

Combined Percutaneous Ethanol Injection and Radiofrequency Ablation for a Large Recurrent Cystic Thyroid Nodule

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A B S T R A C T

Large predominantly cystic thyroid nodules often respond well to percutaneous ethanol injection (PEI); however, cases with substantial residual solid components may require adjunctive treatment. This case study illustrates the clinical utility of combining PEI and radiofrequency ablation (RFA) to achieve optimal therapeutic outcomes in a patient with a symptomatic, compressive thyroid nodule not amenable to PEI alone. A 57-year-old male presented with a >180 mL predominantly cystic thyroid nodule causing dysphagia and neck discomfort. Ultrasound-guided aspiration and PEI were performed multiple times, however the nodule repeatedly reaccumulated fluid. Given the suboptimal response, the patient underwent a subsequent session of RFA targeting the solid nodule portion followed by repeat PEI. Over a 12-month follow-up, the nodule volume decreased by >95% and the patient experienced complete resolution of symptoms without adverse effects. This case demonstrates that combined PEI and RFA therapy is a safe and effective strategy for managing large predominantly cystic thyroid nodules when PEI alone is insufficient. The synergistic use of PEI for the cystic portion followed by RFA for residual solid tissue may offer a valuable non-surgical alternative even in very large nodules for selected patients.

Keywords: Thyroid nodule; Percutaneous ethanol injection; Radiofrequency ablation; Thermal ablation

Introduction

Recurrent large thyroid nodules present a clinical challenge, particularly when conventional surgical or ablative options are limited due to anatomical complexity or patient comorbidities. In such cases, a combined minimally invasive approach using radiofrequency ablation (RFA) and percutaneous ethanol injection (PEI) has shown promise. RFA offers effective debulking of solid components, while PEI enhances treatment efficacy by targeting residual cystic or vascular regions, reducing recurrence risk. This case study explores the synergistic benefits of combining RFA and PEI for managing a large, recurrent thyroid nodule that was not responsive to PEI alone, highlighting

improved volume reduction, symptom relief and procedural safety.

Case Presentation

56-year-old male presented to the clinic for rapidly enlarging thyroid cystic nodule for the prior year. He was experiencing neck discomfort especially when bending his neck forward that was worsening. He underwent multiple aspirations of this nodule and fine needle aspiration (FNA) biopsy performed twice was negative for malignancy. He wanted to avoid surgery if possible.

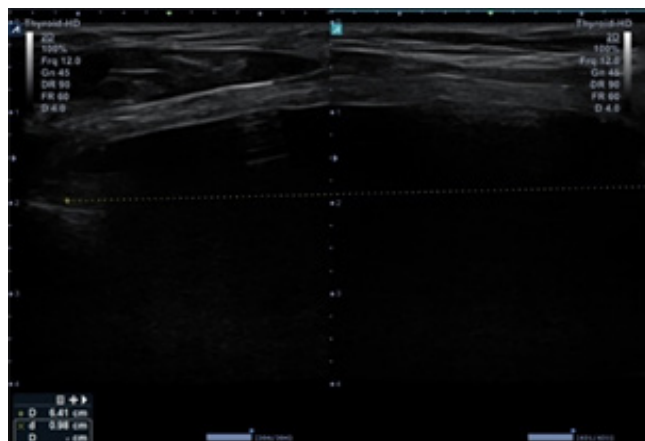
Diagnostic assessment

Baseline evaluation and ultrasound were performed in the

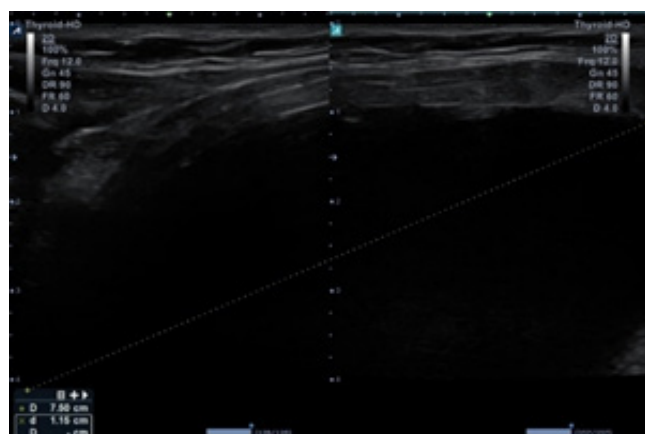
office (**Figure 1**).



a) Photo



b) Ultrasound image - AP and transverse view



c) Ultrasound image – lateral view

Figure 1: Baseline images before intervention.

Treatment

After initial consultation and review of all the potential treatment options, the decision was made to aspirate the cystic nodule and perform percutaneous ethanol injection. The cystic fluid rapidly re-accumulated. FNA and PEI were repeated two additional times, aspirating 150 mL and 120 mL respectively. The decision was made to repeat aspiration and perform RFA concentrating on the complex areas adjacent to the walls of the nodule that were not easily visible before aspiration. The amount of energy delivered was up 50 mHz with an active ablation time of 20 minutes and 38 seconds.

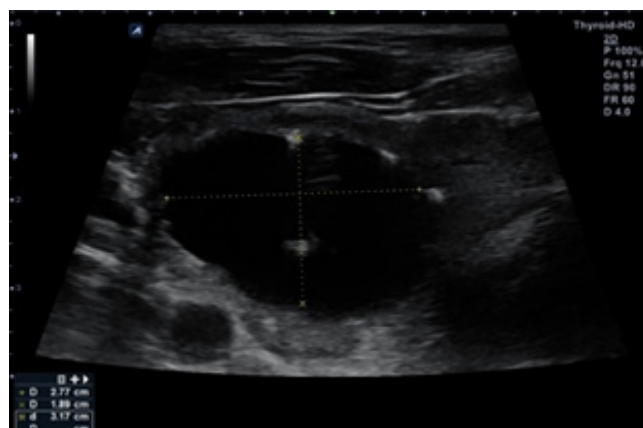
Outcome and follow-up

At one month follow-up, the patient noted significant improvement in neck discomfort. The patient was seen in follow

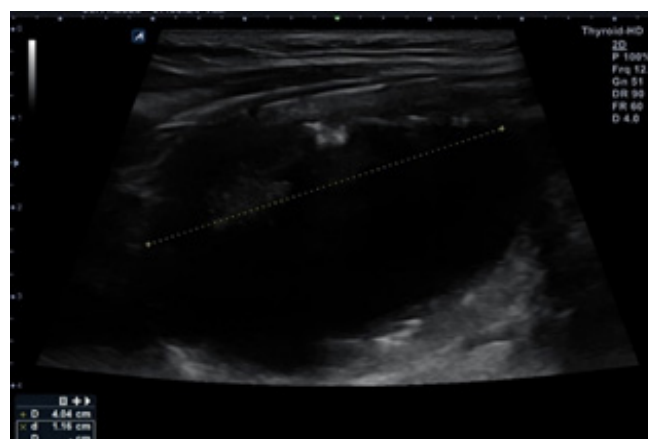
up at three and six months. At twelve-month follow-up of RFA the nodule remains stable to decreased in size to approximately 10 mL, significantly decreased in size by more than 95% from baseline status post RFA and PEI (**Figure 2**). His thyroid function tests remained normal. Discussion was made regarding repeat intervention, but since the patient was so pleased with his status, the decision was made to re-evaluate in one year with repeat ultrasound.



a) Photo



b) Ultrasound image – AP and transverse view



c) Ultrasound image – lateral view

Figure 2: Images one-year post-PEI and RFA.

Discussion

Thyroid nodules are discrete lesions within the thyroid gland that are radiologically distinct from the surrounding parenchyma and are a common clinical finding, with a prevalence ranging from 20% to 76% depending on the population and detection method used¹. While most thyroid nodules are benign, approximately 5% to 15% may be malignant, necessitating careful evaluation

through physical examination, thyroid function testing, ultrasonography and fine-needle aspiration cytology². Risk factors for the development of nodules include iodine deficiency, radiation exposure, advancing age and female sex³. Most benign nodules are non-functional and asymptomatic; however, they may cause compressive symptoms or cosmetic concerns in some patients. Management strategies vary based on size, growth, cytological characteristics and patient preference, ranging from active surveillance to surgical removal. Understanding the pathophysiology and optimal diagnostic approaches is essential for effective and individualized treatment planning.

Treatment options for thyroid nodules depend on the nodule's size, functional status, cytological findings and malignancy risk. Benign, asymptomatic nodules without compressive features are typically managed with observation and periodic ultrasound monitoring⁴. In cases of nodular hyperfunction, such as toxic adenomas or multinodular goiter, treatment options include radioactive iodine therapy, antithyroid medications or surgery, depending on symptom severity, patient age and comorbidities⁵. Surgical intervention, typically via lobectomy or total thyroidectomy, is recommended for nodules with suspicious cytology, rapid growth or confirmed malignancy⁶. Minimally invasive techniques such as ultrasound-guided PEI or RFA are alternatives for patients with symptomatic benign nodules, toxic nodules, some papillary thyroid cancers and for patients who are poor surgical candidates or wish to avoid surgery⁷. The therapeutic approach must be individualized, weighing the risks and benefits of each modality within the context of the patient's overall health, nodule characteristics and preferences.

Non-surgical options for managing benign thyroid nodules have gained increasing attention as effective and less invasive alternatives to thyroidectomy, particularly in patients seeking to preserve thyroid function and avoid surgical risks. These approaches have demonstrated substantial efficacy in reducing nodule volume and alleviating compressive symptoms. Such interventions are especially valuable in treating cystic or solid nodules that are symptomatic or cosmetically concerning but histologically benign. Compared to surgery, these techniques offer the advantages of minimal downtime, low complication rates and cost-effectiveness, aligning with current trends toward precision and personalized thyroid care⁸.

PEI is a minimally invasive, ultrasound-guided treatment used primarily for benign cystic or predominantly cystic thyroid nodules. The procedure involves injecting 95-99% ethanol directly into the nodule to induce cellular dehydration, coagulative necrosis and vascular thrombosis, leading to volume reduction and symptomatic relief⁹. PEI is particularly effective for recurrent thyroid cysts that reaccumulate fluid after aspiration, with reported volume reductions of up to 85-90% and low recurrence rates¹⁰. Compared to surgery, PEI offers advantages such as preservation of thyroid function, minimal risk of complications and reduced healthcare costs. However, its efficacy in solid or malignant nodules is limited and multiple sessions may be required for optimal outcomes. Complications are generally rare and mild, including transient pain, voice changes or local inflammation.

RFA is an image-guided, minimally invasive procedure increasingly used for the treatment of benign thyroid nodules, particularly those causing compressive symptoms or cosmetic

concerns. It involves the application of high frequency alternating current via an electrode to generate localized heat, inducing thermal coagulative necrosis and progressive shrinkage of nodule tissue. RFA has demonstrated excellent efficacy in reducing nodule volume-typically by 50-90% over 6-12 months-with significant improvements in symptom and cosmetic scores¹¹. Unlike surgical resection, RFA preserves thyroid function, avoids general anesthesia and is associated with a low risk of complications, such as transient voice changes or hematoma. It is now endorsed by international guidelines, including the Korean Society of Thyroid Radiology and the European Thyroid Association, as a first-line treatment for appropriate benign nodules¹². Ongoing research is also exploring its role in selected low-risk papillary thyroid microcarcinomas.

The combined use of PEI and RFA has emerged as a promising strategy for the management of complex thyroid nodules, particularly those with both solid and cystic components or those that are partially recurrent after single-modality treatment¹³. PEI is highly effective for aspirating and sclerosing cystic portions of nodules, while RFA is better suited for ablating solid tissue. When used sequentially-typically with PEI applied first to manage the cystic part followed by RFA for the solid portion-the combined approach enhances overall volume reduction, minimizes recurrence and improves symptom and cosmetic outcomes¹⁴. Studies have shown that this synergistic technique can achieve greater efficacy than either modality alone, particularly for predominantly cystic nodules with residual solid tissue¹⁵. Additionally, the combination may help avoid surgery in selected patients, preserving thyroid function, reducing the risk of complications and increasing patient satisfaction. Microwave ablation (MWA) shows equally effective results in similar cases and could be an alternative to RFA¹⁶. Although in this case study, RFA was only performed on one occasion, this patient's success demonstrates the additive benefits of PEI with RFA over time in challenging nodules.

Learning points

Combination therapy enhances efficacy in complex nodules:

Using RFA and PEI in tandem can be especially beneficial for large, mostly cystic or recurrent thyroid nodules that do not respond well to PEI alone. PEI targets the cystic component effectively, while RFA ablates the solid portion, offering a more complete and sustained reduction in nodule volume.

Minimally invasive alternatives reduce surgical burden:

For patients who are poor surgical candidates or prefer non-surgical approaches, the combined use of PEI and RFA provides a safe, outpatient-based solution with fewer complications, quicker recovery and preservation of thyroid function.

Treatment must be individualized based on nodule composition and recurrence:

Assessment of the nodule's size, cystic-to-solid ratio and prior treatment response is critical in planning a tailored approach. This case highlights the importance of adapting the treatment modality to optimize long-term outcomes and minimize recurrence.

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Contributors

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Disclosures

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Informed Patient Consent for Publication

Signed informed consent was obtained directly from the patient.

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