Microwave Thermal Ablation of Spinal Metastatic Bone Tumors

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ABSTRACT

Purpose: To assess feasibility, safety, and efficacy of microwave ablation of spinal metastatic bone tumors.

Materials and Methods: Retrospective study of 17 patients with 20 spinal metastatic tumors treated with microwave ablation under computed tomographic guidance between March 2011 and August 2013 was performed. Ablations were performed under local anesthesia and nitrous oxide ventilation. Lesions were lumbar (n = 10), sacral (n = 7), and thoracic (n = 3) in location. Primary neoplastic sites were lung (n = 9), prostate (n = 4), kidney (n = 6), and uterus (n = 1). Adjunct cementoplasty was performed in nine cases, and a temperature-monitoring device was used in four cases. Procedure effectiveness was evaluated by visual analog scale (VAS) during a 6-month follow-up. Patient medical records were reviewed, and demographic and clinical data, tumor characteristics, and information on pain were assessed.

Results: Mean ablation time was 4.4 minutes ± 2.7 (range, 1–8 min), with an average of 3.8 cycles per ablation at 60 W (range, 30–70 W). The preprocedure mean VAS score was 7.4 ± 1.2 (range, 6–9). Pain relief was achieved in all but one patient. Follow-up VAS scores were as follows: day 0, 1.3 ± 1.8 ($P < .001$); day 7, 1.6 ± 1.7 ($P < .001$); month 1, 1.9 ± 1.6 ($P < .001$); month 3, 2.2 ± 1.5 ($P < .001$); and month 6, 2.3 ± 1.4 ($P < .01$). No complications were noted.

Conclusions: Microwave ablation appears to be feasible, safe, and an effective treatment of painful refractory spinal metastases and may be considered as a potential alternative percutaneous technique in the management of spinal metastases.

ABBREVIATIONS

RF = radiofrequency, RT = radiation therapy, VAS = visual analog scale

Spinal metastases are a significant source of morbidity in patients with systemic cancer. It has been reported that as many as 75%–90% of patients with metastatic or advanced-stage cancer will experience significant pain (1). Cadaver studies have shown that spinal metastases occur in 30%–90% of patients with terminal cancer (2). Moreover, each year, symptomatic spinal metastases will develop in approximately 5% of patients with cancer (2). The most common primary sources of these metastases are the breast, lung, and prostate (3). The most common symptom at presentation is pain, which can be radicular (exaggerated by percussion or palpation) and/or mechanical (exacerbated by movement) (4,5). Quality of life in these patients is markedly disturbed despite specific therapies. Because of the short life expectancies and high systemic tumor burdens of affected patients (6), treatment regimens are most often palliative rather than curative. Therefore, quick pain relief has become a priority in these patients.

Conventional management primarily includes analgesic agents, chemotherapy, hormonal therapy, radiopharmaceutical therapy, radiation therapy (RT), and surgery (1). During the past two decades, image-guided interventional techniques have emerged and produced satisfactory results in the management of spinal neoplasms; these techniques include cementoplasty (7–9), radiofrequency (RF) ablation (10), combined RF ablation and cementoplasty (11,12), and cryotherapy ablation (13). More recently, percutaneous microwave ablation has been described for the treatment of various types of

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nonosseous tumors. However, we are aware of only two reports on the use of percutaneous microwave ablation of metastatic spinal lesions (14,15). Therefore, the objective of the present study was to assess the feasibility, safety, and efficacy of computed tomography (CT)–guided microwave ablation of metastatic spinal bone tumors.

MATERIALS AND METHODS

Local institutional review board approval was obtained, and written informed consent was waived. The medical records of patients were reviewed, and the following data were collected and evaluated: demographic and clinical data, tumor characteristics, and information about pain.

Patient and Tumor Characteristics

Seventeen patients with 20 spinal metastases treated with microwave ablation between March 2011 and August 2013 were included in this retrospective study. All patients presented with painful spinal metastatic lesions that were refractory to all previously attempted conventional therapies, including opioid agents, chemotherapy, and RT. The decisions to perform microwave ablation were made by a multidisciplinary staff that included radiologists, pain physicians, oncologists, and palliative care physicians. All patients had undergone imaging before the procedure that included a CT scan in all cases and adjunct magnetic resonance imaging in eight cases. All patients with one or more painful spinal tumors refractory to other therapies were eligible for microwave ablation treatment if the tumor was considered to be percutaneously accessible.

The study cohort consisted of 17 patients (12 men and five women; mean age, 65.7 y) who underwent 20 microwave ablations of secondary bone lesions. The distribution and etiologies of the lesions are detailed in the Table. The mean Karnofsky performance status was 61 (range, 40–80). Five patients had sclerotic lesions and the other 15 had lytic lesions. Adjunct cementoplasty was performed in nine cases. The decision to perform adjunct cementoplasty was made for cases with lesions with associated fractures, lesions that were considered to be at high risk for fracture, extensive osteolytic lesions, or disruption of the cortical bone. One patient underwent two microwave ablation sessions because of multiple lesions. In four cases, the decision to use a temperature-monitoring device (thermocouple) was made based on tumor proximity to the emergence of the radicular nerves, and pedicle lysis. The mean maximum tumor size (ie, maximum diameter) was 26.6 mm ± 17 (range, 12–70 mm).

Table. Distribution and Origin of Lesions

	Spine			
Distribution	**Dorsal**	**Lumbar**	**Sacrum**	**Total**
Lytic	3	8	5	14
Sclerotic	1	3	2	6
Total	3	10	7	20
Lesion origin				
Lung	2	2	5	9
Prostate	2	1	1	4
Kidney	2	4	0	6
Uterus	0	0	1	1
Total	6	7	7	20

Procedure

Microwave ablations were performed under CT guidance (SOMATOM Sensation 64; Siemens, Erlangen, Germany) during a 1–2-day hospital stay. The microwave generator used was an Acculis 2.45 GHz MTA system (Microsulis/AngioDynamics, Latham, New York). The procedures were performed with the use of strict sterile technique. All 20 procedures were performed under local anesthesia (lidocaine hydrochloride 1% and ropivacaine hydrochloride 0.25%, administered from a skin entry point to the vertebral periosteum with a 22-gauge spinal needle) and light conscious sedation with nitrous oxide ventilation. Additionally, intravenous administration of paracetamol (1 g) was initiated 5 minutes before the start of the procedure. Additional intratumoral injections of anesthetic agents were also performed with 1–3 mL of the aforementioned mixture. The spinal needle was left in place at the target site to administer additional intraprocedural anesthetic injections in case of intraprocedural pain (Figs 1, 2).

In cases of osseous osteosclerotic lesions and osteolytic lesions that were situated far from the cortical bone, a 13-gauge bone needle (t'CD II; Thiebaud, Margenciel, France; or OsteoSite; Cook, Bloomington, Indiana) was inserted under CT guidance until the needle tip was correctly situated at the defined target (generally at the center of the lesion). The microwave antenna shaft (1.8-mm diameter, 14 or 19 cm long) was then coaxially inserted into the bone needle (Fig 3). In cases of lytic bone lesions, the microwave antenna was directly inserted into the lesion (Figs 1, 2, 4).

In cases of lesions larger than 4 cm (three cases), the microwave antenna shaft position was repositioned between ablation cycles to obtain a larger thermoablation zone. In the four cases in which the lesions were situated close to neural structures, a 22-gauge thermocouple needle was inserted and placed in proximity to the neural structure to monitor real-time temperature variations during thermoablation. Thermoablation was discontinued in case the temperature reached above 42°C (Fig 4). The microwave ablation power was set between 30 W and 70 W and applied for a duration that ranged from 1 to 8 minutes depending on the lesion size. Short repeated microwave cycles (30–90 s) were