomy*

Postoperatively, TSH levels were similar between groups. The median TSH values were 2.0 mU/L (IQR: 0.6–3.1) in the NRT group compared to 1.3 mU/L (IQR: 0.7–2.0) in the PRT group. The median operative time for the PRT (110 minutes, IQR: 81–142) and NRT groups (92 minutes, IQR: 70.5–142) were similar ($P = .40$). When sub-grouped by the type of surgery, similar results were observed Table IV.

*Complication rates after thyroidectomy*

Out of the total 96 patients in the study, 13 experienced complications, accounting for 13.5% of all cases. When divided into their cohorts, the 2 cohorts maintained similar rates of complication ($P = .54$). Specifically, the rates of complication in the NRT and PRT cohorts were 12.3% (9 out of 73 patients) and 17.4% (4 out of 23 patients), respectively (Table IV).

There was a single report of hematoma, which did not require operative intervention and belonged to the PRT cohort ($P = .07$). Loss of nerve signal was observed in 6 patients overall (6.2%). It was reported in 3 patients (4.1%) from the NRT group and in 3 patients (13%) from the PRT group ($P = .12$). The most common complication observed was transient RLN injury or hoarseness, reported in 8 patients overall (8.3%). It was observed in 6 patients (8.2%) in the NRT group and 2 patients (8.7%) in the PRT group ($P = .94$). Transient hypoparathyroidism that resolved within 3 weeks was observed in 2 patients in the NRT group (2.7%, $P = .42$). Importantly, there were no instances of permanent RLN injury or permanent hypoparathyroidism in either the NRT or PRT groups (Table IV).

In the PRT cohort, the latency period between the ablation procedure and the thyroidectomy operation did not have a significant impact on the risk of complications. Analyzing the data for patients who did not experience complications ($N = 19$) compared to those who did ($N = 4$), the median latency period for patients without complications was 6.53 months (IQR: 3.62–13.42). In contrast, among the patients who experienced complications, the median latency period was 8.05 months (IQR: 6.35–9.39). This observation suggests that the timing of surgery after RFA may not be a crucial factor in determining the likelihood of complications in patients undergoing thyroid surgery. As depicted in Figure 3, multivariate regression analysis showed that prior RFA treatment did not render a higher risk of complications (odds ratios = 3.48, 95% CI = 0.70–17.43, $P = .16$).

## Discussion

Considering its impressive safety profile and the desire to avoid the potential morbidities of conventional thyroid surgery, RFA has been widely implemented in the field of thyroidology. Its effectiveness in treating various thyroid conditions, including benign nodules, hyperfunctioning nodules, and papillary microcarcinomas, has been well-documented.[3,11-13] However, a small proportion of patients treated with RFA may encounter suboptimal outcomes or nodule recurrence, leading to an additional ablation procedure or, rarely, thyroid surgery[7,8]. Patients may undergo thyroid lobectomy after RFA for several reasons, including nodule regrowth. In 2020, Bernardi et al reported a 20% regrowth rate within 5 years after RFA,[14] whereas our previous investigation of 125 benign nodules found an 11.2% regrowth rate.[11] Moreover, some patients may develop a new thyroid nodule in the same lobe previously treated with RFA. In the current study, a mere 23 cases (4.4%) required subsequent thyroidectomy, emphasizing RFA's impressive >95% effectiveness in avoiding surgical intervention. The reasons for thyroidectomy after RFA varied in our cohorts, with the most common being positive molecular testing (10 out of 522, 1.92%), and only 9 out of 522 patients (1.72%) reported inadequate VRRs or nodule regrowth. A notable observation was the significantly higher age of patients in the PRT group, suggesting that older patients may prefer less invasive treatment options like RFA initially. This, however, may also be influenced by medical insurance, which covers the RFA procedure. Altogether, RFA stands out as a safe procedure, including elderly patients or those with high-risk comorbidities or unwilling to undergo surgery, and an effective treatment for most of our patients.

Radiofrequency ablation has emerged as a popular treatment modality due to its minimally invasive nature, which revolves

**Table III**
Characteristics of post-RFA thyroidectomy and non-RFA thyroidectomy groups

| Characteristics | NRT ($N = 73$) | PRT ($N = 23$) | *P* value |
|---|---|---|---|
| Demographics | | | |
| Age, mean ± SD, y | 50.5 ± 14.1 | 62.5 ± 11.7 | < .001 |
| Female sex, *n* (%) | 59 (80.8) | 16 (69.6) | .25 |
| Black race, *n* (%) | 27 (37) | 8 (34.8) | .06 |
| BMI, mean ± SD, kg/m$^2$ | 31.6 ± 7.5 | 30.0 ± 6.2 | .35 |
| Comorbidities, *n* (%) | | | |
| Comorbidities | 18 (24.7) | 12 (51.2) | .22 |
| Type of comorbidities | | | |
| Diabetes | 12 (16.4) | 8 (34.8) | .06 |
| Cardiovascular diseases | 11 (15.1) | 2 (8.7) | .44 |
| Pulmonary diseases | 6 (8.2) | 3 (13) | .49 |
| Preoperative work-up | | | |
| Pre-TSH, median (IQR), mU/L | 1.8 (0.9–2.6) | 1.1 (0.5–2.6) | .13 |
| Toxic nodules, *n* (%) | 5 (6.8) | 5 (21.7) | .06 |
| Nodule size, median (IQR), cm | 1.8 (1.2–3.6) | 2.5 (1.3–6.2) | .21 |
| Procedure, *n* (%) | | | |
| Type of surgery | | | |
| Lobectomy | 54 (74.0) | 20 (87.0) | .26 |
| Total thyroidectomy | 19 (26.0) | 3 (13.0) | |
| Hospital length of stay | | | |
| Outpatient | 16 (21.9) | 2 (8.7) | .16 |
| Stay overnight | 57 (78.1) | 21 (91.3) | |

Data is presented as frequency (percentage), mean and SD, or median and IQR. Two-sided $\chi^2$ analysis, Student's *t* test, and Mann-Whitney *U* test were used.
*BMI*, body mass index; *NRT*, non-RFA thyroidectomy; *PRT*, post-RFA thyroidectomy; *RFA*, radiofrequency ablation; *TSH*, thyroid-stimulating hormone.

around the initiation of coagulative necrosis leading to fibrosis in the targeted lesion.[9,10] Despite concerns regarding potential thermal damage to the thyroid capsule and adjacent tissues that could complicate future surgical interventions, our study, supported by prior literature,[15] demonstrates that RFA does not adversely impact subsequent thyroid surgery or alter surgical techniques. Previous research has indicated that patients who undergo RFA before thyroidectomy experience low complication rates, implying a risk profile comparable to traditional thyroidectomy.[5,16] In 2020, Sun et al examined 21 patients with papillary thyroid carcinoma who underwent thyroidectomy after RFA treatment and noted increased swelling of the strap muscles but no surgical complications.[17] Although our PRT group did not include any patients initially diagnosed with cancer, the Sun et al findings indicate that the risk of complications in malignant PRT is relatively low and likely similar to conventional NRT.

The safety of RFA can be attributed to the precision employed during the procedure, ensuring that the active needle tip is within the nodule. Furthermore, the use of hydrodissection during RFA can further minimize the risk of thermal damage to surrounding tissues, thereby preserving tissue planes and reducing fibrosis.[14,18] Some patients may require thyroid lobectomy after RFA due to inadequate responses or nodule regrowth. However, our study found no significant differences in surgical techniques or intraoperative findings between the PRT and NRT cohorts. This crucial finding suggests that RFA does not hinder the ability to perform a subsequent thyroidectomy, if necessary, nor does it increase the risk of complications. Consequently, this information may provide reassurance to clinicians and patients regarding the viability of RFA as an initial treatment option for benign thyroid nodules, reserving thyroidectomy as a follow-up option if required.

### *Study limitations*

Although we believe our study contributes valuable insight to the field, it is not without limitations. The relatively small group of patients undergoing thyroidectomy after RFA restricts the generalizability of our findings. Future research involving larger, multi-institutional studies will be critical to confirm and expand upon our findings. Furthermore, new research avenues could explore long-term patient outcomes post-RFA, the cost-effectiveness of RFA versus conventional surgical procedures, and the impact on patient quality of life in the transition from RFA to thyroid surgery. These aspects could be vital in enhancing patient outcomes and overall quality of care.

In conclusion, our study provides initial evidence supporting the safety and effectiveness of thyroid surgery after RFA. Future studies are warranted, and broader implications of these findings could affect future management guidelines and treatment approaches.

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**Table IV**
Operative outcomes in the study groups

| Characteristics | Total ($N = 96$) | NRT ($N = 73$) | PRT ($N = 23$) | *P* value |
|---|---|---|---|---|
| Postoperative work-up | | | | |
| Post-TSH, median (IQR), mU/L | 1.7 (0.6–2.6) | 2 (0.6–3.1) | 1.3 (0.7–2) | .11 |
| Operative time, median (IQR), min | | | | |
| Overall | 99 (74–142) | 92 (70.5–142) | 110 (81–142) | .40 |
| Lobectomy | 99 (69–141.3) | 86.5 (64.8–129) | 121 (101–144.3) | .08 |
| Total thyroidectomy | 102 (81–194.5) | 114 (85–205) | 81 (78–0) | .07 |
| Complications, *n* (%) | | | | |
| Overall complications | 13 (13.5) | 9 (12.3) | 4 (17.4) | .54 |
| Type of complications | | | | |
| Bleeding/hematoma | 1 (1.04) | 0 (0) | 1 (4.3) | .07 |
| Seroma | 0 (0) | 0 (0) | 0 (0) | – |
| Loss of signal | 6 (6.2) | 3 (4.1) | 3 (13) | .12 |
| Transient RLN injury | 8 (8.3) | 6 (8.2) | 2 (8.7) | .94 |
| Permanent RLN injury | 0 (0) | 0 (0) | 0 (0) | – |
| Transient hypoparathyroidism | 2 (2.7) | 2 (2.7) | 0 (0) | .42 |
| Permanent hypoparathyroidism | 0 (0) | 0 (0) | 0 (0) | – |

Data is presented as frequency (percentage) or median and IQR. Two-sided $\chi^2$ analysis and Mann-Whitney *U* test were used.
*NRT*, non-RFA thyroidectomy; *PRT*, post-RFA thyroidectomy; *RFA*, radiofrequency ablation; *RLN*, recurrent laryngeal nerve injury/hoarseness; *TSH*, thyroid-stimulating hormone.

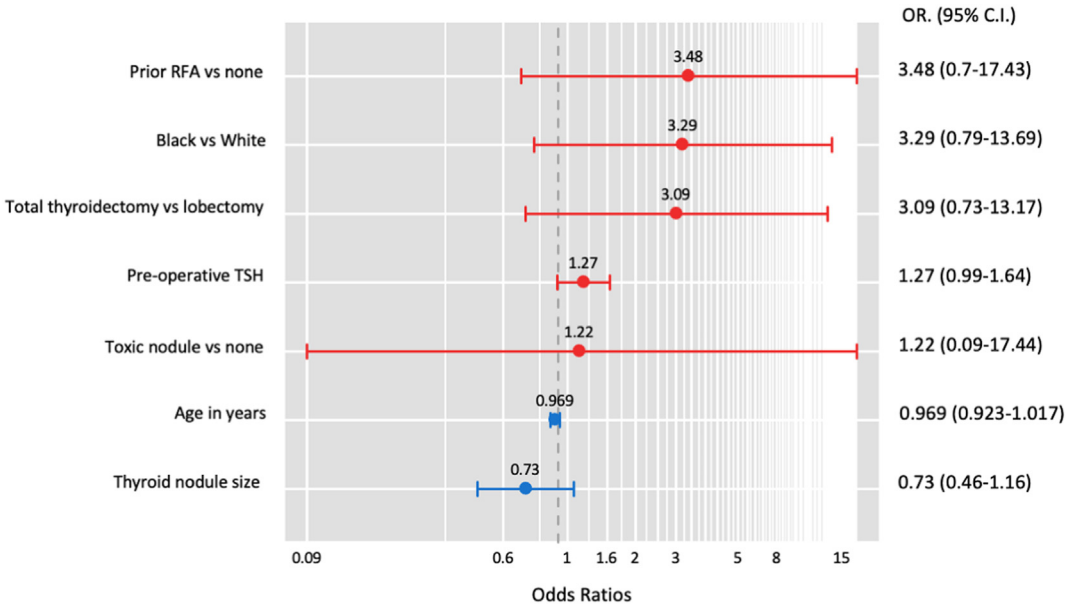


**Figure 3.** Predictor risk factors of complications after thyroidectomy. Multivariate logistic regression analysis was performed, and data reported as odds ratio and 95% CI, reflecting the relative likelihood of experiencing complications for each factor. *OR*, odds ratio; *RFA*, radiofrequency ablation; *TSH*, thyroid-stimulating hormone.

## Conflict of interest/Disclosure

Emad Kandil received speaking Honoraria from Taewoong USA. The sponsors had no role in the design, execution, interpretation, or writing of the study.

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# Discussion

**Eren Berber** (Cleveland, OH): Can you please describe your decision-making process on when to choose radiofrequency ablation (RFA) versus surgery? How long would you wait after RFA to perform surgery if necessary?

**Peter Issa:** This is a discussion with the patient. If ideal volume reduction rates after RFA are not reached by 6 to 12 months, then surgery can be considered. Similarly, in patients with toxic nodules, after RFA, if thyroid-stimulating hormone levels are not normalized

in 2 to 6 months, then surgery can be considered. It is important to note that our median time to thyroidectomy in this cohort was 7 months.

**Salem Noureldine** (Washington, DC): Do you inject saline or local anesthetic into planes around the thyroid? How many of the nodules were located posteriorly, and does that make the dissection around the ligament of the berry more difficult?

**Peter Issa:** Our technique is a short-access approach. Local anesthetic is used for pericapsular anesthesia. This is usually enough to perform the procedure. I do not recall the exact number of posteriorly located nodules. Dissection in this area can be tricky, and hydro-dissection can be useful to lift tissue planes away from the recurrent laryngeal nerve.

**Richard Harding** (Phoenix, AZ): Is your treatment failure rate associated with the amount of energy delivered to those nodules? How many Joules were delivered to the nodules that failed RFA or had regrowth?

**Peter Issa:** Unfortunately, we do not have the power or the Joules delivered per nodule, so we cannot make any conclusions on that. Nonetheless, we have been collecting energy delivered per nodule data prospectively for the past few months.

**Brendan Finnerty** (New York, NY): Do you have any details about the malignancies that were ablated?

**Peter Issa:** They were all papillary thyroid microcarcinomas, 1 cm or less in size. For indeterminate Bethesda 3 and 4 nodules, genetic testing was performed, and if negative, then the nodule was considered for RFA.