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Microwave Ablation of Spinal Osteoid Osteoma—Role of Air Insulation

Ajit Yadav[1] Raghav Seth[1] Arun Gupta[1]

[1] Department of Interventional Radiology, Sir Ganga Ram Hospital, New Delhi, India

Address for correspondence Arun Gupta, MBBD, MD, EBIR, Department of Interventional Radiology, Sir Ganga Ram Hospital, New Delhi 110060, India (e-mail: irdrarungupta@gmail.com).

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Abstract

Osteoid osteomas are benign tumors seen in children and young adults. The management options include surgical resection and percutaneous ablation. In the present scenario, percutaneous ablation is the preferred modality, as it is minimally invasive, safe, and reliable. However, when the tumor is near a heat-vulnerable structure, thermal injury can occur.

We report the case of spinal osteoid osteoma in a young female that was treated by microwave ablation (MWA) with air insulation to prevent heat injury to the spinal cord. Currently, there is paucity of literature describing the use of air insulation with MWA. In this report, we describe the technique, advantages, and limitations of using air insulation with MWA.

Keywords
- osteoid osteoma
- microwave ablation
- air insulation

Introduction

Osteoid osteomas are benign bone tumors that involve the long bones and spine most commonly. The most common presentation in these cases is painful scoliosis (concave on the side of the lesion) with or without soft tissue swelling. Pathologically, the tumor contains three concentric regions: innermost nidus (neoplastic meshwork of osteoblasts, dilated vessels, and osteoid), middle fibrovascular rim, and outermost reactive sclerosis. The actual cause of pain is the release of prostaglandins by the nidus. The diagnosis of osteoid osteoma is based on imaging. On computed tomography (CT), the nidus is seen as a central hypodensity with or without central calcification and surrounding sclerosis. On magnetic resonance imaging (MRI), the nidus shows low signal intensity on T1-weighted images and variable signal intensity on T2-weighted images with enhancement of the nidus on postcontrast images. Surgery and percutaneous ablation are considered as treatment options for these lesions, with ablation proving to have a lower hospitalization period and fewer complications as compared to surgery.

We report the case of a young female with an osteoid osteoma in the dorsal spine, which was managed by microwave ablation (MWA) (with air as the insulating agents for preventing thermal injury to the spinal cord) as surgical option was refused by the patient. The patient was symptom-free after the procedure without any neurological deficit.

Technique

A 25-year-old female presented to the Department of Interventional Radiology, with painful scoliosis for 1 year. The visual analog pain score (VAS) of the patient was 10. CT scan showed a well-defined lesion (8 mm in size) with a central nidus and surrounding sclerosis in the right lamina of the T11 vertebra, located 5 mm away from the spinal cord (►**Fig. 1**). MRI showed a central low signal-intensity nidus on T1-weighted images with mild edema in the surrounding right

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Fig. 1 Preprocedural axial computed tomography section showing the nidus with surrounding sclerosis in right lamina of T11 vertebral body—white arrow.

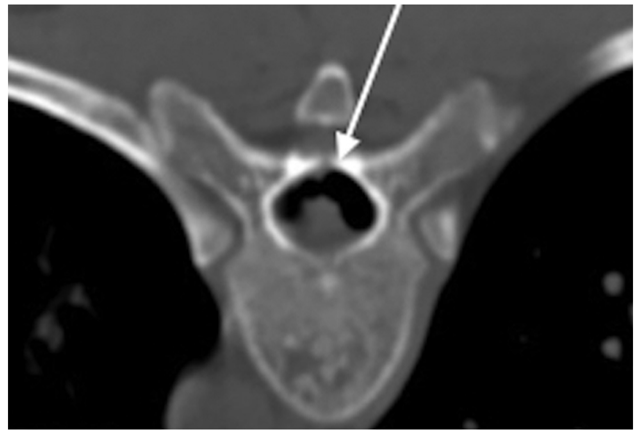

Fig. 3 Intraprocedural axial computed tomography section showing air-cuff (white arrow) around the spinal cord.

lamina. Postcontrast images showed enhancement of the nidus. A diagnosis of spinal osteoid osteoma was made. The patient was categorized as class I according to the American Society of Anaesthesiologists' classification. Her clinical examination, airway, spinal anatomy, and preoperative laboratory investigations were within normal limits. She was planned for CT-guided MWA of the lesion under general anesthesia.

The lesion was localized under CT guidance and after the induction of general anesthesia, a 11-gauge bone access cortical drill (Arrow On Control, Teleflex Inc., Morrisville, North Carolina, United States) was used to traverse the bone cortex. Subsequently, the coaxial advancement of a 13-gauge coring needle was performed into the nidus using intermittent imaging guidance. Then, the coring needle was removed and a 16-gauge, liquid-cooled microwave antenna with a 10cm shaft and 3.5mm exposed tip (ECO Medical Saberwave Microwave tumor ablation system, Jiangsu, China) was placed in the lesion. At the same level, a spinal needle (22 gauge) was inserted into the epidural-space under CT guidance (►**Fig. 2**), using an interlaminar approach (the spinal needle was placed through the interlaminar space and ligamentum flavum into the epidural space on the same side of the lesion). Subsequently, 10cc of air was infused in aliquots. A repeat CT scan was performed to assess the completeness of the air-cuff around the spinal cord. An air-cuff of 5 mm thickness outlining the epidural space was seen with an increased distance between the spinal cord and the lesion (►**Fig. 3**). MWA was performed at 40 watts for 60 seconds (single cycle) with an ablation zone of 18 mm (along the length of the antenna) x 10mm (width of the ablation zone).

The procedure was uneventful. Postprocedure CT showed the ablation tract as a linear hypodensity in the location of the lesion with an intact air-cuff around it (►**Fig. 4**). There was complete resolution of pain on postprocedure day 1(VAS 0/10), without any sensory or motor deficit. The patient was followed up by a monthly clinical examination. No recurrence of pain was reported by the patient.

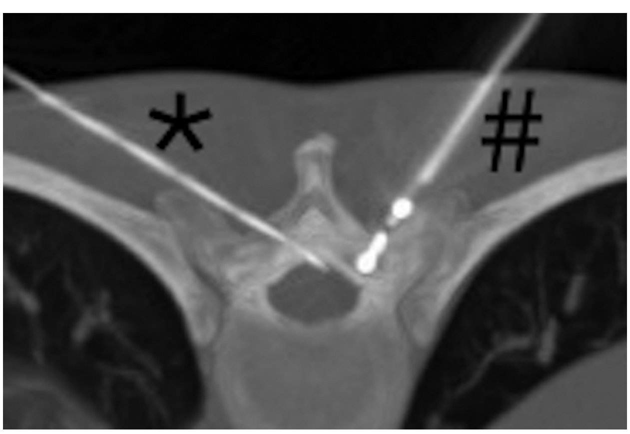

Fig. 2 Intraprocedural axial computed tomography section showing the microwave antenna (#) placed in the lesion along with the spinal needle (*) for injection of air.

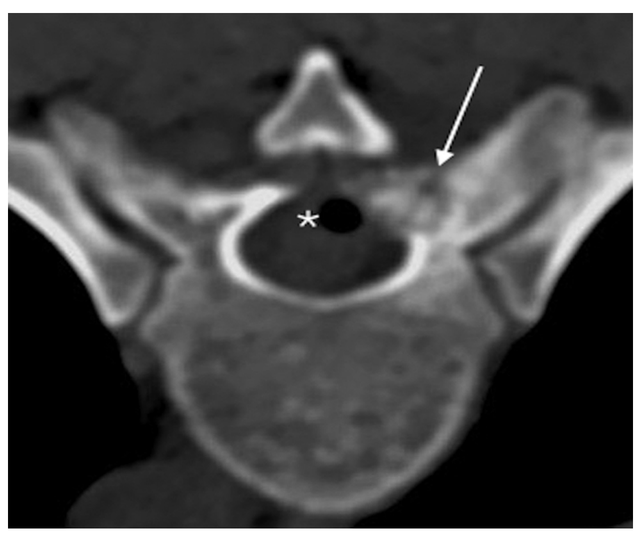

Fig. 4 Postprocedural axial computed tomography section showing the tract (white arrow) of the microwave antenna used for ablation with air-cuff (*) around the cord.

Discussion

Thermal ablation is now an established first-line treatment modality for osteoid osteoma. It includes a variety of modalities like radio-frequency ablation (RFA), MWA, and laser ablation. Due to its good efficacy and safety profile, MWA is gradually being established as a treatment option for osteoid osteoma. In MWA, percutaneous microwave antennae are placed under CT guidance, which deliver high-energy alternating electromagnetic waves leading to frictional heat generation and peak temperatures up to 150 °C. This leads to coagulative necrosis and protein denaturation. The target temperature is reached rapidly in MWA as compared to RFA, thus leading to a shorter ablation time. In the pediatric population, a shorter ablation time is extremely important due to concerns regarding cumulative anesthetic use.

An important consideration of any form of thermal ablation for spinal lesions is the injury to the spinal cord and surrounding nerve roots. Many studies have tried to analyze the major factors responsible for heat transmission to the spinal canal during thermal ablation. These factors include distance of the neural elements to the heat source, a possible insulating effect of the intervening cortical and medullary bone and the length of the antenna/probe used. According to Dupuy et al, both the cortical and cancellous bone have a thermal protective effect for the spinal cord.[1] They also postulated a protective effect of the cerebrospinal fluid (CSF) pulsations and epidural blood flow. However, Nour et al conducted an experiment using RFA on pigs, and found serious neurologic injuries despite an intact intervening cortex.[2] As the studies on the protection of the neural elements by natural barriers like bone and CSF have conflicting results, additional neural-protection techniques must be used during thermal ablation of spinal lesions, for an additional margin of safety. These neural-protection techniques can be either active or passive. Passive techniques include using temperature monitoring tools like thermocouples, intraoperative monitoring of nerves by evoked potential electrodes or by electromyography. Active protection techniques include insulation by air and hydrodissection. Apart from gas insulation and hydrodissection, the availability of the rest of the devices is limited.

Both hydrodissection and gas dissection increase the distance between the probe and the structure to be protected and hence help in producing a safe ablation zone. Whenever hydrodissection is used with RFA, 5% dextrose in water is preferred over normal saline as the latter has a high electrical conductivity.[3] However, for MWA, any fluid can be used. As far as gas dissection is concerned, it can also help in the protection of the neural elements, due to its insulating effect and increase in distance between the probe and the spinal cord. The use of air as well as carbon dioxide insulation[3–5] has been successfully demonstrated, with RFA. However, the literature on the use of air/carbon dioxide insulation with MWA for spinal osteoid osteoma is extremely scarce.

This report suffers from various limitations. Carbon dioxide is considered a superior protective agent than air for thermal ablation, as it is a better insulator than air and is less soluble than air (reducing the chances of air embolism).[4,5] However, specialized prefilled syringes are required for using carbon dioxide, which are not available at our institution. Nevertheless, there have been no reports of air embolism with such minute quantities of air injected epidurally under imaging guidance. Although MWA shows consistent surface temperatures with less variation, in comparison to RFA, it is preferred to use a thermocouple in the epidural space for temperature monitoring. However, it was not used in this study due to its nonavailability at our institution.

Thermal protective techniques like epidural injection of air may provide adequate insulation and neuroprotection during thermal ablation of spinal osteoid osteoma. However, further studies with larger sample sizes and longer follow-up periods are required to confirm the findings.

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Conflict of Interest
None declared.

References

1 Dupuy DE, Hong R, Oliver B, Goldberg SN. Radiofrequency ablation of spinal tumors: temperature distribution in the spinal canal. AJR Am J Roentgenol 2000;175(05):1263–1266
2 Nour SG, Aschoff AJ, Mitchell IC, Emancipator SN, Duerk JL, Lewin JS. MR imaging-guided radio-frequency thermal ablation of the lumbar vertebrae in porcine models. Radiology 2002;224(02):452–462
3 Filippiadis DK, Tutton S, Mazioti A, Kelekis A. Percutaneous image-guided ablation of bone and soft tissue tumours: a review of available techniques and protective measures. Insights Imaging 2014;5(03):339–346
4 Tsoumakidou G, Buy X, Garnon J, Enescu J, Gangi A. Percutaneous thermal ablation: how to protect the surrounding organs. Tech Vasc Interv Radiol 2011;14(03):170–176
5 Vidoni A, Grainger M, James S. Experience of neuroprotective air injection during radiofrequency ablation (RFA) of spinal osteoid osteoma. Eur Radiol 2018;28(10):4146–4150

