Original Article

Ultrasound-Guided Percutaneous Microwave Ablation for Submucosal Uterine Fibroids

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ABSTRACT Study Objective: To prospectively evaluate the efficiency and safety of ultrasound-guided percutaneous microwave ablation (PMWA) in treating symptomatic submucosal uterine myomas.

Design: Self-controlled study (Canadian Task Force classification II-1).

Setting: Single center.

Patients: Twenty-two premenopausal women with 22 symptomatic submucosal uterine myomas.

Intervention: All patients underwent ultrasound-guided PMWA.

Measurements and Main Results: PMWA was performed in 22 premenopausal women with 22 symptomatic submucosal uterine myomas. Mean (SD) patient age was 42 (4.60) years (95% confidence interval [CI], 39.96–44.04). Five symptomatic submucosal uterine myomas were identified as type 0, 7 as type 1, and 10 as type 2. Contrast-enhanced ultrasound and magnetic resonance imaging were performed before and after surgery. Myoma volume, hemoglobin concentration, and scores on the UFS-QOL (Uterine Fibroid Symptom and Quality of Life) questionnaire were recorded before and at 3 and 12 months after ablation. Complications were also recorded. In all patients, therapy was completed with a single ablation. The baseline diameter of the symptomatic submucosal uterine myomas was 4.90 (1.60) cm. Mean myoma volume reduction rate was 81.46% (16.33%) (95% CI, 73.06%–89.86%) at 3 months (p < .001) and reached 90.00% (9.79%) (95% CI, 85.07–95.13) at 12 months (p < .001). At 3 months after ablation, hemoglobin concentration increased from 88.64 (21.87) g/L (95% CI, 78.94–98.34) to 123.21 (15.77) g/L (95% CI, 115.10–131.32) (p < .001), and remained stable at 12 months, with a value of 125.92 (14.90) g/L (95% CI, 117.98–133.86). Scores on the UFS-QOL were comparable, with normal levels observed at 1 year. No major complications were observed. Nine patients were discharged with necrotic masses.

Conclusion: PMWA seems to be effective and safe for treatment of submucosal myomas. Journal of Minimally Invasive Gynecology (2014) 21, 436–441 © 2014 AAGL. All rights reserved.

Keywords: Ablation; Leiomyoma; Microwave; Ultrasound

DISCUSS You can discuss this article with its authors and with other AAGL members at http://www.AAGL.org/jmig-21-3-JMIG-D-13-00543

Symptomatic submucosal uterine myomas are common benign gynecologic tumors that increase the incidence of abnormal uterine bleeding, heavy menstrual bleeding, and the risk of recurrent early pregnancy loss [1]. They are traditionally treated via abdominal myomectomy or hysterectomy [2]. In the 1970s, Neuwirth and Amin [3] introduced hysteroscopic myomectomy, which was soon applied to symptomatic submucosal uterine myomas. Because of increased risk of perforation and serious injury, this technique is not considered appropriate when the leiomyoma is close to the serosal layer [1]. In addition, hysteroscopic
myomectomy has some inevitable complications including fluid overload, central nervous system disorders, uterine perforation, and gas embolism [4,5].

Recently, ultrasound-guided percutaneous microwave ablation (PMWA) has been widely used to treat symptomatic myomas and adenomyosis [6,7]. However, no studies have assessed use of PMWA to treat symptomatic submucosal uterine myomas. Thus, the present study was performed to evaluate the efficacy and safety of PMWA for treatment of symptomatic submucosal uterine myomas.

**Materials and Methods**

**Enrollment Criteria**

Twenty-two patients with 22 submucosal myomas were recruited from October 2010 to February 2013. Included in the study were women who had completed childbearing, had declined hysterectomy or other conservative treatments, and had uterine myoma–related symptoms (e.g., menorrhagia, pelvic pain, bulk pressure, or urinary frequency). Excluded were those with lack of an appropriate percutaneous access route, history of malignancy, abnormal ThinPrep cytology test results, pelvic infection, or contraindications for intravenous anesthesia. All patients were counselled about the potential risks and benefits of PMWA and possible alternative treatments, and all provided written informed consent. Approval of the PLA General Hospital Institutional Review Board was obtained for this prospective study (ratification No. 20100930-004, registration No. ChiCTR-TRC-10001119).

Patients ranged in age from 32 to 48 years (mean [SD], 42 [4.60] years), and all were Chinese. No patient had a diagnosis of adenomyosis after magnetic resonance imaging and ultrasound. According to the Harlem classification, myomas are classified into 3 types: type 0, pedunculated myomas; type 1, myomas with intramural extension 50%; and type 2, those with intramural extension >50% [8]. In the present study, 5 myomas (22.72%) were identified as type 0, pedunculated myomas; type 1, myomas with intramural extension <50%; and type 2, those with intramural extension >50% [8]. In the present study, 5 myomas (22.72%) were identified as type 0, 7 (31.82%) as type 1, and 10 (45.46%) as type 2. Myoma diameter ranged from 2.60 cm to 8.00 cm (4.91 [1.60] cm), and myoma volume ranged from 6.93 cm³ to 197.74 cm³ (68.87 [59.97] cm³). Eleven (64.71%) type 1 and type 2 myomas had diameters >5 cm. Two parts of the UFS-QOL, including the Symptom Severity Score and Health-Related Quality of Life, were used to evaluate the effectiveness of PMWA [9].

**Instruments**

A microwave tumor coagulator (KY-2000 MW; Kangyou Medical Instruments Co., Nanjing, China), with a frequency of 2450 MHz and capability of continuous ultrasound microwave emission modes, was used for ultrasound. The needle antenna had a 15-gauge external diameter (1.9 mm) and was 18 cm long. The distance from the aperture of the microwave emission to the needle tip was 11 mm, and the emission aperture was 1 mm.

We used the Acuson Sequoia 512 Ultrasound System (Signature 10.2; Siemens Medical Solutions, Inc., Mountain View, CA) with a puncture-guided device and a low MI contrast-enhanced function. The frequency of the transducers ranged from 2.5 to 4.5 MHz.

Contrast-enhanced ultrasonography was performed using 2.4 mL of SonoVue medium (Bracco, Milan, Italy) before and immediately after ablation. The microbubble contrast agent was mixed with 5 mL normal saline solution and was administered via rapid bolus into the median cubital vein, followed immediately by 5 mL normal saline solution.

**Preablation Preparation**

Before ablation, all patients were admitted to the hospital for essential examinations including routine blood, urine and stool tests, electrocardiography, chest radiography, and contrast-enhanced magnetic resonance imaging. Ultrasonography was performed to assess the volume of the myomas. The mean diameter and volume of the myomas were calculated via ultrasound using the following formulas: Mean diameter = (Length + Width + Height)/3, and Volume = 4/3 × π × r³, where r is the mean radius at ultrasound (mean diameter/2).

**Therapy**

Patients were placed in a supine position. Ablation was performed using intravenous ultrasound with the patient under conscious sedation (induction with 1.0 mg midazolam, 0.05 ng fentanyl, and 1.0–1.5 mg/kg propofol; maintenance with 0.4–1.2 mg/kg/hr propofol). All ablation procedures were performed by the same physician (Z.J.), who has performed >500 PMWA procedures. Using real-time ultrasound guidance, the antenna needle was inserted into the...
center of the myoma, and the needle tip was located 5 mm from the distal end of the myoma [10] (Fig. 1). According to the dose-effect relationship of microwave ablation [11,12], a single antenna was used, at 50 W for 300 to 600 seconds. For nonspherical myomas, the margin of the thermal field was controlled at the shortest diameter, and the antenna was then withdrawn along the long axis or was reinserted into the unablated zone for another ablation session. During ablation, variations in the echo from the myoma were monitored via real-time ultrasonography. The energy was stopped when the hyperecho (calculated according to microbubbles generated during microwave emission and roughly delineating the thermal field edge [13]) covered the entire nodule. Preliminary evaluation of ablation effectiveness was performed immediately using contrast-enhanced ultrasound [14]. Once the perfusion was found within the myoma, a supplemental treatment was performed immediately.

Effectiveness Assessment

Contrast-enhanced MRI was performed within 3 days of ablation to assess the range of the target nonperfused area and any possible injury to adjacent organs. The nonperfused area was defined as necrotic tissue [15].

The outcomes were evaluated at 3 and 12 months after PMWA and included myoma volume, hemoglobin concentration, and Uterine Fibroid Symptom and Quality of Life (UFS-QOL) questionnaire scores. Major complications, defined as complications that required further interventions and/or hospitalization [16], were also recorded. To minimize any interobserver variations, ultrasonograms were assessed by the same trained sonographer-ultrasonologist (Z.J.).

Statistical Analysis

All analyses were performed using commercially available software (SPSS version 13.0; SPSS, Inc., Chicago, IL). Data are given as mean (SD) and were tested using analysis of variation for repeated measures. The least significant difference $t$-test was used in the multiple comparison tests. Analysis of variance was used to compare myoma volumes, hemoglobin concentrations, and UFS-QOL scores. A value of $p < .05$ was considered significant.
Results

General condition

In all patients, treatment was completed with a single ablation (Fig. 2, A–C). In 9 of 22 patients, necrotic masses were discharged from the vagina at 6 to 180 days after PMWA; the largest necrotic mass was 67.40 cm³. All type 0 myomas and 1 type 1 myoma were entirely discharged, and 1 type 1 and 2 type 2 myomas were partially discharged. All myomas were completely necrotic (Fig. 3, A and B).

The mean body temperature within 2 days after ablation was 36.7°C. Temperatures of 37.3°C and 37.4°C occurred in 2 patients, but their blood analyses showed no signs of inflammation.

Efficacy

Myoma volume reduction rates, hemoglobin concentrations, and UFS-QOL scores are given in Table 1. Compared with baseline, these data indicate notable improvements after ablation (Table 1).

Complications and Adverse Effects

No major complications occurred, and no patients developed amenorrhea during follow-up. Seven patients (31.82%) had lower abdominal pain; grade 4 (on a 5-point scale) in 4 patients, and grade 2 in 3 patients. Pethidine or buncimazine hydrochloride was administered in the 4 patients, and they recovered within 6 hours. One patient felt ongoing pain just before the necrotic tissues were discharged, and the pain resolved immediately after the necrotic tissue was expelled.

All 22 patients had a small amount of vaginal secretion. The fluid was colorless in 1 patient, bloody in 2 patients, and light pink in the others. In most patients, secretions resolved within 2 weeks of ablation; in only 1 patient did the discharge last for approximately 1 month. On observation of secretions and culture of bacteria, antibiotic therapy such as tinidazole was administered for approximately 3 days after ablation to prevent infection.

Discussion

Submucosal uterine myomas are always symptomatic and require aggressive management [17]. Hysteroscopy has been widely used, in particular in type 0 and type 1 myomas. However, this technique has some disadvantages insofar as deep intramural myomas, including high risk of hemorrhage and the need for multiple operations [2,18]. Currently, in situ ablation techniques have enabled great progress in conservative treatment of uterine myomas [19–22]. Compared with other thermal ablation techniques, microwave ablation achieves higher intratumoral temperatures and larger ablation zones [23]. The technique has been successfully used to treat liver cancer [24], renal cancer [25], uterine myomas [22], and adenomyosis [7]. In addition, PMWA-related instruments, including a microwave generator and an ultrasonic imager, are much less expensive than the instruments required for uterine arterial embolization or focused ultrasound surgery [26].

Because PMWA is a relatively simple and safe procedure and provides more general indications for submucosal myomas, it has some unique advantages compared with hysteroscopic myomectomy. First, because no preconditioning of the cervix is required, a percutaneous approach makes the procedure more convenient and less invasive. Second, type 1 and type 2 myomas are largely composed of myometrium, whereas the excision of deep intramural and thin serosal myomas may lead to uterine perforation and bleeding during hysteroscopic myomectomy [27]. In the present study, most myomas were large and deep intramurally; however, our results show that the therapy had a satisfactory effect. Ultrasound-guided percutaneous techniques can protect

![Fig. 3](image-url)
visible vessels from puncture, and microwave ablation provides continuous coagulation [28], and thus there is little bleeding during the procedure. Because PMWA does not require distention of the uterus, it is impossible to cause fluid overload or gas embolism or to allow local anesthetics into the systemic circulation. Although hysteroscopic myomectomy is the optimal choice for type 0 myomas, PMWA can also be used to coagulate pedunculated myomas and enable the myoma to be expelled entirely.

During the first 3 months after PMWA, myoma volumes decreased sharply. In addition, 6 myomas were expelled completely; thus the volume reduction rate reached 90.10%. On the basis of findings of a previous [17], myoma diameter is the most important factor in determining which patients have anemia. Thus, reducing the submucosal volume alleviated hypermenorrhea, and anemia correction was notable.

Spies et al [9] have demonstrated that the mean Symptom Severity Score is approximately 20 in healthy controls, compared with 40 in patients with myoma. In the present study, the mean (SD) score was 35.78 (17.377) before ablation, and declined to 24.69 (2.91) after 3 months and 15.16 (13.2) after 12 months, reaching the same level as in healthy controls. In the Health-Related Quality of Life survey, the mean score for healthy controls was approximately 86.4, and the results reached the same level at 12 months in the present study (Table 1). Both parts showed considerable improvement.

During 12 months of follow-up, no major complications occurred. Discharged necrotic masses from the vagina, which is the purpose of this therapy, were also reported at uterine artery embolization and MRI-guided focused ultrasound surgery [20,29] and were considered a means to attain a cure [30]. Liquefaction and shrinkage of coagulated myomas, and any irritation of the endometrium are possible explanations for vaginal secretions. However, the potential disadvantages and severe complications of PMWA should be realized and given attention. For example, in theory, the percutaneous approach might be associated with risk of bowel puncture and could lead to perforations. Thus, it is necessary to use the probe to push the intestinal tract gradually before inserting the antenna. These observations may have been the result of the limited sample size, and thus further research, in particular multicenter research, is needed.

In conclusion, PMWA is a convenient, efficient, safe, and minimally invasive technique to treat almost all types of submucosal myomas. This technique provides another choice for treatment of these myomas and contributes to individual treatment.

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of Patients</th>
<th>Myoma Volume, % (95% CI)</th>
<th>Hemoglobin, g/L (95% CI)</th>
<th>UFS-QOL Symptom Severity Score, mean (SD) (95% CI)</th>
<th>HRQL (95% CI)</th>
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<tr>
<td>Baseline</td>
<td>22</td>
<td>NA</td>
<td>88.64 (21.87)(78.94–98.34)</td>
<td>35.78 (17.37)(28.07–43.48)</td>
<td>56.34 (26.18)(44.73–67.95)</td>
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<td>3-Month</td>
<td>17</td>
<td>81.46 (16.33)(73.06–89.86)</td>
<td>123.21 (15.77)(115.10–131.32)</td>
<td>24.69 (2.91)(23.19–26.19)</td>
<td>74.96 (17.27)(66.08–83.84)</td>
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<tr>
<td>12-Month</td>
<td>16</td>
<td>90.10 (9.79)(85.07–95.13)</td>
<td>125.92 (14.90)(117.98–133.86)</td>
<td>15.16 (13.2)(8.12–22.19)</td>
<td>84.13 (12.46)(77.49–90.77)</td>
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CI = confidence interval; HRQL = Health-Related Quality of Life; NA = not available; UFS-QOL = Uterine Fibroid Symptom and Quality of Life questionnaire.

References