Radiofrequency Ablation in the Treatment of Benign Thyroid Nodules: An Efficient and Safe Alternative to Surgery

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ABSTRACT

Purpose: To evaluate the efficacy and safety of radiofrequency (RF) ablation in the treatment of benign thyroid nodules (BTNs) by applying a modification of the moving-shot technique.

Materials and Methods: Fifty-one BTNs in 46 patients for whom surgery was contraindicated or who refused surgery were treated with RF ablation: 31 had lesion volumes < 20 cm^3 (group A) and 20 had volumes ≥ 20 cm^3 (group B). The solid component percentage of each lesion was assessed, and any present fluid component was aspirated. Symptomatic scores and cosmetic scores (CSs) were assessed. All RF ablations were performed under ultrasound (US) guidance with an 18-gauge electrode. Treatment response was evaluated by contrast-enhanced US at 6-month intervals for 18 months in group A. In group B, after the 6- and 12-month follow-up assessments, a second treatment was performed in selected cases, and the 6-month contrast-enhanced US follow-up was started again. Volume reduction rate (VRR) was evaluated at each follow-up examination.

Results: No permanent paralysis of the laryngeal nerve was observed; 2 patients experienced transient hoarseness. In all nodules treated with a single RF ablation session, the VRRs at 6, 12, and 18 months were 69.4%, 78.7%, and 84% in group A, respectively, and 66.6%, 79.4%, and 81.5% in group B, respectively. The VRRs of group B nodules treated with a second RF ablation procedure (n = 6) were 86.4% and 88.2% at 6 and 12 mo after the second treatment, respectively. All patients reported symptom relief and CS improvement.

Conclusions: RF ablation is a reliable alternative to surgery in patients affected by BTNs and can be safely repeated in selected cases.

ABBREVIATIONS

BNT = benign thyroid nodule, CS = cosmetic score, RF = radiofrequency, SS = symptomatic score, VRR = volume reduction rate

Surgery is the gold-standard treatment of symptomatic goiter (1,2). However, in the case of benign thyroid nodules (BTNs) with compressive symptoms, surgical intervention may be harmful as a result of important comorbidities or difficult intubation because of extrinsic tracheal compression by the goiter (3).

Since 1998 (4), several papers (5–10) have been published on radiofrequency (RF) ablation as a minimally invasive alternative treatment for thyroid nodules, demonstrating the efficacy and safety of RF ablation in the treatment of nonfunctioning or autonomously functioning BTNs. The efficacy of RF ablation is based on the ability of hyperthermia to induce tissue coagulative necrosis and fibrotic changes to reduce thyroid nodule volume, whereby local symptoms and cosmetic concerns improve and thyroid function normalizes (11). To obtain more precise ablations and to improve efficacy and safety, thyroid RF ablation evolved almost immediately from the use of multitined "fixed" expandable 14-gauge electrodes (7,12) to that of straight, internally cooled electrodes that are sequentially moved within the nodule to achieve complete ablation.

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Conventionally, in benign disease, the technique applied is the moving-shot technique with a transisthmic approach (5–6,13–16). The moving-shot technique consists of subdividing the thyroid nodules into multiple small conceptual ablation units to perform RF ablation unit by unit by moving the electrode. The conceptual units are smaller at the periphery of a nodule and larger in the center of a nodule or in regions remote from critical structures (17). The electrode tip moves slowly but continuously to prevent the RF ablation cutoff phenomenon. Then, when an echogenic area is detected at the tip of the electrode, the electrode tip is pulled along the long axis of the electrode itself. Finally, the electrode tip is superficially repositioned in the long axis of the electrode and pulled along it again (18). This technique has some disadvantages: it requires multiple insertion points and a mandatory approach in a mediolateral direction under a transverse ultrasound (US) view.

The aim of the present study was to further investigate the role of RF ablation in the nonsurgical treatment of thyroid nodules by assessing the efficacy and safety of US-guided RF ablation in the treatment of symptomatic BTNs. A modified moving-shot technique was applied, which consists of a radial movement of the electrode performed on an anteroposterior US view, together with the transisthmic approach performed on a transverse US view.

MATERIALS AND METHODS

This prospective single-institution study was approved by the institutional review board, and written informed consent was obtained from all patients.

Patients

Fifty-one nodules in 46 patients (31 female, 15 male; mean age, 56.4 y ± 11.3; range, 26–74 y) were treated with US-guided RF ablation. In 2 patients, the surgical treatment option was excluded as a result of marked reduction of tracheal caliber, which did not allow safe intubation; 7 patients were classified as status IV according to the American Society of Anesthesiologists; therefore, the conscious sedation needed for RF ablation was deemed preferable. In the remaining 37 cases, the patients refused surgery for various reasons.

Nodule inclusion criteria were benign disease (THYR 2) (19) that was proven by biopsy repeated on 2 occasions (the second one within 1 y before RF ablation), whole visualization by US examination with a linear 7.5-MHz probe or convex 3.5-MHz probe in selected cases (MyLab Twice, Esaote, Italy), and no retrosternal or intrathoracic extension. During the assessment stage, it was decided to divide the nodules according to their size based on the evidence that treatment efficacy, in terms of volume reduction, is dependent on the pretreatment volume of the nodule (20). The 20-cm^3 cutoff was established based on the fact that RF ablation yields better results if the nodule volume is less than 20 cm^3 (21). Patients with nodules larger than 20 cm^3 may require more than 1 RF ablation session or, whenever possible, surgery as the first-line treatment option (11). Thirty-one nodules were smaller than 20 cm^3 (group A), whereas 20 nodules were equal to or larger than 20 cm^3 (group B).

Preablation Assessment

All patients were evaluated by B-mode US and contrast-enhanced US examinations. The solid component percentage of the nodule, defined as the nodular component showing contrast enhancement by contrast-enhanced US examination, was evaluated. When BTNs showed a mixed structure (ie, fluid and solid) by B-mode US, a preliminary aspiration of the main fluid component was performed to obtain predominantly solid lesions (solid component $>$ 75% by contrast-enhanced US). Finally, the volume of each nodule was calculated before RF ablation according to the ellipsoid formula: $V = \pi abc/6$ (where V is volume, a is the largest diameter, and b and c the 2 other orthogonal diameters).

A symptomatic score (SS) was also evaluated (22): all patients were asked to grade their neck compression discomfort on a scale ranging from 0 to 10. A physician recorded a cosmetic score (CS) (22) as follows: 1, no palpable mass; 2, invisible but palpable mass; 3, mass visible on swallowing only; and 4, easily visible mass.

Procedure

RF ablation was performed under conscious sedation after a local US-guided lidocaine injection to achieve thyroid capsular anaesthesia. All RF ablations were performed with a VIVA RF generator (STARmed, Seoul, South Korea) and an 18-gauge internally cooled, single-tipped electrode with a 10-mm active tip. Under US guidance, RF ablation was performed by using the modified moving-shot technique. The conventional moving-shot technique requires the electrode to be completely removed and reinserted several times into the isthmic region to ablate the nodule (5,6,23). To avoid the entry-point constraint and the multiple insertions and removals of the electrode from the skin, a radial movement of the electrode was used in posterior-anterior and lateral-medial directions. This approach also allows a reduction of the constraints of US guidance: the previously mandatory transversal US view can be replaced with an anteroposterior US view, which allows selection of the shortest pathway to the nodule and the deepest placement into the nodule.

During the procedure, RF power was applied in a range from 30 to 50 W. The impedance was automatically measured by the system to precisely monitor the power deposition within the nodule and to avoid tissue carbonization. Impedance was the parameter used to guide the operator in moving back the electrode from the deepest part to the superficial part of the nodule. The treatment continued by changing the angle of the electrode axis and inserting it again into the deepest part of the nodule without removing the electrode from the insertion point (**Fig 1**).