CLINICAL STUDY

US-Guided Percutaneous Microwave Ablation for Primary Hyperparathyroidism with Parathyroid Nodules: Feasibility and Safety Study

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ABSTRACT

Purpose: To test the feasibility, safety, and efficacy of microwave (MW) ablation for primary hyperparathyroidism (pHPT) in patients who are unsuited or unwilling to undergo surgery.

Materials and Methods: Fifteen patients with benign parathyroid nodules were treated with MW ablation. Ultrasound, laboratory data, and clinical symptoms were evaluated before treatment; 1 week and 1, 3, 6, and 12 months after treatment; and every 6–12 months thereafter.

Results: All patients were followed up for more than 1 year, with an average duration of 32.8 months ± 17.9. Eleven patients underwent successful ablation in a single session, and two patients with bilateral disease and two patients with residual disease were treated with two sessions each. The rate of complete nodule disappearance was 17.6%. Nodule volume and serum parathyroid hormone (PTH) and calcium levels were significantly lower at the last follow-up than before treatment (volume, 0.39 cm^3 ± 0.69 vs 2.62 cm^3 ± 3.32; PTH, 54.5 pg/mL ± 24.1 vs 592.5 pg/mL ± 579.1; and calcium, 2.32 mmol/L ± 0.12 vs 2.93 mmol/L ± 0.47; $P < .01$). Treatment was well tolerated. Minor complications included transient voice change in one patient.

Conclusions: MW ablation is a safe and effective technique for the treatment of pHPT. It is a good alternative for patients who do not meet surgery criteria or decline surgery.

ABBREVIATIONS

CNB = core needle biopsy, pHPT = primary hyperparathyroidism, PTH = parathyroid hormone, RF = radiofrequency

Primary hyperparathyroidism (pHPT) is the third most common endocrine disorder, with its highest incidence being in postmenopausal women. In pHPT, in the absence of a known or recognized stimulus, one or more of the four parathyroid glands secrete excess parathyroid hormone (PTH), resulting in hypercalcemia. Single-gland adenoma is the most common cause (75%–85%), multigland adenoma arises in a substantial proportion (two glands in 2%–12% of cases, three glands in < 1%–2%, and four or more in < 1%–15%), and parathyroid carcinoma is rare (~1%) (1).

The standard therapy for pHPT is surgical removal of a parathyroid adenoma or adenomas (1). It is estimated that experienced surgeons identify an affected gland in 95% of cases. However, the morbidity and mortality associated with parathyroid surgery are increased in elderly patients (2,3). Minimally invasive parathyroidectomy can have advantages in an elderly population at

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None of the authors have identified a conflict of interest.

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J Vasc Interv Radiol 2016; XX:∎∎∎–∎∎∎

http://dx.doi.org/10.1016/j.jvir.2016.02.013

risk with general anesthesia and full neck exploration. It requires initial image localization (with technetium-99m [^{99m}Tc] sestamibi imaging, ultrasound [US], computed tomography [CT], magnetic resonance imaging, or a combination thereof) to identify the adenoma, as well as intraoperative PTH measurement to confirm adenoma removal (4,5). However, localization techniques are less successful for investigation of patients with mild hypercalcemia and in identification of multiple glands (6). Therefore, some elderly patients may be unsuitable for surgery, and others with considerations about cost, expedited recovery, and scar formation may refuse surgery. This explains the considerable interest in identifying therapeutic alternatives to surgery for pHPT.

Microwave (MW) ablation is a minimally invasive technique that has been used to treat benign and malignant tumors of the liver, kidney, adrenal gland, spleen, and lung by inducing tissue necrosis via heat (7–12). Recently, many centers have attempted to apply the technique to debulk benign thyroid nodules and recurrent papillary thyroid carcinomas and achieved good results (12–14). Parathyroid nodules have similar anatomic position and US imaging characteristics as thyroid nodules, which inspired us to propose the idea to use MW ablation to treat pHPT.

The aim of the present study was to evaluate the feasibility, safety, and efficacy of MW ablation for the treatment of pHPT in patients who were ineligible for surgery or refused surgery.

MATERIALS AND METHODS

This retrospective study was approved by our local ethical committee, and written informed consent was obtained from every patient before the procedure.

Study Cohort

From 2011 to 2014, a total of 15 patients (six men and nine women; mean age, 55.6 y ± 14; age range, 32–82 y; 13 patients with a single lesion located in one side of the neck and two with two lesions located in both sides of the neck) were treated with US-guided MW ablation in our department. Patients were enrolled if they fulfilled the following criteria: age > 18 years, diagnosis of pHPT on the basis of recommendations proposed by the International Workshop on Primary Hyperparathyroidism (15), biopsy results confirmed as benign parathyroid adenoma or hyperplasia by US-guided core needle biopsy (CNB), largest lesion diameter < 45 mm, lack of suitability or willingness to undergo surgery, and follow-up for at least 1 year after last ablation. The baseline characteristics of the parathyroid nodules (largest diameter, volume, proportion of solid component, and vascularity), and patients' serum PTH and calcium levels are summarized in **Table 1**.

Equipment

The MW unit (KY-2000; Kangyou Medical, Nanjing, China) consists of an MW generator, a flexible low-loss coaxial cable, and a cooled-shaft antenna. The generator is capable of producing 1–100 W of power at 2,450 MHz in pulse or continuous form. The MW antenna is a 16-gauge needle (1.9 mm in diameter and 3 mm or 5 mm in length) coated with polytetrafluoroethylene to prevent adhesion. To prevent shaft overheating, distilled water is circulated through dual channels inside the antenna shaft, continuously cooling the shaft.

Sonograms of parathyroid nodules (including two-dimensional, color Doppler US and contrast US images) were obtained by using a HI VISION Preirus system (Hitachi Aloka Medical, Tokyo, Japan) before ablation and at each follow-up. A real-time 5–13-MHz transducer was used. SonoVue (Bracco, Milano Italy) was used as a contrast agent. The contrast/low mechanical index 0.18 mode was applied to obtain contrast-enhanced sonographic perfusion maps for the region of interest.

Procedure

All treatments were performed as outpatient procedures by an experienced radiologist who had been performing US, CNB, and MW ablation for clinical care for 3 years. Before ablation, an intravenous access was obtained via an antecubital vein. Patients were placed in a supine position with their neck extended. Local anesthesia with 2% lidocaine was obtained subcutaneously. For mixed/mainly cystic nodules, ablation was performed after cyst aspiration. For parathyroid nodules with rich color-flow signals on color Doppler imaging, the "vascular pedicle ablation" technique was applied before ablation. The MW antenna was placed into the corresponding colored area to ablate the main feeding vessel until the apparent color flow around the parathyroid nodule disappeared, as shown in **Figure 1**.

The hydrodissection technique (16–18) was then performed. With US guidance, physiologic saline solution was injected into the region between the parathyroid nodule and vital structures of the neck (carotid artery, trachea, esophagus, nerve, and thyroid) to achieve a > 5-mm liquid-isolating region (**Fig 1**). Then, under US guidance, the nodule was localized and divided into multiple small conceptual ablation units, and an optimal approach was determined to minimize thermal injury to surrounding critical structures.

The antenna was then placed into the parathyroid nodule along its longest axis in the optimal direction, followed by ablation using the "moving-shot" technique (19–21). The antenna tip was initially positioned in the deepest and most remote portion of the nodule, after which it was moved backward to the superficial and nearest portion. During MW ablation, a power output of 40 W was usually used. The ablation power and time and the antenna location were regulated according to the