Original Article

J Korean Soc Radiol 2024;85(3):618-630
https://doi.org/10.3348/jksr.2023.0056
eISSN 2951-0805

JOURNAL of THE KOREAN SOCIETY of RADIOLOGY

The Comparison of Efficacy and Safety between Radiofrequency Ablation Alone and Ethanol Ablation Followed by Radiofrequency Ablation in the Treatment of Mixed Cystic and Solid Thyroid Nodule

낭성 및 고형성 혼합 갑상선 결절 치료에서 고주파 절제술 단독요법과 에탄올 절제 후 고주파 절제술 요법의 유효성 및 안전성 비교

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Received May 17, 2023
Revised June 15, 2023
Accepted August 10, 2023
Published Online January 22, 2024

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Purpose To compare the efficacy and safety of radiofrequency ablation (RFA) and ethanol ablation (EA) followed by RFA in treating mixed cystic and solid thyroid nodules.
Materials and Methods We included 243 nodules from 243 patients who underwent RFA for mixed cystic and solid benign nodules. The nodules were divided into two groups (RFA alone and EA + RFA). We evaluated volume reduction rate (VRR), therapeutic success rate, improvement in symptomatic and cosmetic issues, complications, and adverse effects.
Results The RFA group included 204 patients, and the EA + RFA group included 39 patients. The long-term success rates in the RFA only and EA + RFA groups were 90.2% and 97.4%, respectively. The mean VRR at the last follow-up in the RFA and EA + RFA groups were 81.6% and 87.2%, respectively. Therapeutic results were similar in both groups at the last follow-up. Cosmetic and symptomatic problems markedly improved in both groups. No major

complications were observed.

Conclusion Both RFA alone and EA + RA are safe and effective methods for treating mixed cystic and solid thyroid nodules, although EA + RFA is slightly more effective.

Index terms Radiofrequency Ablation; Ethanol Ablation; Ultrasonography; Volume Reduction Ratio

INTRODUCTION

Although thyroid nodules are common, they have a low risk of malignancy (1). They are usually detected incidentally on ultrasonographic (US) examination but can cause pressure symptoms and cosmetic problems in the neck. As less invasive treatments, ultrasound-guided radiofrequency ablation (RFA) and ethanol ablation (EA) are performed to relieve symptomatic and cosmetic problems caused by thyroid nodules with excellent efficacy and safety (2-4).

RFA is a thermal ablation technique that causes tissue necrosis and shrinkage through high-frequency alternating electric currents (5). EA causes microvascular thrombosis, cell dehydration, and hemorrhagic infarction of thyroid nodules due to ethanol retention (6, 7). EA has shown excellent efficacy and is recommended as the first-choice ablation technique, particularly for treating cystic or predominantly cystic thyroid nodules (8). Considering the 5%–25% recurrence rate, the effectiveness of EA in treating mixed cystic and solid nodules is still debatable, although EA is the first choice for cystic thyroid nodules (9). Specifically, the recurrence rate was > 50% when EA was used to treat mixed cystic and solid thyroid nodules containing > 20% solid portion (10).

However, EA treatment alone may be insufficient because mixed cystic and solid nodules usually induce spontaneous bleeding within the solid portion during and after ablation (11). In a meta-analysis of benign thyroid nodules, RFA demonstrated excellent efficacy and safety in treating them (9). Moreover, a previous study on the ablation of mixed cystic and solid thyroid nodules showed good performance and efficacy of RFA and EA + RFA techniques (10). Previous studies have also described various ablation techniques for treating mixed cystic and solid nodules. Notably, internal cystic and colloid materials were aspirated before the initial RFA to ensure treatment efficacy and prevent repeated RFA sessions (10, 12). Furthermore, the solid components of thyroid nodules are mostly refractory to EA, as reported in a comparative study on the efficacy of EA against cystic and solid nodules (13). Finally, a large initial nodule volume (> 20 mL) and a solid portion accounting for > 20% of the total nodules are factors known to reduce the efficacy of EA (8, 14, 15).

Therefore, we believe that a combination therapy consisting of ethanol and RF ablation could be a tolerable and effective treatment option for mixed cystic and solid thyroid nodules. We compared the efficacy and safety of RFA alone and EA + RFA in treating mixed cystic and solid benign thyroid nodules, mainly focusing on volume reduction of the nodules, resolving subjective discomfort experienced by patients, and reducing the risk of procedure-related complications.

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MATERIALS AND METHODS

STUDY POPULATION

This retrospective study was approved by the Institutional Review Board of Seoul St. Mary's Hospital, Catholic University of Korea (IRB No. KC23RISI0229). The requirement for informed consent was waived. Demographic information and clinical data were retrospectively collected from the electronic medical records. We included patients who underwent RFA or EA + RFA for mixed cystic and solid benign thyroid nodules between November 2007 and March 2022. The inclusion criteria were as follows: 1) diagnosis of benign thyroid nodules using US-guided fine needle aspiration (FNA) or core needle biopsy (CNB), 2) presence of mixed cystic and solid thyroid nodules on US, and 3) a follow-up period of at least 12 months. The exclusion criteria were as follows: 1) patients with a biopsy-confirmed malignancy during follow-up, 2) patients lost to follow-up, and 3) inadequate US data. In addition, we classified mixed cystic and solid thyroid nodules into two groups according to the nodule's major component based on the 2021 Korean Thyroid Imaging Reporting and Data System (K-TIRADS): 1) predominantly cystic nodules, composed of more than 50% cystic portion of the nodule, and 2) predominantly solid nodules, composed of equal or less than 50% cystic portion (16).

We categorized the patients into two groups: RFA only and EA + RFA.

PRE-PROCEDURAL EVALUATION

All patients underwent US and US-guided FNA or CNB (18-gauge semi-automatic needle, BARD, Tempe, AZ, USA) using a 5–14 MHz linear probe (PLT-1005BT, Canon Aplio i700, Otawara, Tochigi, Japan). During the preprocedural evaluation, the thyroid nodules' size, volume, location, and vascularity were evaluated using US. Adjacent structures (nerves, vessels, trachea, and esophagus) were evaluated using US before the procedure. The volume of each nodule was calculated as follows: $V = \pi \times w \times d \times l/6$, where w is the width, d is the depth, and l is the length (17). For the evaluation of symptoms and relief of cosmetic problems, a 10-cm visual analog scale was administered to the patients. The cosmetic score was assessed by a physician (1: no palpable lesion, 2: no cosmetic problem but a palpable mass, 3: cosmetic problem when swallowing only, and 4: primarily detectable cosmetic problem) (2). Patients with predominantly cystic thyroid nodules chose between two treatment options, RFA only or EA + RFA, considering their personal preferences and the cost of treatment. Prior to their decision, they were sufficiently informed of the pros and cons of both procedures.

RFA AND EA PROCEDURE

All RFA and EA procedures were performed at the outpatient clinic or during short-term admission by an experienced radiologist with 14 years of experience in RFA and EA, according to the guidelines of the Korean Society of Thyroid Radiology (18). RFA was performed using an RF generator (VIVA RF generator, STARmed, Goyang, South Korea) and 18-gauge thyroid-dedicated modified internally cooled electrodes (Well-point RF Electrode-Proteus; STARmed, Goyang, South Korea and RFTP-0710N; RF Medical, Seoul, South Korea) with multiple active tips (0.5, 0.7, 1, and 1.5 mm). The size of the active tip and ablation power were selected based on the size of the thyroid nodules (3). During ablation, 1% lidocaine was injected

into the perithyroidal area and skin puncture site for pain control (3, 19). Each patient's vital signs and voice changes were monitored during the procedure. RFA was performed using basic techniques such as the trans-isthmic approach and moving-shot methods after hydrodissection along the perithyroidal space to prevent thermal injury to critical structures (20-23). The tip of the RF electrode was continuously monitored using real-time US during the procedure to avoid thermal injury. Moreover, RFA was terminated when the entire targeted nodule became transiently hyperechoic due to steam (19). After RFA, cold fluid was injected to prevent thermal injury to critical structures around the RFA nodule. Patients were observed for approximately 2 h to check for possible RFA-related complications.

For the RFA-only group, preprocedural fluid aspiration was not performed prior to RFA when treating predominantly solid thyroid nodules. When treating predominantly cystic nodules, preprocedural fluid aspiration was performed before RFA in all patients between 2010 and 2014. However, this routine procedure poses greater difficulty to the operator when active bleeding may occur during aspiration. Therefore, after 2014, RFA was first performed on the nodule's highly vascular, solid portion, followed by fluid aspiration.

In the EA + RFA group, the patients underwent EA followed by RFA either on the same day or on a different day, depending on the operator's decision. RFA was performed only after the cystic portion of the nodule had been reduced by more than 50%. Patients in this group did not undergo additional fluid aspiration before RFA because the major component of all nodules was either solid or predominantly solid after EA.

EA was performed by the same radiologist under US guidance using an 18-G needle, a 10-mL syringe, and high-purity (99%) ethanol. For local anesthesia, 1% lidocaine was injected through the skin puncture site and the perithyroidal area after skin sterilization. The trans-isthmic route was used to prevent changes in the position of the needle tip and ethanol leakage when the patients swallowed or talked (2). After removing all contents and saline irrigation, ethanol was injected as much as possible. Approximately 50% of the aspirated fluid was injected with ethanol. The total amount of injected ethanol did not exceed 10 mL. The injected ethanol was aspirated after 5 minutes.

POST-PROCEDURAL EVALUATION

Follow-up US was performed at 1 (or 2), 6, and 12 months, and annually thereafter to assess efficacy. We evaluated the nodule size, volume, and vascularity.

The volume reduction ratio (VRR) was calculated as follows: VRR = ([initial volume {mL} - final volume {mL}] × 100%)/initial volume (mL) (24).

Therapeutic success was defined as a VRR of > 50% at follow-up US. We evaluated the long-term therapeutic success and VRR at the last follow-up. We also evaluated the improvements in symptoms and cosmetic problems.

For safety evaluation, we determined complication rates during and after the procedure. Major and minor complications and side effects were classified according to the Society of Interventional Radiology guidelines (25, 26). Major complications were those that caused significant morbidity and disability and required hospital admission or prolonged hospital stay.

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STATISTICAL ANALYSIS

The demographic data were evaluated for statistical analysis. Continuous variables, including age, initial nodule size and volume, ablation power, electrode size, and ablation time, were evaluated using the Student *t*-test or Mann–Whitney test according to the results of the Shapiro–Wilk test for normality, and nominal variables, such as sex, were assessed using the χ^2 test.

For the analysis of efficacy, that is, immediate and long-term VRR, the Mann–Whitney U test was used. Other clinical outcome data, such as follow-up period and therapeutic success rate, were assessed by Mann–Whitney test or χ^2 test according to the type of data. A p-value < 0.005 indicated statistical significance. All analyses were performed using MedCalc version 20.111 (MedCalc, Mariakerke, Belgium).

RESULTS

Among the 274 patients who underwent treatment for mixed cystic and solid benign thyroid nodules, 243 patients (male:female [M:F] = 37:206; mean age, 52.0 ± 15.2 years) were finally included: 204 (M:F = 33:171; mean age, 53.0 ± 15.3 years) were treated with RFA only and 39 (M:F = 4:35; mean age, 45.7 ± 12.7 years) were treated with EA + RFA. The demographic and nodule data of the patients are summarized in Table 1. The RFA group was older than the EA + RFA group (53.0 ± 15.3 vs. 45.7 ± 12.7 years, p = 0.006). The initial mean nodule

Table 1. Demographic Findings and Clinical Characteristics of the Study Population

	Ablation Type		Total (n = 243)	p-Value
	RFA Only (n = 204)	EA + RFA (n = 39)		
Age (years)	53.0 ± 15.3	45.7 ± 12.7	52.0 ± 15.2	0.006
Sex*				0.347
Male	33 (16.2)	4 (10.3)	37 (15.2)	
Female	171 (83.8)	35 (89.7)	206 (84.8)	
Location*				
Right thyroid lobe	100 (49.0)	14 (35.9)	114 (46.9)	
Left thyroid lobe	100 (49.0)	23 (59.0)	123 (50.6)	
Isthmus	4 (2.0)	2 (5.1)	6 (2.5)	
Mean diameter (cm)*	4.2 ± 2.7	4.1 ± 1.3	4.2 ± 2.6	0.961
Mean volume (mL)*	17.0 ± 17.4	19.1 ± 22.0	17.1 ± 18.2	0.506
Symptom score	2.9 ± 1.44	2.3 ± 1.27		
Cosmetic score	3.56 ± 0.79	4.0 ± 1.47		
Component				
Predominant solid	196 (96.1)	0 (0)	196 (80.7)	
Predominant cystic	8 (3.9)	39 (100)	47 (19.3)	
Total energy (J)*	50783.4 ± 32185.9	45326.3 ± 25029.6	48190.9 ± 31626.7	0.002
Electrode size (cm)*	10.0 ± 0.2	0.8 ± 0.2	10.0 ± 0.2	< 0.001
Ablation time (minutes)*	15.0 ± 7.2	10.9 ± 5.2	14.4 ± 7.1	0.001

Data are presented as mean ± standard deviation or n (%).
*Nodule based number.
EA = ethanol ablation, RFA = radiofrequency ablation

diameter and volume showed no significant difference between the groups (4.2 ± 2.7 cm vs. 4.1 ± 1.3 cm and 17.0 ± 17.4 mL vs. 19.1 ± 22.0 mL, $p = 0.961$ and 0.506, respectively). There were no statistically significant differences in sex distribution or symptomatic and cosmetic scores between the two groups. The total RFA energy was lower, and the RFA ablation time was shorter in the EA + RFA group than in the RFA group (45326.3 ± 25029.6 J vs. 50783.4 ± 32185.9 J, $p < 0.0001$ and 10.9 ± 5.2 min vs. 15.0 ± 7.2 min, $p = 0.001$, respectively).

In the RFA-only group, the majority (186 nodules, 91.2%) received the procedure only once, although it was repeated up to five times if needed (mean procedure number, 1.27 ± 0.54). In the EA + RFA group, all patients ($n = 39$, 100%) underwent one RFA session. Only six patients in this group received both ablation procedures on the same day before 2014, while the rest received EA and RFA with some extent of time interval (mean interval value, 9.23 ± 14.1 months).

The clinical outcomes of each group are summarized in Table 2. The total average follow-up period after ablation was 36.9 ± 33.4 months, with no statistical difference between the groups (RFA vs. EA + RFA: 37.3 ± 34.5 vs. 35.0 ± 25.6, $p = 0.554$). There was no statistical difference in the long-term success rate (RFA vs. EA + RFA: 90.2% vs. 97.4%, $p = 0.141$) and VRRs at the last follow-up (RFA vs. EA + RFA: 81.7 ± 21.1 vs. 90.8 ± 14.2, $p = 0.087$) between the groups. However, at long-term follow-up, the EA + RFA group showed a slightly better success rate and higher VRRs than the RFA group.

Further analysis of predominantly cystic thyroid nodules showed no clinically significant difference between long-term success rates (RFA vs. EA + RFA: 100% vs. 97.4%, $p = 0.651$) and VRRs measured during the last follow-up (RFA vs. EA + RFA: 83.1 ± 14.2 vs. 87.2 ± 16.6, $p = 0.321$). The clinical results are presented in Table 3.

In the RFA-only group, 30 patients with predominantly solid nodules and one patient with predominantly cystic nodules showed 100% VRR at the final follow-up (Figs. 1, 2). In the EA +

Table 2. Clinical Outcomes of Ablation for Mixed Cystic and Solid Thyroid Nodules

	Ablation Type		Total ($n = 243$)	p-Value
	RFA Only ($n = 204$)	EA + RFA ($n = 39$)		
Follow-up period (months)	37.3 ± 34.5	35.0 ± 25.6	36.9 ± 33.4	0.539
Long-term success* (%)	184 (90.2)	38 (97.4)	222 (91.4)	0.141
VRR at the last follow-up	81.7 ± 21.1	90.8 ± 14.2	83.1 ± 20.5	0.087

*Defined as VRR > 50% or resolution or improvement of cosmetic problems and symptoms without recurrence at the last follow-up.
EA = ethanol ablation, RFA = radiofrequency ablation, VRR = volume reduction rate

Table 3. Clinical Outcomes of Ablation for Predominantly Cystic Nodules

	Ablation Type		Total ($n = 47$)	p-Value
	RFA Only ($n = 8$)	EA + RFA ($n = 39$)		
Follow-up period (months)	18.6 ± 27.2	35.0 ± 25.6	32.1 ± 26.9	0.017
Long-term success* (%)	8 (100)	38 (97.4)	46 (97.9)	0.651
VRR at the last follow-up	83.1 ± 14.2	87.2 ± 16.6	86.5 ± 16.4	0.321

*Defined as VRR > 50% or resolution or improvement of cosmetic problems and symptoms without recurrence at the last follow-up.
EA = ethanol ablation, RFA = radiofrequency ablation, VRR = volume reduction rate

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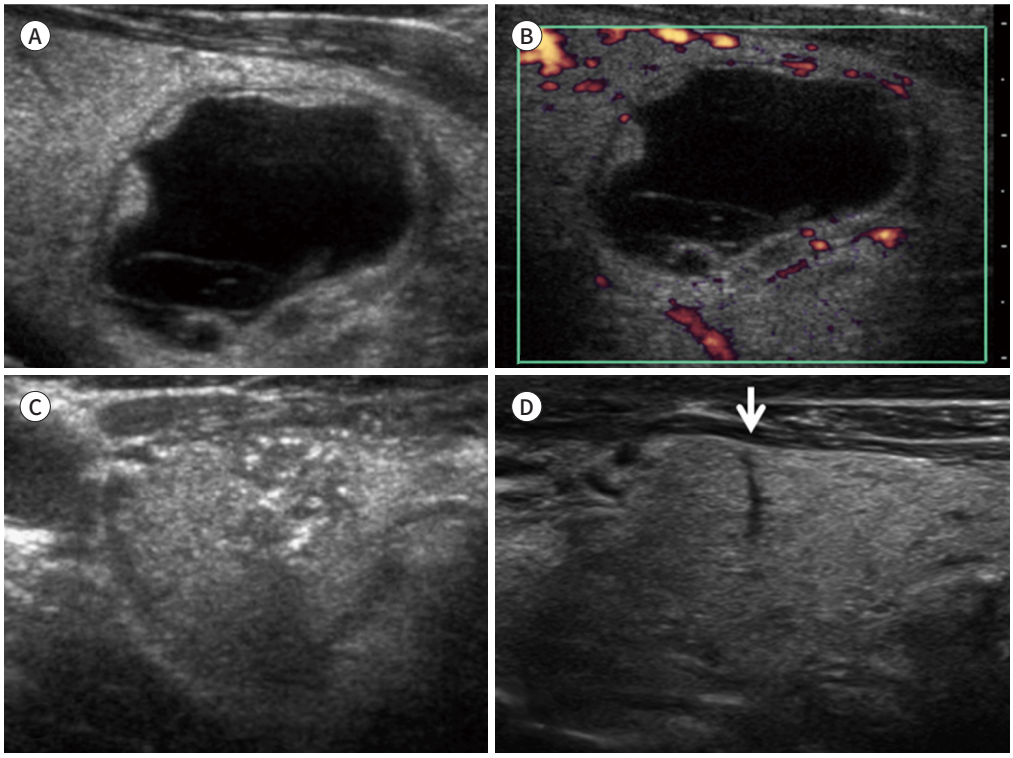
Fig. 1. A 77-year-old male who had been treated with radiofrequency ablation only for predominantly cystic benign thyroid nodule.
A-D. A predominantly cystic nodule with a 2.6-cm long diameter and a 5.4-mL volume (A) that was pathologically confirmed as a benign thyroid nodule by fine needle aspiration shows mild perinodular vascularity in the solid portion on microvascular flow scan (B). After RFA, the entire nodule becomes hyperechoic due to the vapored steam (C). At the last follow-up, 88 months after RFA, only a 2-mm sized ill-defined hypoechoic area (arrow) remains, suggesting fibrosis (D).
RFA = radiofrequency ablation



RFA group, seven of the 39 patients with predominantly cystic nodules showed 100% VRR at the final follow-up (Fig. 3).

The data on complications and side effects are shown in Table 4. In the EA + RFA group, no side effects were observed during or after ablation. In the RFA group, 35 patients (35/204, 17%) complained of side effects such as pain, nausea or vomiting, transient voice changes, chest discomfort, vasovagal symptoms, and dyspnea; moroever, 19 patients complained of transient voice changes during or immediately after RFA. All patients with transient voice changes recovered without pharmacological or interventional treatments. This might have been caused by the lidocaine. Other side effects subsided during RFA or the post-RFA observation period.

DISCUSSION

This retrospective study demonstrated that both RFA only and RFA + EA + RFA had similarly high therapeutic success rates and VRRs at the 3-month follow-up and latest long-term follow-up for mixed cystic and solid thyroid nodules and even predominantly cystic nodules. In cases with mixed cystic and solid thyroid nodules, there was no statistically significant difference in therapeutic success between RFA only group (81.7% ± 21.1% VRR at last follow-up,

Fig. 2. A 54-year-old female who had been treated with radiofrequency ablation only for predominantly solid benign thyroid nodule.
A-D. A predominantly solid nodule with a 4.1-cm long diameter and a 16-mL volume (A) that was pathologically confirmed as a benign thyroid nodule by core needle biopsy shows perinodular and mild intranodular vascularity on color Doppler image (B). After RFA, the entire nodule becomes hyperechoic with posterior acousting shadowing (C). At the last follow-up, 48 months after RFA, only an ill-defined mild hypoechoic area (arrow) remains, suggesting fibrosis (D).
RFA = radiofrequency ablation

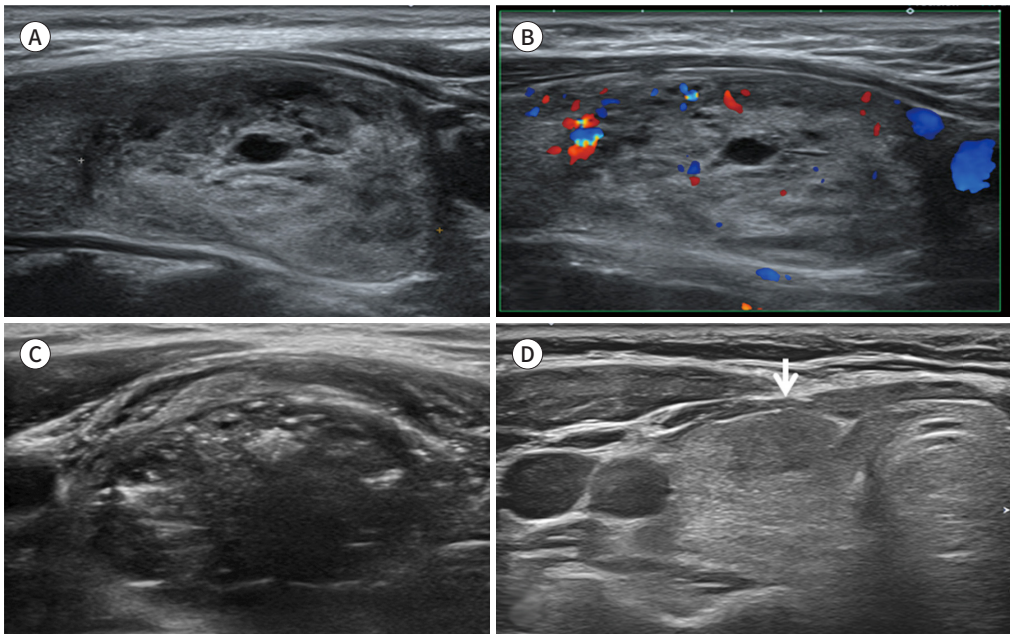


Fig. 3. A 44-year-old female who had been treated with ethanol ablation + radiofrequency ablation for predominantly cystic benign thyroid nodule.
A-E. A predominantly cystic nodule shows a 3.3-cm long diameter and a 34.3-mL volume (A) which was pathologically confirmed as a benign thyroid nodule by core needle biopsy. After EA, the cystic portion almost totally disappears (B). At 38-months follow-up after EA, the nodule shows predominantly solid appearance with more than a 50% decrease of internal cystic portions (C), and then RFA was performed (D). At the last follow-up, 27 months after RFA, only ill-defined mild hypoechoic area (arrow) remains, suggesting fibrosis (E).
EA = ethanol ablation, RFA = radiofrequency ablation

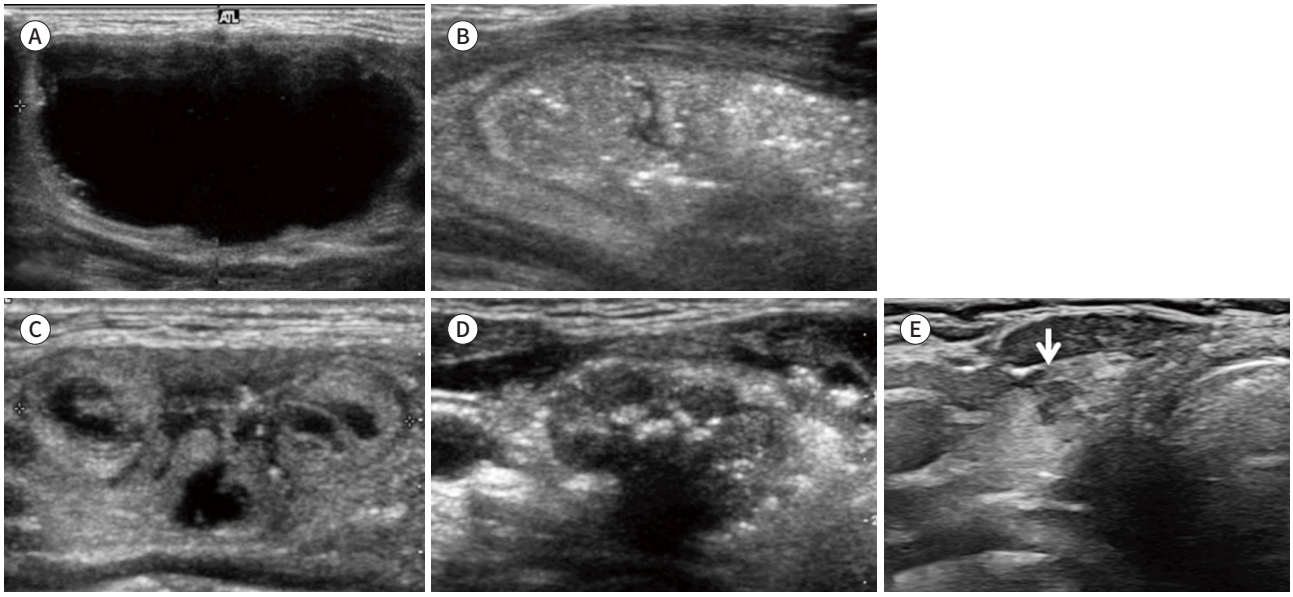


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Table 4. Complications and Side Effects of Ablation of Mixed Cystic and Solid Thyroid Nodules

Complications	SIR Class	Total (*n* = 243)	RFA Only (*n* = 204)	EA + RFA (*n* = 39)
Side effects*				
Pain	N/A	9	9	0
Vomiting or nausea	N/A	4	4	0
Voice change (transient)	N/A	19	19	0
Chest discomfort	N/A	1	1	0
Vasovagal symptom	N/A	1	1	0
Dyspnea	N/A	1	1	0

*Nodule based number.
EA = ethanol ablation, N/A = not applicable, RFA = radiofrequency ablation, SIR = Society of Interventional Radiology

90.2% long-term success rate) and the EA + RFA group (90.8% ± 14.2% VRR at last follow-up, 97.4% long-term success rate) (Table 2). In cases with predominantly cystic thyroid nodules, there was no statistically significant difference between the RFA-only group (83.1% ± 14.2% VRR at last follow-up, 100% long-term success rate) and the EA + RFA group (87.2% ± 16.6% VRR at last follow-up, 97.4% long-term success rate) (Table 3). No major or minor complications requiring treatment during the procedure or follow-up were observed in either group. Hence, RFA and EA + RFA are effective and safe treatments for mixed cystic and solid thyroid nodules, respectively.

RFA-only therapy is considered a more cost-effective treatment option for mixed cystic and solid benign thyroid nodules. The EA + RFA group showed slightly higher VRRs at the last follow-up and slightly better long-term success rates. This group also demonstrated a significantly shorter ablation time and lower total energy of ablation than the RFA-only group for treating mixed cystic and solid thyroid nodules. Therefore, if the patient's economic situation permits accessibility to the hospital, the operator may treat mixed cystic and solid thyroid nodules with greater stability by performing EA before RFA based on sufficient consideration of procedural difficulty, such as nodule size and the bleeding tendency of nodules.

A previous study comparing the efficacy of RFA and EA in the treatment of mixed or sponge-type benign thyroid nodules also found that both treatment techniques were similarly effective in terms of VRR, with a VRR of 70.7% at the 6-month follow-up after EA and 80.1% after RFA (27). Another study by Kim et al. (13) achieved 65% VRR when treating cystic nodules with EA. In a study by Lee et al. (28), the VRRs were > 50% at the first follow-up (68.33% vs. 66.85%) and last follow-up (83.68% vs. 84.01%) in patients with cystic and predominantly solid nodules, respectively. Our study showed better VRRs than did other studies on the ablation treatment of mixed cystic and solid thyroid nodules. These seemingly improved results might be due to two reasons: first, we evaluated the treatment efficacy of combination therapy (EA + RFA), and second, two or more RFA sessions were performed in the RFA-only group according to the individual clinical need.

A previous large multicenter study on RFA by Baek et al. (25) reported a major complication rate of 3.3%, with voice changes being the most common complication. Another meta-analysis of RFA by Muhammad et al. (29) reported a major complication rate of 1.3%. Meanwhile, many studies on EA have reported no major complications (8, 30-33), except for a

retrospective study by Cho et al. (17), who observed a major complication rate of 8.2% for single-session EA. In this study, few side effects were observed in the RFA-only group and none in the EA + RFA group. Furthermore, pretreating the nodule with EA before RFA reduced the complication rate by significantly decreasing the size of the nodule, thereby reducing the ablation time and ensuring a safe distance between the nodule and important structures near the thyroid gland. However, treating large nodules with only RFA posed the possibility of complications due to the long ablation time and nodule proximity to critical structures such as the nerves, trachea, and esophagus.

According to previous studies, the proportion of the solid component of a nodule is a major predictive factor for EA success (15, 33). The greater the proportion of the solid component, the more resistant the nodule is to EA; the vessels inside the solid portion drain ethanol, decreasing EA's therapeutic efficacy (34). Large mixed cystic and solid nodules may have larger solid component volumes compared to small mixed cystic and solid nodules. However, some large mixed cystic and solid nodules were composed entirely of cystic matter. Therefore, the ablation technique must be selected according to the volume of the solid component within mixed cystic and solid thyroid nodules.

This study has several limitations. First, the clinical outcomes and cosmetic problems were evaluated according to the patients' subjective complaints and were not based on objective and quantifiable measurements. Second, RFA was performed by only one skilled radiologist; hence, the results might have been biased because we were unable to compare the efficacy of the treatments performed by other physicians with various skills and proficiency levels. Third, this was a single-center retrospective study, and the number of patients who underwent combination therapy (EA + RFA) was small (39 nodules, 16%). Further large-scale prospective studies are required to determine the best treatment methods and sequences. Finally, we included only 6 patients who underwent EA + RFA simultaneously. Owing to the small group size, we could not evaluate the differences between patients who underwent EA and RFA simultaneously or a few months later.

In conclusion, this study showed that both RFA and EA + RFA are effective and safe treatment options for mixed cystic and solid benign thyroid nodules.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization, J.M.G., L.M.K., S.J.H.; data curation, J.M.G., L.M.K., J.S.L.; formal analysis, J.M.G., L.M.K.; investigation, L.M.K., J.S.L.; methodology, J.M.G., L.M.K., J.S.L.; resources, L.M.K., J.S.L.; software, L.M.K., S.J.H., S.M.G.; supervision, L.M.K., J.S.L.; validation, J.S.L.; visualization, J.M.G., L.M.K., S.M.G.; writing—original draft, J.M.G., L.M.K.; and writing—review & editing, S.J.H., S.M.G., J.S.L.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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Funding

None

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낭성 및 고형성 혼합 갑상선 결절 치료에서 고주파 절제술 단독요법과 에탄올 절제 후 고주파 절제술 요법의 유효성 및 안전성 비교

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목적 본 연구는 낭성 및 고형성 혼합 갑상선 결절 치료에서 고주파 절제술 단독요법과 에탄올 절제 후 고주파 절제술 요법의 유효성 및 안전성을 비교하고자 하였다.

대상과 방법 본 연구는 초음파 유도 하 조직검사에서 양성으로 확인된 243개의 낭성 및 고형성 혼합 갑상선 결절을 대상으로 진행됐으며, 243개의 결절은 243명의 환자로부터 진단되었다. 연구 대상이 된 결절들은 고주파 절제술 단독요법과 에탄올 절제 후 고주파 절제술 요법을 받은 군의 두 군으로 나누어 분류됐다. 본 연구는 각 군에서의 시술 후 부피 감소율, 치료 성공률, 증상 및 미용 문제의 개선 정도를 평가하였다. 또한 시술 후 연관된 합병증이나 부작용이 발생하였는지 확인하였다.

결과 고주파 절제술 단독 요법 군에는 204명의 환자가 포함되었고, 에탄올 절제 후 고주파 절제술 요법 군에는 39명의 환자가 포함되었다. 단독요법군과 혼합요법 군에서 최종 추적 검사 시 평균 부피 감소율은 각각 81.6%와 87.2%였다. 두 군에서의 장기적 치료 성공률은 각각 90.2%와 97.4%였다. 치료 결과는 마지막 추적 관찰 시기에서 두 군에서 유사하게 나타났다. 대부분 낭성 결절에 국한된 추가 분석에서도 두 군 간에 치료 효과에 있어 유의미한 차이가 없었다. 증상 및 미용적 문제는 두 군에서 모두 현저하게 개선되었다. 시술 후 연관된 큰 합병증은 두 군 모두에서 발생하지 않았다.

결론 에탄올 절제 후 고주파 절제술 혼합 요법이 고주파 절제술 단독요법에 비해 약간 더 나은 치료 방법이지만, 두 치료 요법 모두 낭성 및 고형성 혼합 결절의 치료에 안전하고 효과적인 방법이다.

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