Spine Microwave Ablation: Safety and Efficacy for Treatment of Vertebral Metastases

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The spine is the most common site for bone metastasis, which is involved in approximately 40% of patients with metastatic cancer. Vertebral metastases impose substantial economic burden on the national health care system, and skeletal-related events such as pain due to pathologic fractures and spinal cord or nerve impingement as well as neurologic deficits often adversely affect patients' quality of life.[1] While external beam radiation therapy is considered the current criterion standard for the management of painful vertebral metastases, pain relief following radiation therapy may be delayed, incomplete, and transient. In addition, painful vertebral metastases are often refractory to systemic therapies such as chemotherapy, radiopharmaceuticals, hormonal therapy, and bisphosphonates. Furthermore, surgical intervention, which is of limited benefit in such patients due to morbidity and often poor patient functional status, is primarily considered in patients with neurologic compromise or spinal instability.[1] Such limitations in management render systemic analgesics the only option for pain palliation in many patients.

During the past 2 decades, investigators have exploited minimally invasive percutaneous thermal ablation (often combined with vertebral augmentation) for management of a subset of patients with spinal metastases to achieve pain palliation and/or local tumor control, demonstrating excellent procedural safety and efficacy profiles as well as durability of treatment effects.[1-6]

In their excellent recent study published in the *American Journal of Neuroradiology*, Chen et al,[5] reported the safety, efficacy, and durability of percutaneous microwave ablation combined with vertebral augmentation for the management of spinal metastases. The authors successfully treated 91 patients with 140 vertebral metastases (thoracic and lumbar spine) and achieved statistically significant pain palliation, decreased analgesic use, and improved functional status up to 6 months following the treatment.[5] The investigators reported a local tumor control rate of 94.8% at the 6-month posttreatment time point.[5] The authors clearly describe the inclusion and exclusion criteria; however, the status of spinal stability, which is a key factor in determining patients' eligibility to undergo thermal ablation (Spine Instability Neoplastic Score) was not discussed. In addition, a major strength of microwave ablation (in comparison with radiofrequency ablation) for the treatment of osteoblastic metastases was not evaluated because sclerotic tumors were not included in the study.

The procedural technique for microwave ablation and vertebral augmentation is described in adequate detail, a feature beneficial to readers who may be interested in implementing these interventions in clinical practice. However, several points in the procedural technique require clarification. Most important, the authors claimed that they treated the clinical target volume (CTV) to achieve more durable pain palliation and improved local tumor control rates aligned with the International Spine Radiosurgery Consortium consensus recommendations and a previously published investigation on thermal ablation of spinal metastases,[2,7] yet in only 6 vertebrae (4% of patients) was a bipedicular approach implemented, and all ablations were performed using straight antennas in the vertebral body. Therefore, the CTV could not have been be treated using such approaches. Furthermore, access to tumors in the posterior central vertebral body, which is commonly involved in vertebral metastases, is challenging using straight applicators. This is an important limitation of the current microwave ablation antennas compared with navigational radiofrequency ablation electrodes.[1,2]

The authors describe the use of passive thermal protection by placement of thermocouples in the neuroforamina, which is a critical safety measure when ablating spinal tumors. However, the role of active thermal protection was not discussed, and it is unclear if the authors initiated active thermal protection when thermal monitoring indicated impending thermal injury. The authors' approach to cementation is suboptimal because real-time monitoring of cement distribution was not implemented, and this approach may have been a contributing factor to the high rate of undesired cement leakage, albeit asymptomatic (30%, 42/140 vertebrae). Only a single case of reversible spinal cord compression by the epidural component of the tumor was reported by the authors. The use of low-power-wattage settings along with short and repetitive ablation cycles implemented by the authors supported procedural safety. The investigators' claim of the superiority of the efficacy and time efficiency of microwave ablation compared with radiofrequency ablation for the treatment of bone tumors is misleading and inaccurate. While microwave ablation is less susceptible to variations of tissue

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impedance compared with radiofrequency ablation, studies have demonstrated that both modalities have similar success rates and safety profiles for the treatment of spinal metastases,[2-6] and direct comparison of the total ablation time is inaccurate because variable ablation protocols may be implemented to achieve the desired patient outcome (such as the entire CTV).

While several recent studies have demonstrated excellent efficacy, safety profile, and durability of the treatment effects of microwave ablation, radiofrequency ablation, and cryoablation to achieve pain palliation and local tumor control in a subset of patients with spinal metastases, prospective studies with larger patient cohorts are warranted to not only provide more robust levels of evidence but also offer insight into possibly establishing specific ablation protocols for each ablation technique.

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