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

Can Liu, MB, Bin Wu, MD, Pintong Huang, MD, Qian Ding, MM, Lei Xiao, MB, Mei Zhang, MB, and Jing Zhou, MD

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. 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, $0.39 \text{ cm}^3$ vs $2.62 \text{ cm}^3$; PTH, 54.5 pg/mL vs 592.5 pg/mL; and calcium, 2.32 mmol/L vs 2.93 mmol/L; $P < .01$). 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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risk with general anesthesia and full neck exploration. It requires initial image localization (with technetium-99m [99mTc] 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 sono- graphic 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
Table 1. Baseline Characteristics of Initial Parathyroid Nodules and Patients’ Serum PTH and Calcium Levels before Ablation and at Last Follow-up

<table>
<thead>
<tr>
<th>Pt. No./Age (y)/Sex</th>
<th>Adenoma Location</th>
<th>Largest Diameter (mm)</th>
<th>Size (mm)</th>
<th>Solid Component (%)</th>
<th>Vascularity</th>
<th>No. of Sessions</th>
<th>Serum PTH (pg/mL)</th>
<th>Calcium (mmol/L)</th>
<th>Serum PTH (pg/mL)</th>
<th>Calcium (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/50/M</td>
<td>Superior right</td>
<td>17</td>
<td>17 × 12 × 9</td>
<td>100</td>
<td>3</td>
<td>1</td>
<td>761</td>
<td>4.56</td>
<td>48</td>
<td>2.45</td>
</tr>
<tr>
<td>2/37/F</td>
<td>Inferior right</td>
<td>21</td>
<td>21 × 15 × 12</td>
<td>100</td>
<td>2</td>
<td>2</td>
<td>267</td>
<td>2.72</td>
<td>35</td>
<td>2.35</td>
</tr>
<tr>
<td>3/62/M</td>
<td>Inferior right</td>
<td>30</td>
<td>30 × 26 × 21</td>
<td>100</td>
<td>4</td>
<td>1</td>
<td>2146</td>
<td>2.83</td>
<td>124</td>
<td>2.3</td>
</tr>
<tr>
<td>4/68/F</td>
<td>Inferior right</td>
<td>18</td>
<td>18 × 13 × 9</td>
<td>100</td>
<td>4</td>
<td>1</td>
<td>145.2</td>
<td>2.91</td>
<td>76</td>
<td>2.27</td>
</tr>
<tr>
<td>5/65/F</td>
<td>Inferior left</td>
<td>26</td>
<td>26 × 15 × 12</td>
<td>100</td>
<td>2</td>
<td>1</td>
<td>267</td>
<td>2.7</td>
<td>24</td>
<td>2.18</td>
</tr>
<tr>
<td>6/34/F</td>
<td>Inferior right</td>
<td>22</td>
<td>22 × 15 × 10</td>
<td>100</td>
<td>3</td>
<td>2</td>
<td>1542.7</td>
<td>2.95</td>
<td>54</td>
<td>2.21</td>
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<tr>
<td>7/52/F</td>
<td>Inferior right</td>
<td>14</td>
<td>14 × 12 × 7</td>
<td>100</td>
<td>2</td>
<td>1</td>
<td>427.8</td>
<td>2.8</td>
<td>67</td>
<td>2.23</td>
</tr>
<tr>
<td>8/59/F</td>
<td>Suprasternal fossa</td>
<td>14</td>
<td>14 × 7 × 6</td>
<td>50</td>
<td>2</td>
<td>1</td>
<td>123</td>
<td>2.7</td>
<td>61</td>
<td>2.12</td>
</tr>
<tr>
<td>9/45/M</td>
<td>Superior left</td>
<td>16</td>
<td>16 × 11 × 9</td>
<td>100</td>
<td>2</td>
<td>1</td>
<td>157</td>
<td>2.66</td>
<td>39</td>
<td>2.49</td>
</tr>
<tr>
<td>10/64/M</td>
<td>Superior right</td>
<td>17</td>
<td>17 × 12 × 10</td>
<td>100</td>
<td>2</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11/82/F</td>
<td>Inferior right</td>
<td>15</td>
<td>15 × 9 × 10</td>
<td>100</td>
<td>3</td>
<td>1</td>
<td>284</td>
<td>2.78</td>
<td>43</td>
<td>2.33</td>
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<tr>
<td>12/59/F</td>
<td>Inferior left</td>
<td>19</td>
<td>19 × 13 × 10</td>
<td>80</td>
<td>3</td>
<td>1</td>
<td>332</td>
<td>2.77</td>
<td>60</td>
<td>2.28</td>
</tr>
<tr>
<td>13/67/F</td>
<td>Inferior left</td>
<td>30</td>
<td>30 × 10 × 8</td>
<td>100</td>
<td>2</td>
<td>1</td>
<td>282</td>
<td>2.81</td>
<td>31</td>
<td>2.5</td>
</tr>
<tr>
<td>14/32/M</td>
<td>Superior left</td>
<td>32</td>
<td>32 × 17 × 16</td>
<td>50</td>
<td>4</td>
<td>1</td>
<td>1035</td>
<td>2.85</td>
<td>60</td>
<td>2.31</td>
</tr>
<tr>
<td>15/58/M</td>
<td>Inferior left</td>
<td>38</td>
<td>38 × 12 × 13</td>
<td>70</td>
<td>2</td>
<td>1</td>
<td>411</td>
<td>2.79</td>
<td>57</td>
<td>2.55</td>
</tr>
</tbody>
</table>

PTH = parathyroid hormone.
echogenic change. If the heat-generated hyperechoic water vapor did not completely encompass the entire nodule at one site, the tip of the antenna was kept in place for a further 5 seconds. If a hyperechoic zone did not form surrounding the antenna within 5–10 seconds, the ablation power was increased in 5-W increments. Ablation was intended to terminate when all conceptual units of the targeting nodule had changed to transient hyperechoic zones. Before termination, patients received a peripheral venous bolus injection of 2.4 mL SonoVue, followed by 10 mL NaCl. Contrast-enhanced US was performed to investigate the boundaries of the induced necrosis, thereby evaluating whether the treatment could be terminated.

Ablation was terminated when nonenhancement was shown on contrast-enhanced US (Fig 2). The needle tract was ablated during antenna withdrawal to prevent subcutaneous hemorrhage. During the whole procedure, the patients were intermittently asked how they felt, with the intent to assess their status of phonation. After finishing the treatment, we evaluated the complications and kept the patients under observation for 30 minutes with compression of their necks. Patients were discharged if there was no complication that required hospitalization.

**Preablation Assessment**

All patients were evaluated by US examination, CNB, ⁹⁹ᵐTc sestamibi scintigraphy, laboratory examinations, and clinical symptom assessment. The volume of each nodule was calculated as \( V = \pi abc/6 \) (where \( V \) is volume, \( a \) is the largest diameter, and \( b \) and \( c \) are the two other perpendicular diameters). The composition of the nodules was assessed by the US examiner subjectively and was classified as mainly solid (ie, solid portion > 80%), mainly cystic (ie, cystic portion > 80%), or mixed type (ie, solid portion of 20%–80%). Nodule vascularity was classified on a four-point scale, with scores of 1, 2, 3, and 4 representing no Doppler signals, signals in < 25% of the nodule, signals in 25%–50% of the nodule, and signals in > 50% of the nodule, respectively. US-guided CNB was performed with a 16-gauge semiautomatic biopsy needle (Precisa; Hospital Service, Pomezia, Italy). Laboratory examinations included measurements of serum PTH (normal range, 11–67 pg/mL), serum calcium (normal range, 2.00–2.65 mmol/L), and phosphate levels (reference range, 0.80–1.50 mmol/L), in addition to platelet count and blood coagulation tests.

**Follow-up Evaluation**

Patients underwent a medical visit, US, and serum PTH, calcium, and phosphate measurement at 1 week and 1, 3,
6, and 12 months after the procedure and every 6–12 months thereafter in the same manner as before ablation. During these visits, nodule-related symptoms, side effects, and/or other complications (hematomas, skin burns, fever, voice change, brachial plexus injury, and Horner syndrome) were recorded. If PTH and calcium levels were still high or increased again (PTH > 67 pg/mL and calcium > 2.75 mmol/L), a second ablation session was performed and follow-up was restarted just as after the initial therapy. Therapeutic success was

Figure 2. Images from a 64-year-old man with a 42 × 28 × 21-mm mixed parathyroid nodule posterior to the right lobe of the thyroid gland (a). (b,c) Contrast-enhanced US was performed before and after the procedure. Before treatment, the solid component of the nodule was enhanced (b), whereas nonenhancement was shown right after the treatment (c). The patient’s serum PTH and calcium levels decreased from 707 ng/L and 3.2 mmol/L to 164 ng/L and 2.36 mmol/L, respectively, 3 days after the procedure, and 39 ng/L and 2.49 mmol/L, respectively, at last evaluation.

Figure 3. (a,b) Images from a 45-year-old man with a 16 × 11 × 9-mm parathyroid nodule posterior to the left lobe of the thyroid gland. US examination revealed the nodule to be 1.191 cm³ in volume before MW ablation (a). At last follow-up after ablation, the volume of the nodule had decreased to 0.126 cm³ (b). The patient’s serum PTH and calcium levels decreased from 1,542 ng/L and 2.9 mmol/L to 24 ng/L and 2.18 mmol/L, respectively, at last evaluation. (c,d) Images from a 59-year-old woman with a 14 × 7 × 6-mm mixed nodule above the suprasternal fossa, which was localized by ⁹⁹mTc sestamibi scintigraphy. (c,d) US examination revealed the nodule to be 0.307 cm³ in volume before MW ablation (c). The nodule had disappeared at the last follow-up (d). The patient’s serum PTH and calcium levels decreased from 123 ng/L and 2.7 mmol/L, respectively, to 67 ng/L and 2.23 mmol/L, respectively, at last evaluation.
defined by normal PTH and calcium levels at last follow-up together with disappearance of nodule-related symptoms. The percentage reduction in volume was calculated as (initial volume – final volume)/initial volume × 100%. Technetium-99m sestamibi scintigraphy was routinely performed 1 week after the procedure to evaluate the efficacy of MW ablation. Fiber laryngoscopy was performed in patients who reported hoarseness after treatment.

Statistical Analysis
Values for quantitative variables are expressed as means ± standard deviation and range. Wilcoxon signed-rank tests were used to compare changes in largest nodule diameter, volume, vascularity, and serum PTH, calcium, and phosphate levels from before ablation to follow-up. Differences were considered statistically significant when the P value was less than .05. All analyses were conducted by using SPSS for Windows (version 16.0; IBM, Armonk, New York).

RESULTS
Eleven patients underwent successful ablation in a single session, and four patients underwent successful ablation in two sessions. Two patients underwent second MW ablation sessions 7 days after the initial therapy because of parathyroid adenomas located in both sides of the neck. MW ablation was performed one side at a time. The other two patients underwent second MW ablation sessions because of relapse of hyperparathyroidism and regrowth of the tumors 5 months and 32 months after the initial therapy, respectively. The mean duration of the procedure was 26.75 minutes ± 6.02 (range, 19–40 min).

Treatment Response and Clinical Outcome
Characteristics of the parathyroid nodules were measured before MW ablation and at each follow-up period. Largest diameter, volume, and vascularity of the nodules were significantly lower at last follow-up than before treatment (Fig 3; largest diameter, 10 mm ± 8.72 vs 22.82 mm ± 8.67; volume, 0.39 cm³ ± 0.69 vs 2.62 cm³ ± 3.32; vascularity, 1.60 ± 0.51 vs 2.8 ± 0.86; P < .01 for all comparisons). The complete nodule disappearance rate was 17.6% (three of 17). Mean volume reduction ratio at last follow-up was 85.9% ± 15.3 (range, 78.6%–100%).

The changes in serum PTH and calcium levels before MW ablation and at each follow-up period are summarized in Tables 1 and 2. Serum PTH and calcium levels were significantly lower at the last follow-up than before treatment (PTH, 54.5 pg/mL ± 24.1 vs 592.5 pg/mL ± 579.1; calcium, 2.32 mmol/L ± 0.12 vs 2.93 mmol/L ± 0.47; P < .01 for all comparisons). Thirteen patients’ PTH and calcium levels returned to normal, and 99mTc sestamibi scintigraphy confirmed success of the ablation (Fig 4). These, together with disappearance of nodule-related symptoms such as ostealgia (in all five cases), malaise (in both cases), and vomiting (in all three cases) revealed the effectiveness of ablation. The final therapeutic efficacy rate was 86.7% (13 of 15).

Side Effects and Complications
Treatment was well tolerated. A mild sensation of heat in the neck was experienced by most patients, but no one requested termination of the procedure. Only one patient reported voice change, but this resolved without any treatment within 3 weeks. Laryngoscopic evaluation demonstrated no vocal-cord palsy. No cases of local infection, skin burning, or damage to the vital structures of the neck (carotid artery, trachea, esophagus, nerve, and thyroid) were observed.

DISCUSSION
Surgical parathyroidectomy performed with the patient under general anesthesia remains the standard therapy for symptomatic pHPT. Guidelines for surgery have been established by the International Workshop on Primary Hyperparathyroidism, but many patients do not meet these guidelines or have comorbid conditions that prohibit surgery (22). This raises considerable interest in identifying therapeutic alternatives to surgery.

Nowadays, local anesthesia and minimally invasive nonsurgical therapies are increasingly used to treat pHPT, but the value of minimally invasive nonsurgical therapies is still controversial (23). US-guided percutaneous ethanol injection of parathyroid adenomas has proven to be useful in treating pHPT in highly selected patients (24,25). However, because of the need for

Table 2. Changes in Volume, Serum PTH Level, and Calcium Levels before Microwave Ablation and at Each Follow-up

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>1 Wk</th>
<th>1 Mo</th>
<th>3 Mo</th>
<th>6 Mo</th>
<th>Last Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (cm³)</td>
<td>2.62 ± 3.32</td>
<td>2.58 ± 2.98</td>
<td>1.69 ± 2.45*</td>
<td>0.97 ± 1.72*</td>
<td>0.58 ± 1.03*</td>
<td>0.39 ± 0.69*</td>
</tr>
<tr>
<td>PTH (pg/mL)</td>
<td>592.51 ± 579.11</td>
<td>84.57 ± 100.75*</td>
<td>58.2 ± 58.26*</td>
<td>76.23 ± 104.46*</td>
<td>46.4 ± 26.36*</td>
<td>54.5 ± 24.1*</td>
</tr>
<tr>
<td>Calcium (mmol/L)</td>
<td>2.93 ± 0.47</td>
<td>2.35 ± 0.09*</td>
<td>2.35 ± 0.07*</td>
<td>2.38 ± 0.10*</td>
<td>2.35 ± 0.07*</td>
<td>2.32 ± 0.12*</td>
</tr>
</tbody>
</table>

Note–Values presented as mean ± standard deviation.

PTH = parathyroid hormone.

*P < .01 vs baseline.
repeated treatments, the incidence of relapse, and the side effects, the use of percutaneous ethanol injection for pHPT is limited (26). US-guided laser ablation can produce a transient reduction of serum PTH and calcium levels but not a lasting resolution of hyperparathyroidism. Therefore, laser ablation cannot be proposed as a definitive therapy for pHPT (23,27). Other nonsurgical therapies, such as radiofrequency (RF) ablation (28) and high-intensity focused US (26,29), have been recently proposed. However, clinical experience with these techniques is still too limited because only a few patients have been treated.

Yu et al reported that MW ablation may be safe and effective in the management of recurrent and persistent secondary hyperparathyroidism nodules (30). Here, we provide data on MW ablation in the treatment of pHPT with parathyroid nodules. As MW ablation has many potential advantages over RF ablation, including faster ablation, higher temperature without limitations related to electric impedance, a relative insensitivity to “heat sinks,” and the ability to create much larger ablation zones (31), MW ablation may be more suitable for the ablation of large parathyroid nodules than RF ablation. However, for tumors larger than 45 mm, MW ablation was not recommended because parathyroid adenoma rarely reaches this size unless it is malignant (32) and tumor residue may occur frequently.

MW ablation requires preoperative accurate localization of the parathyroid nodules. To confirm the location of the nodules in the present study, US was consistently used in addition to routine use of 99mTc-labeled sestamibi single-photon emission CT. US can detect most parathyroid nodules, but it is occasionally difficult to differentiate an ectopic parathyroid nodule from an enlarged lymph node. In the present study, 99mTc sestamibi scintigraphy was helpful to localize an ectopic adenoma in the suprasternal notch that was initially interpreted as a lymph node. Technetium-99m sestamibi scintigraphy also helped us confirm the effectiveness of ablation. After the treatment, there was no uptake of 99mTc at late phase, which confirmed the success of the ablation.

The results of the present study suggest that MW ablation is feasible and can decrease nodule size and serum PTH and calcium levels in a single session in most patients. For those patients with relapse of hyperparathyroidism and regrowth of the tumor a few months after the first session, a second MW ablation session could solve most nodule-related clinical problems. It is well known that parathyroid cells have the capacity to grow and replicate (33). Persistence of even a few adenomatous parathyroid cells after ablation might result in suboptimal efficacy of ablation and require more treatment sessions. Therefore, complete ablation of the periphery of the parathyroid nodule is important to prevent marginal regrowth. To prevent marginal regrowth, moving-shot, “vascular pedicle ablation,” and hydrodissection techniques have been suggested as suitable methods. These techniques were also considered as means to potentially reduce complications. They have been previously used in MW ablation of benign thyroid nodules in our department, so we applied them to the treatment of parathyroid nodules.

The moving-shot technique was developed to optimize efficacy and minimize complications. Baek et al (19–21) suggested that the moving-shot technique is useful in completely ablating the peripheral portions of autonomously functioning thyroid nodules without significant complications. We applied this technique in the MW ablation of parathyroid nodules and found it feasible. Multipoint and multislice ablation in a unit–by–unit manner is the key point of this technique.

Figure 4. Technetium-99m sestamibi scintigraphy confirmed coagulative necrosis of parathyroid adenomas after MW ablation. (a,b) Scintigraphy images before ablation revealed existence of parathyroid adenoma posterior to the middle right lobe of the thyroid gland (a). After treatment, there was no uptake of 99mTc at late phase, which confirmed coagulative necrosis of parathyroid adenomas after ablation (b).

The vascular pedicle ablation technique was inspired by the handling of the parathyroid gland in thyroidectomy. Regardless of whether a unilateral lobectomy or total thyroidectomy is performed, all identified parathyroid tissue should be preserved with its native blood supply. If a gland is devascularized during dissection, it
is extremely important in the MW ablation of parathyroid nodules. In the ablation of benign thyroid nodules, thermal injury to critical structures may be prevented by “undertreating” the conceptual ablation units adjacent to the critical structures (16). However, this cannot be used in the ablation of parathyroid nodules, as persistence of even a few adenomatous parathyroid cells in adenoma after ablation might result in relapse of hyperparathyroidism. To prevent relapse, their peripheries should be ablated completely, and the hydrodissection technique could isolate the critical structures from the nodules (17,18). It allowed us to target the whole gland with the desired energy level, even near the periphery of critical structures. At the same time, it could mitigate the thermal effect to the surrounding critical structures, preventing thermal injury.

The side-effect and complication rates in the present preliminary study were low. Only one patient reported a voice change, but it was temporary and resolved without treatment within 3 weeks. Laryngoscopic evaluation demonstrated no vocal-cord palsy.

The limitations of the present study are the limited applicability to large nodules, small number of cases, and short follow-up period. Therefore, further study with large samples and long-term follow-up will be needed. In addition, US-guided MW ablation could be difficult for ectopic lesions in the mediastinum, and alternate guiding tools might be needed.

In conclusion, MW ablation is a safe and effective technique for the treatment of pHPPT with parathyroid nodules. It can reduce adenoma size, decrease serum PTH and calcium levels, and relieve nodule-related symptoms. Although surgery is still the gold-standard technique for the treatment of pHPPT, MW ablation may become an alternative for patients who do not meet the criteria for surgery or refuse surgery.

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