Safety and efficacy of ultrasound-guided percutaneous thermal ablation in treating low-risk papillary thyroid microcarcinoma: A pilot and feasibility study

ABSTRACT

Objective: This study aimed to evaluate the safety and efficacy of thermal ablation in treating low-risk unifocal papillary thyroid microcarcinoma (PTMC).

Materials and Methods: Patients with unifocal PTMC were enrolled in this study, and thermal ablations were performed. Contrast-enhanced ultrasound was used to estimate the extent of ablation immediately after thermal ablation; complications were recorded. The size and volume of the ablated area and thyroid hormones were measured, and the clinical evaluations were performed at 1, 3, 6, 12, and 18 months after thermal ablation. From July 2016 to July 2017, the prospective study was conducted involving 107 patients. Thermal ablation was well tolerated without serious complications.

Results: Compared with the volume immediately after thermal ablation, the mean volume reduction ratio (VRR) of ablated lesions was 0.457 ± 0.218 (range: 0.040–0.979), 0.837 ± 0.150 (range: 0.259–1), 0.943 ± 0.090 (range: 0.491–1), 0.994–0.012 (range: 0.938–1), and 0.999 ± 0.002 (range: 0.992–1) at 1, 3, 6, 12, and 18 months after thermal ablation, respectively. Significant differences in the VRR were found between every two follow-up visits (P < 0.01). Results of patients’ thyroid function test before thermal ablation and at 1 month after thermal ablation were normal, and no significant differences were observed (P > 0.05). No tumor regrowth, local recurrence, or distant metastases were detected during follow-up visits.

Conclusion: Thermal ablation is a short-term safe and effective method in treating low-risk small PTMCs, which can be considered a potential alternative therapy for patients with PTMC.

KEY WORDS: Microwave ablation, papillary thyroid carcinoma, postoperative complications, radiofrequency ablation, ultrasound

INTRODUCTION

Thyroid cancer is the most common endocrine malignancy; the incidence of papillary thyroid carcinoma (PTC) in China had increased from 10.4/100,000 people in 2000 to 96.8/100,000 in 2010. In the United States, more than 56,000 new cases were reported in 2015. The increase in PTC incidence has been mainly attributed to early detection of papillary thyroid microcarcinoma (PTMC), which is defined as a PTC with a maximum dimension of no more than 10 mm. PTMC has favorable outcomes with a clinically indolent course and a relatively low mortality rate. Although most PTMC patients can be treated effectively with surgery, the management...
strategies for these patients remain controversial due to its good prognosis. There is no existing consensus regarding the treatment of PTMC. The current recommended treatment ranges from observation alone to total thyroidectomy (TT) with radioactive iodine ablation.[1,5,6] Moreover, management occasionally becomes a dilemma for PTMC patients who are not willing to undergo surgery, are at a high risk of surgery, or just refuse to be observed. In these cases, a minimally invasive local therapy, which could eradicate the small PTMC nodules, may be recommended.

Thermal ablation mainly includes radiofrequency ablation (RFA), microwave ablation (MWA), and laser ablation (LA). With regard to benign thyroid nodules, ultrasound-guided thermal ablation is safe and effective.[7-10] Studies evaluating the efficacy of thermal ablation were usually sporadic and retrospective, and the sample size was relatively small.[11-14] Hence, this prospective study aimed to evaluate the clinical safety and efficacy of ultrasound-guided percutaneous thermal ablation in treating PTMC.

MATERIALS AND METHODS

This study was approved by the Ethics Committees of Cancer Hospital of University of Chinese Academy of Sciences (Zhejiang Cancer Hospital), the Second Affiliated Hospital of Wenzhou Medical University, the First Affiliated Hospital of Zhengzhou University, Xixi Hospital of Hangzhou, and Zhejiang Xiaoshan Hospital. Informed consent for each procedure was obtained from all patients beforehand.

Inclusion and Exclusion Criteria

The aforementioned hospitals set up a study group to evaluate the safety and efficacy of ultrasound-guided thermal ablation in treating low-risk PTMC patients who were not willing to undergo surgery, at a high risk of surgery, or refused to be observed. The inclusion and exclusion criteria were established by reviewing published articles and guidelines.[5,6,11,14-18]

Patients (1) with a single lesion measuring <10 mm; (2) with PTMC confirmed by ultrasound-guided fine-needle aspiration biopsy (FNAB) or core needle biopsy; (3) with no contact and disruption of thyroid capsule (distance ≥2 mm); (4) with no metastatic tumors in the neck on ultrasound and computed tomography (CT) examinations, and no metastatic tumors beyond the neck on physical examination and chest radiography; (5) with an appropriate puncture route noted on ultrasound; (6) who were ineligible for surgery due to a high risk of general anesthesia and/or refused to undergo surgery; and (7) who refused to be clinically observed and requested for minimally invasive treatment due to excessive fear of the disease were included. Patients (1) with clinically apparent multicentricity confirmed by ultrasound and pathology, (2) with another type of thyroid malignancies such as medullary carcinoma or medullary carcinoma confirmed by pathology after biopsy, (3) with the presence of coarse calcification in PTMC nodules, (4) with cervical or distant metastasis revealed by ultrasound or other image techniques, (5) with family history of thyroid cancer and/or history of radiation therapy and/or other high-risk factors, (6) with contralateral vocal cord dysfunction, (7) with blood coagulation disorders, (8) with serious cardiopulmonary disease, and (9) who refused to sign informed consent were excluded.

From July 2016 to July 2017, 162 PTMC patients underwent thermal ablation therapy in the abovementioned hospitals. Among them, 107 patients who met the inclusion criteria and had consecutive follow-up visits (not <12 months) were enrolled in this study, including 31 men and 76 women aged 17–77 years (average: 44.08 ± 13.13 years). A total of 54 PTMC nodules were detected on the left lobe and 53 on the other lobe; the maximum tumor diameter was 0.2–1.0 cm (average: 0.59 ± 0.18 cm). The clinical characteristics of these 107 patients with PTMC are summarized in Table 1.

Radiofrequency ablation instrument

The RFA system (Star RF ElectrodeFixed, STARmed Co., Ltd., Korea) consists of a radiofrequency (RF) generator and a matched electrode. An 18-gauge 7-cm shaft and 0.5-cm (or 10-cm) straight fixed active tip electrode with internally cooled circulation is connected to an RF generator. The modified straight internally cooled electrode was specially developed for treating thyroid tumors. This modified electrode is shorter and thinner than the conventional electrode, and smaller active tips can easily penetrate small thyroid tumors. A peristaltic pump is used to perfuse chilled water (15°C–20°C) at 80 mL/min through the perfusion port of the electrode to prevent tissue charring and to improve the radius of RF energy deposition.

Microwave ablation instrument

The KY2000 MWA system (Kangyou Medical Instrument, Nanjing, China) consists of a MWA generator, a flexible low-loss coaxial cable, and a thyroid-dedicated cooled shaft antenna. The generator is capable of producing 1–100 W of power at 2450 MHz (under pulsed or continuous condition). The microwave antenna was developed and modified for the thyroid gland. The 16-gauge antenna in this study is 10 cm long and has a 10-cm straight internally cooled electrode with internally matched electrode. An 18-gauge 7-cm shaft and 0.5-cm (or 10-cm) straight fixed active tip electrode with internally matched electrode.

Table 1: Clinical characteristics of 107 patients with papillary thyroid carcinoma

| Characteristics               | Description       | Nodules, n (%) |
|-------------------------------|-------------------|----------------|
| Gender                        | Male              | 31 (29.0)      |
|                               | Female            | 76 (71.0)      |
| Age (years)                   | <40               | 39 (36.4)      |
|                               | ≥40               | 68 (63.6)      |
| Maximum diameter (cm)         | ≤0.5              | 51 (47.7)      |
|                               | 0.6-0.8           | 44 (41.1)      |
|                               | 0.9-1.0           | 12 (11.2)      |
| Location                      | Left lobe         | 54 (50.5)      |
|                               | Right lobe        | 53 (49.5)      |
| Echogenicity                  | Hypoechoic        | 87 (80.7)      |
|                               | Isoechoic         | 10 (9.3)       |
| Calcification                 | Microcalcification| 25 (23.4)      |
|                               | No calcification  | 82 (76.6)      |
over the entire length and 3 mm between the narrow radiating segment and the tip of antenna; the microwave antenna is coated with polytetrafluoroethylene to prevent thyroid tissue adhesion and is designed for easy control and minimal normal tissue injury. To prevent shaft overheating, distilled water is circulated through dual channels inside the antenna for continuous cooling of the shaft.

**Ultrasound system**
In the abovementioned five hospitals, various ultrasound devices with high-frequency probes were used for guiding the thermal ablation processes. Conventional ultrasound and contrast-enhanced ultrasound (CEUS) examinations were performed before and after thermal ablation as well as during follow-up visits. The ultrasound devices in our study included IU22 (Philips Medical Systems, Bothell, WA, USA), Logiq E9 (GE Healthcare, Wauwatosa, WI, USA), and MyLab Class C (ESaote, Genoa, Italy).

**Preablation assessment**
Coagulation, thyroid function, and related thyroid tissue autoantibody (TT3, TT4, ft3, ft4, and thyroid stimulating hormone [TSH]) tests were performed before treatment. Patients with normal coagulation function were allowed to undergo the treatment. Patients with long-term use of anticoagulant drugs were required to discontinue the medication at least 3 days before treatment.

Before RFA and MWA, three orthogonal diameters of each PTMC nodule (the largest diameter and two perpendicular diameters), volume, location, echogenicity, internal architecture, contour, shape (height/width), calcifications, and vascularity were carefully evaluated using real-time ultrasound. Tumor volumes were calculated using the following equations: 

\[ V = \frac{\pi abc}{6} \]

\( V \) as volume, \( a \) as the largest diameter, and \( b \) and \( c \) as other two perpendicular diameters) and volume reduction ratio (VRR) = (initial volume − final volume)/initial volume.

**Radiofrequency ablation procedures**
For CEUS and intraoperative rescue risk, an intravenous line was introduced via the antecubital vein before ablation, but no analgesic agent was administered before or during the procedure. The patients were placed in the supine position with the neck fully extended. Two grounding pads were attached to the waist.

All RFA procedures were performed by experienced ultrasound radiologists in participating hospitals. One radiologist performed the RFA procedure, and another guided the needle under real-time ultrasound. The most appropriate puncture path and type of ablation were determined based on the size, location, blood flow, and internal components of PTMC nodules.

If the PTMC nodule to be ablated was adjacent to the ipsilateral recurrent laryngeal nerve or cervical large vessels or thyroid capsule, physiological saline should be injected into the surrounding thyroid capsule under the guidance of ultrasound to form a “liquid isolating region” before ablation. To prevent thermal injury, a liquid isolating region must be formed (at least 3 − 5 mm) between the ablated tumor and the critical structure. The liquid injection sites included the area between the thyroid anterior capsule and anterior neck muscles, the area between the thyroid lateral capsule and carotid artery, and the area between the posterior thyroid capsule and the trachea or esophagus. During the injection of liquid, we talked to the patient to carefully monitor the status of phonation.

After administering anesthesia, the RF electrode was percutaneously inserted into the PTMC nodule and positioned in its designated place under real-time ultrasound guidance. The RFA session in our study was started with 15 W of power. If a transient hyperechoic zone did not form at the electrode tip within 5–10 s, the RF power may be increased to 5–10 W by steps, with maximum increments up to 30–45 W. The ablation therapy was not discontinued until the hyperecho covered the whole ablated nodule and lasted for 30–45 s. For most PTMC nodules, mono-section fixed ablation is enough. If the ablation range is not satisfied, the radiologist can adjust the position of the RF needle to undertake additional ablation. When withdrawing the RF electrode, the needle track should be coagulated to prevent tumor cell seeding.

**Microwave procedures**
Except for the differences in ablation devices and ablation needles (RF electrode vs. microwave antenna) and output, both MWA and RFA have substantial similarities in terms of preoperative preparation, ablation tactics, and intraoperative precautions. The previous paragraphs have detailed the RFA process and thus can offer references for the MWA process. In our study, power outputs of 20–35 W and lasting time of 33–700 s were applied in MWA procedures.

For the ablated PTMC nodules, we achieved 2–5-mm larger necrosis than the original lesion. Immediately after RFA and MWA, CEUS was performed to evaluate the perfusion property of the ablated area. After thermal ablation, the patients were closely monitored for 1–2 h in the hospitals while neck compression was performed for 10–20 min. The complications (such as skin burns, voice change, esophageal perforation, and tracheal injury) that occurred during ablation and immediately after ablation were carefully evaluated and recorded according to the patients’ clinical signs and symptoms.

**Postablation assessment and follow-up visits**
At clinical follow-up, ultrasound, CEUS, thyroid function test, and related thyroid tissue autoantibody examinations were performed, as well as clinical evaluations at 1, 3, 6, and 12 months and every 6 months thereafter.

Conventional ultrasound and CEUS examinations were performed to evaluate the changes in diameters and volumes of the ablated...
tumors and detect the developments of possible recurrent and metastatic tumors. The sizes of the ablated tumors were confirmed by CEUS examinations, and the extent of the ablated zone, defined as the area with lack of enhancement, was measured. If the ablated tumors measured 3 mm in diameter, the tumor volumes and percentage volume reductions were calculated and recorded. During the follow-up visits, an ultrasound-guided FNAB was performed to evaluate the ablated areas in some patients and all lymph nodes (LNs) suspected of metastasis.

**Statistical analyses**

Statistical analysis was performed using SPSS for Windows (Version 19.0; SPSS, Chicago, IL). Continuous data are presented as mean ± standard deviation. The VRR of ablated lesions between every consecutive interval of follow-up visits (immediately, 1 month, 3 months, 6 months, 12 months, and 18 months after thermal ablation) was compared by one-way repeated-measures analysis of variance. The results of thyroid function tests before and 1 month after thermal ablation were compared by paired t-test. Differences were considered significant when P < 0.05.

**RESULTS**

Among 107 patients enrolled in this study, 98 were treated with RFA and 9 with MWA; the maximum output power and total delivery time during RFA procedures were 15–45 W (average: 30.82 ± 3.96 W) and 30–840 s (average: 97.86 ± 121.01 s), respectively; the maximum output power and total delivery time during MWA procedures were 20–35 W (average: 28.9 ± 6.01 W) and 33–700 s (average: 215.56 ± 233.40 s), respectively.

The follow-up visits were performed at 1, 3, 6, 12, and 18 months after thermal ablation; the follow-up period lasted for 12–18 months (average: 15.14 ± 3.01 months). In some cases, after the absorption of the ablated area, a scar-like needle track would appear in the thyroid, which was only a focal concavity in the capsule caused by scar shrinkage. If these scar-like remaining needle tracks were considered completely absorbed nodules, the largest diameter and volume of which cannot be calculated. The thermal ablation treatment and follow-up visits of one PTMC case is demonstrated in Figure 1. Nodules in 49 patients (45.8%) completely disappeared, while those in 48 patients (44.9%) appeared as scar-like needle tracks at the last follow-up visit. Changes in the largest diameter and volume of ablated lesions after ablation and at each follow-up visit are demonstrated in Table 2.

Initially, the mean volumes of ablated lesions were 1.083 ± 1.819 cm³ (range: 0.109–10.978 cm³) immediately after thermal ablation, and the volume gradually decreased to 0.606 ± 1.259 cm³ (range: 0.019–7.463 cm³), 0.273 ± 0.784 cm³ (range: 0–5.217 cm³), 0.069 ± 0.154 cm³ (range: 0–0.946 cm³), 0.006 ± 0.156 cm³ (range: 0–0.093 cm³), 0.001 ± 0.004 cm³ (range: 0–0.012 cm³), and 0 at postoperative 1, 3, 6, 12, and 18 months, respectively. The mean VRRs were 0.457 ± 0.218 (range: 0.040–0.979), 0.837 ± 0.150 (range: 0.259–1), 0.943 ± 0.090 (range: 0.491–1), 0.994 ± 0.012 (range: 0.938–1), and 0.999 ± 0.002 (range: 0.992–1) at postoperative 1, 3, 6, 12, and 18 months, respectively. Significant differences in the VRR were found between every two follow-up visits [P < 0.01; Table 3]. The changes in VRR at each follow-up visit after thermal ablation are shown in Figure 2.

Before thermal ablation and 1 month after ablation, all patients showed normal thyroid function test, and no significant difference was observed [P > 0.05; Table 4].

During the follow-up period, no recurrent thyroid nodules and cervical LN metastasis were detected on ultrasound, and no distant metastasis was found on ultrasound or CT. In 32 (29.9%) patients, ultrasound-guided FNAB was performed at the edge of the ablation area and the area surrounding the residual thyroid tissue to exclude recurrence during follow-up...
visits. The ablated zone demonstrated necrotic material and inflammatory cells without viable neoplastic cells.

**Complications and side effects**

In our study, all thermal ablation procedures performed for treating PTMC nodules were well tolerated by all patients. The most common major complication and side effect encountered in the periablation and postablation period was slight pain (31.78%, 34/107). Patients experienced toothaches, submandibular radiation pains, and unilateral headaches during the ablation procedure. After discontinuing the ablation procedure or after moving the ablation needs away from the thyroid capsules, the pain symptoms were immediately relieved. All local pain symptoms were relieved without treatment 24–48 h after thermal ablation. None of the patients developed postablation fever, skin burns, bleeding, and edema, while 5.61% (6/107) of the patients complained of transient postablation neck swelling. Two patients complained of hoarseness immediately after thermal ablation, and the most likely explanation was nerve injury due to direct thermal injury or nerve compression caused by perinodular edema. Methylcobalamin for neurotrophic therapy was administrated, and the two patients recovered within 3 months.

**DISCUSSION**

The wide use of high-frequency neck ultrasound and ultrasound-guided FNAB has resulted in the increasing number of incidentally discovered PTMC. The appropriate clinical treatment for these PTMCs, which is typically associated with the indolent course, is widely debated.

![Figure 2: Change in volume reduction ratio at each follow-up visits](image-url)
Generally, surgery is recommended; the surgical treatment for PTMC patients is ipsilateral lobectomy combined with central LN dissection and postoperative thyroid hormone suppressive therapy with \(^1\)\(^{13}\) treatment administered to some patients.\(^1\) However, some patients are not eligible for surgery due to various reasons, including increased surgical risk with relevant severe comorbidities, cosmetic concerns, and even fear of postoperative pain. The American Thyroid Association (ATA) recently released the third version of one of the most cited differentiated thyroid cancer (DTC) guidelines: 2015 ATA management guidelines for adult patients with thyroid nodules and DTC. The ATA recommended that cautious observation is a safe and effective alternative to immediate surgical resection in low-risk PTMC patients.\(^1\) Nevertheless, a small percentage of PTMC patients exhibit regional or distant metastases.\(^6\)\(^{12}\)\(^{20}\)\(^{21}\) Furthermore, no clinical features can be applied to differentiate the relatively small number of PTMC patients who developed clinically significant progression from the larger population of people who harbor indolent PTMCs and will not cause significant disease.\(^6\)\(^{12}\)\(^{22}\)\(^{24}\) In fact, many patients are very anxious and possibly depressed when they are diagnosed as a “cancer” carrier; they typically refuse to be clinically observed and request to get rid of the lesion. We presumed that once the PTMC nodule is inactivated in situ by thermal ablation, the risk of tumor progression or outward metastasis will be eliminated or greatly reduced. Thus, thermal ablation, a minimally invasive interventional treatment for elimination of PTMC lesions, could be another optional treatment strategy.

In recent years, ultrasound-guided thermal ablation therapy for PTMC has received some attention. Compared with percutaneous ethanol injection techniques, thermal ablation seems more advantageous as it induces a well-defined area of necrosis in thyroid nodules.\(^1\)\(^3\)\(^{20}\)\(^{26}\) Compared with surgery, the thermal ablation procedure is more cost-effective, can be performed quickly, and does not require hospitalization or posttreatment monitoring.\(^1\)\(^2\)\(^3\)\(^{13}\)\(^{12}\) Valcavi et al. demonstrated the clinical feasibility of LA on PTMC after primary treatments, and the study had shown that complete ablation (including the safety margin) could result in complete pathologic eradication.\(^3\)\(^{13}\) Recently, some studies have demonstrated the feasibility, effectiveness, and safety of thermal ablation modalities, such as LA, MWA, and RFA in the treatment of single solitary PTMCs.\(^1\)\(^1\)\(^{12}\)\(^{13}\)\(^{14}\)\(^{19}\) In Zhou et al.’s retrospective study, 30 patients with single PTMC underwent LA as primary treatment. The LA procedure was well tolerated without serious complications. Among 30 patients, 29 were successfully treated under local anesthesia in a single session. Only one patient had incomplete ablation as confirmed by CEUS performed immediately after percutaneous LA. Hence, a second ablation was performed. At the last follow-up visit, 10 (33.3%) ablation zones had disappeared, while 20 (66.67%) appeared as scar-like lesions. No regrowth of treated tumors, local recurrence, and distant metastases were noted.\(^1\)\(^{12}\) Yue et al. conducted an MWA to 21 patients with solitary T1N0M0 PTMC. Four patients complained of hoarseness immediately after the MWA procedure, and all of them recovered within 3 months. All tumors were completely ablated at a single session, and no serious or permanent complications occurred. No recurrence at the treated site and no distant metastases were detected, with a mean follow-up period of 11 months.\(^1\)\(^{14}\)

In our study, although the original study design did not stipulate the use of thermal ablation modality, most radiologists preferred RFA over WMA as treatment for PTMC, and not even one radiologist chose LA. This might be related to the hospital’s equipment conditions and the doctor’s personal preferences. Currently, RFA is the most commonly used modality for thermal ablation of thyroid nodules in China. Compared with WMA and LA, RFA involves the application of a relatively low temperature in central ablated tissues, which is not more than 110°C, and carbonization in an RFA lesion rarely occurs.\(^{27}\)\(^{29}\) RFA uses less ablation temperature, which is much safer than MW or LA.\(^1\)\(^{12}\)\(^{26}\) Although thermal ablation in PTMC only requires one treatment session to achieve complete healing, the “moving-shot” technique (which allows the ablation area to be controlled) would be used to ablate relatively large PTMC nodules. RF electrode is more suitable for “moving-shot” manipulation than laser fiber. Kim et al. had retrospectively evaluated the outcomes of RFA for six low-risk small PTCs (mean diameter: 0.92 cm; range: 0.6–1.3 cm) in six patients who were not eligible for surgery. At 48.5 ± 12.3 months (range: 36–65 months) of follow-up, the results of thyroid function tests were normal in all patients before and after RFA and the mean volumes of the ablated lesions were significantly reduced.\(^1\)\(^{11}\) Zhang et al. also presented their analytical results of RFA treatments for 98 PTMCs in 92 patients. At over 18 months of follow-up, they found that the mean volume of ablated tumor was significantly reduced; no residual or recurrent tumor tissue was detected in the RFA area or residual thyroid tissue, and no suspicious metastatic LNs were detected.\(^1\)\(^{12}\)

Although a few studies have reported the use of thermal ablation in the treatment of PTMC, no evidence of extra-glandular spread or nodal metastases were found. As a novel procedure in treating PTMCs, thermal ablation remains highly controversial and debated not only in China but also worldwide. To present a convincing study using evidence-based medicine, we organized a study group to evaluate the feasibility of thermal ablation in treating low-risk PTMC in patients who were unwilling to undergo surgery, are at a high risk of surgery, or refused to be observed.

In this study, we found that volumes of all ablated PTMC nodules were significantly decreased after RFA treatment. Compared with the volume immediately after thermal ablation, the mean VRR of the ablated lesion was 0.457 ± 0.218 (range: 0.040–0.979), 0.837 ± 0.150 (range: 0.259–1), 0.943 ± 0.090 (range: 0.491–1), 0.994 ± 0.012 (range: 0.938–1), and 0.999 ± 0.002 (range: 0.992–1) at 1, 3, 6, 12, and 18 months.
postablation, respectively. Significant differences in the VRR were found between every two follow-up visits (P < 0.01). Compared with thermal ablation of benign thyroid nodules, the better VRR outcome in our study might be attributed to the fact that the ablated ranges of PTMC were significantly smaller than those of benign nodules reported in previous literature.\(^7\)\(^9\) In addition, Teng et al. reported that the use of lower power for ablation of PTMC might be attributable to better VRR outcome; the use of lower power could make the process of tumor coagulative necrosis more moderate. Hence, there would be less “over burns” in the ablation area, and the absorption of radiation in the ablation area would be easier.\(^10\)

In our study, two patients complained of hoarseness immediately after thermal ablation and both of them recovered within 3 months. No other serious complication was observed after treatment except for transient regional discomfort and local pain. Before and at 1 month after thermal ablation, patients’ thyroid function test results were normal. Then, levothyroxine was administrated to ensure that the patients’ TSH levels are within 0.5–2.0 mU/L. In our study, no residual tumor or metastasis was noted during the follow-up period. The safety and effectiveness of thermal ablation in treating PTMC were also reported in other literatures.\(^11\)\(^-\)\(^14\)

Due to the lack of unified consensus or clinical evidence support, the power, output time, and energy of thermal ablation had not been suggested in our study. In practical applications, there showed great flexibility and obvious differences in different hospitals and radiologists. Teng et al. showed that MWA using low power output of 20 W was effective in the treatment of PTMCs, and the VRR (98.78%) reported in Teng et al.’s study was higher than that reported in Yue et al.’s study (power output of 40 W [90%]). However, the above two studies have shown similar satisfactory safety and effectiveness.\(^14\)\(^,\)\(^19\) Some radiologists who participated in our study used ablation for the treatment of thyroid benign nodules. However, whether it is suitable for the treatment of malignant nodules needs further exploration.

Our study has several limitations. First, although this study was conducted in five hospitals, thermal ablation as an alternative strategy in treating PTMC remains controversial and is not highly accepted by Chinese doctors and patients. The number of patients involved in this study is still relatively small. Second, the follow-up period was relatively short, and the long-term results remained uncertain. PTMC and its recurrent tumor have clinically indolent course. Hence, long-term follow-up for treatment outcomes may be warranted. Third, as a novel strategy in treating PTMC, no standard power, output time, and energy of thermal ablation were established. Instead, the radiologist’s years of experience was only indicated. Fourth, multifocality cannot be absolutely excluded without histological examinations. Therefore, thermal ablation may become the primary choice for the treatment of PTMC only if new knowledge in the future can permit preoperative recognition of multifocality.\(^13\)\(^,\)\(^20\) Fifth, the preablation FNAB and postablation FNAB were performed, which is often complicated by possible false-positive and false-negative results. Finally, we did not further distinguish the various cytological subtypes of PTMC as it was difficult to determine the cell subtypes using preablation FNAB.

CONCLUSION

Ultrasound-guided percutaneous thermal ablation for low-risk PTMC is highly safe, has minimal trauma, causes fewer complications, and preserves thyroid function. It is a short-term safe and effective alternative strategy for treating low-risk PTMCs, particularly in patients who are ineligible for surgery. However, the long-term efficacy and recurrence rate still need to be examined further.

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Conflicts of interest

There are no conflicts of interest.

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