CLINICAL STUDY

Percutaneous High-Energy Microwave Ablation for the Treatment of Pulmonary Tumors: A Retrospective Single-Center Experience

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ABSTRACT

Purpose: To evaluate the safety and efficacy of percutaneous high-energy microwave ablation (MWA) for the treatment for pulmonary tumors.

Materials and Methods: A retrospective review was undertaken of 44 patients (21 men, 23 women; median age, 66 y; range, 17–89 y) who underwent 62 sessions of high-energy MWA for 87 pulmonary tumors at a single tertiary referral center between June 2012 and June 2014. Primary tumor origin was sarcoma (n = 23), colorectal (n = 16), lung (n = 2), esophageal (n = 1), breast (n = 1), and bladder (n = 1). Median tumor size was 12 mm (range, 6–45 mm). Technical success was recorded contemporaneously, complication rate at 30 days was recorded prospectively, and technique effectiveness was assessed by longitudinal follow-up CT scan.

Results: Primary technical success was achieved in 94% of ablation sessions. The median follow-up interval was 15 months (range, 6.2–29.5 mo) during which time local tumor progression was observed in two of 87 tumors (technique effectiveness 98%). Pneumothorax requiring chest tube insertion occurred in 19%; delayed pneumothorax occurred in four patients. No hemoptysis, infection, or other complications were recorded.

Conclusions: High-energy MWA is safe and effective for the destruction of lung tumors.

ABBREVIATIONS

MWA = microwave ablation, PROMs = patient-reported outcome measures

The first choice of treatment for pulmonary malignancy is surgery, and this is believed to improve survival in patients with primary lung cancer and patients with metastatic cancer (1,2). However, patients with pulmonary malignancy may be unfit or unwilling to undergo surgery because of poor cardiopulmonary reserve or significant comorbidity. Since the first report of thermal therapy for pulmonary malignancy in 2000 (3), thermal ablation has been used for primary and metastatic pulmonary tumors. Thermal destruction may be achieved by tissue heating—radiofrequency (RF) ablation and microwave ablation (MWA)—and tissue freezing—cryoablation. In the lung, MWA has significant theoretical advantages over RF ablation (4–6); however, most of the literature pertains to RF ablation. Moreover, most previous reports on MWA used low-energy ablation systems (up to 60 W), and differences have been reported in the size of the ablation zone between these low-energy systems and high-energy systems (> 100 W) (7).

RF ablation is reported in the literature as having a local control rate of 62%–90% and a major complication rate of 10%–59% (8–15). For low-energy MWA (typically 25–80 W), previous studies reported local control rates of 73%–86% and major complication rates between 15% and 20% (16–21). Cryoablation has a reported local control rate of 76.2%–92% and major complication rate of 6.4%–8% (22–25). Although now more common,

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results from high-energy MWA systems have been less frequently reported (26). The purpose of our study is to report our experience of the safety, technical success, and technique effectiveness of high-energy MWA to treat lung tumors compared with both RF ablation and low-energy MWA.

MATERIALS AND METHODS

Patients

Institutional review board approval was granted for this study. All patients who underwent high-energy MWA of one or more pulmonary tumors at our institution between March 2012 and June 2014 were included in this retrospective, single-center review. All patients provided informed written consent for the tumor ablation. The inclusion criterion was a pulmonary tumor considered suitable for thermal ablation by a tumor review board comprising an oncologist, surgeon, and interventional radiologist, all with a specialist interest in lung malignancy. All patients with presumed metastatic lung tumors had a biopsy-proven primary malignancy and at least one enlarging lung mass identified on axial computed tomography (CT) imaging deemed consistent with metastatic disease. Extrapulmonary disease was allowed, as the pulmonary disease was considered to be the most clinically significant component of the disease. The real-life exclusion criteria were any tumor with a maximal diameter $>$ 5 cm, an international normalized ratio $>$ 1.4 or platelet count $< 70 \times 10^9$/L, and septicemia. If a patient had anticoagulant medication, a bridging plan was put in place.

Periprocedural Management

All potential patients referred for ablation were first discussed in a thoracic multidisciplinary team meeting comprising physicians, surgeons, oncologists, and a member of the interventional radiology team with an interest in thermal ablation. The patient was then invited to attend an interventional radiology outpatient clinic, where the physician performing the ablation was able to see the patient, discuss treatment, and obtain written informed consent. A clinical examination and pulmonary function test were also performed, and the interventional clinical nurse specialist performed a preliminary assessment to determine whether formal anesthetic review was required before intervention. Adequate respiratory function was determined in the clinic with a minimum forced expiratory volume in 1 second being 1 L.

MWA Procedure

An unenhanced CT scan of the chest was performed immediately before ablation to plan patient positioning, site of puncture, and route of antenna insertion (Fig 1a). Patients were given deep conscious sedation or general anesthesia, and heart rate, blood pressure, oxygen saturation, and continuous electrocardiogram were monitored during the procedure.

MWA was performed using a high-power system (Acculis MTA System, AngioDynamics, Latham, New York) operating at 2.45 GHz, allowing 140 W to be delivered to the tumor via a 1.8-mm diameter closed water-cooled needle (16 gauge). MWA was performed percutaneously with one antenna under CT guidance (Somatom Sensation 64; Siemens Healthcare, Erlangen, Germany) (Fig 1b). If the tumor diameter was $<$ 2.5 cm, a single puncture and ablation was used at a power of 140 W for up to 2 minutes. For tumors $>$ 2.5 cm in diameter, a single pleural puncture site was used but with several antenna positions, varying ablation power and duration to ensure complete tumor coverage. Satisfactory ablation was defined by circumferential ground-glass surrounding the tumor on CT. Needle tract ablation was not performed.

A chest radiograph was obtained in all patients at 4 hours after the procedure to assess for immediate complications (ie, pneumothorax or bleeding). All patients underwent an unenhanced CT scan the day after ablation to assess the ablation margin and complications (Fig 1c). If the tumor was not covered completely by the ablation zone, further treatment was discussed.

Follow-up Examinations

A CT scan performed 1 day after the procedure was used as a baseline reference image. Further CT imaging data were gathered 1, 3, 6, 12, and 24 months after ablation (Fig 1d–f). These investigations were performed to evaluate the local control rate, presence of new metastatic disease, and complications.

Telephone follow-up was performed on days 3 and 5 after the procedure by the clinical nurse specialist. Every patient was then seen in a dedicated clinic by the treating interventional radiologist 30 days after the procedure. A full history was obtained to determine complications, and physical examination was performed to assess the treatment site. Patient-reported outcome measures (PROMs) were obtained at the 30-day consultation from every patient going through the service.

Complications

All 62 ablation sessions were evaluated and complications were assessed based on the number of tumors treated and defined based on the Society of Interventional Radiology (SIR) classification of complications. Major complications were defined as an event that led to substantial morbidity and disability, increasing the level of care, or resulted in hospital admission or substantially lengthened hospital stay. Delayed pneumothorax was defined as major complication.