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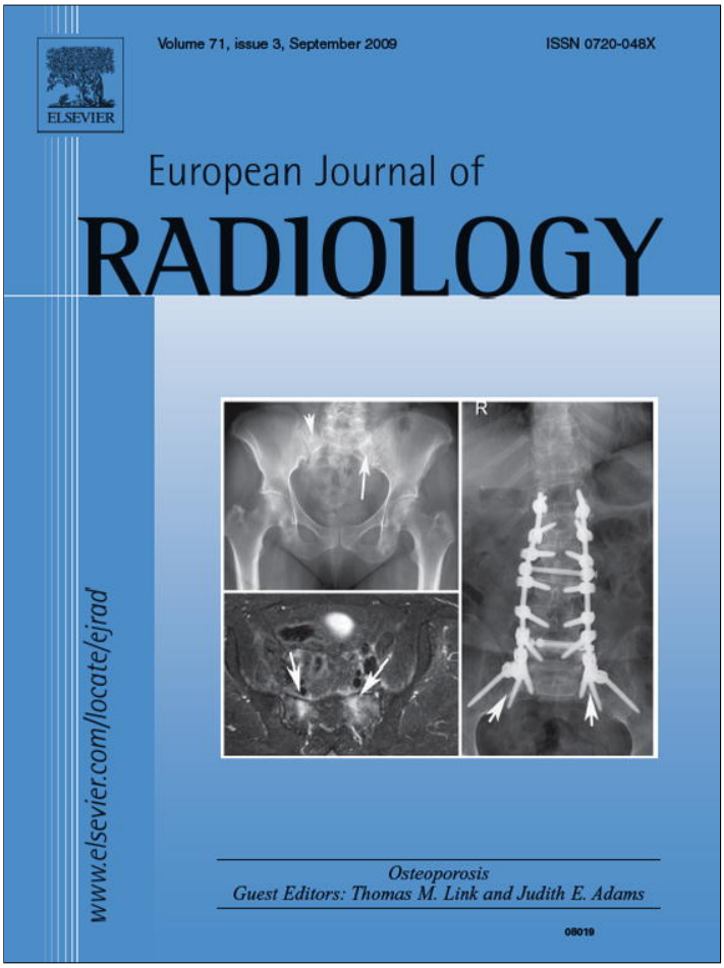

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Osteoid osteoma of the spine: CT-guided monopolar radiofrequency ablation

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Abstract

CT-guided percutaneous radiofrequency ablation and laser photocoagulation have become the methods of choice for the treatment of all osteoid osteomas except those in contact with neural structures.

We report 10 patients with spinal osteoid osteoma adjacent to the neural elements treated with 12 sessions of CT-guided monopolar radiofrequency ablation. The size range of the lesion was 3–14 mm (mean, 7.5 mm) and the distance between the nidus and the adjacent spinal cord or nerve root was 2–12 mm (mean, 5 mm). No intact cortex between the tumor and the spinal cord or nerve roots constituted an exclusion criterion because of a higher risk of undesirable neurotoxic effects.

Patients were under general anesthesia. After location of the lesion, a 11G-bone biopsy was introduced into the nidus. The radiofrequency electrode was inserted through the biopsy needle and heated at 90 °C for 4 min.

Primary success was obtained in eight patients.

At follow-up (mean, 19.5 months; range, 6–24 months), pain persisted in two patients after 2 months. Both of them were re-treated. All patients are currently pain-free and complications were not detected.

In our opinion, radiofrequency ablation can also be considered the treatment of choice for spinal osteoid osteoma.
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Keywords: Radiofrequency ablation; Osteoid osteoma; Spine; Computed tomography

1. Introduction

Osteoid osteoma is a common bone tumor which is small and benign but, nonetheless, painful, and which has a central nidus that rarely exceeds 15 mm in diameter [1]. It is not commonly located in the spine (10%) and when it presents at this site it is more frequently found in the lumbar region (59%). It usually involves the posterior elements of the vertebra but it can also arise from the vertebral body. Despite its small size, this tumor is very symptomatic indeed. When endeavouring to reach a diagnosis, the behaviour of such tumors and their location may be misleading; they may be overlooked and other etiologies suspected, thus delaying treatment.

Although surgical excision is still used in some hospitals, it is no longer always the treatment of choice. Nowadays, if the site of the osteoid osteoma permits, radiofrequency (RF) ablation is often preferred [2–10], except in cases of spinal osteoid osteoma, where surgical excision continues to be recommended due to the associated risk of injure to neural elements [2]. Spinal lesions constitute an area of special interest in view of the hazards inherent in surgery for both patient and surgeon, which give rise to the need for a minimally invasive treatment.

Our paper assesses the safety and efficacy of CT-guided percutaneous RF ablation of osteoid osteoma located in the spine, when correctly performed. No larger additional records of osteoid osteoma confined to the spine and treated by percutaneous RF ablation were found in the literature reviewed.

2. Materials and methods

The approval of the ethical review board was obtained for the retrospective study. Patients with no intact cortex between the

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tumor and the spinal cord or nerve roots were excluded from the study because of a higher risk of undesirable neurotoxic effects.

During the period from March 2002 to February 2007, 12 consecutive patients with spinal osteoid osteoma were possible candidates for RF ablation, although one had, in fact, an osteoblastoma since the lesion measured more than 20 mm in diameter. The cortical was disrupted and it was not considered feasible to remove the entire tumor using only RF ablation without neurotoxicity resulting. The 12 candidates also included an 11-year-old girl with a tumor in the vertebral body, whose parents declined treatment by RF ablation, preferring surgery.

The remaining 10 patients comprising were seven males and three females with a mean age of 27 years (range 6–43 years) underwent CT-guided monopolar radiofrequency ablation.

A total of 12 RF ablation procedures were performed in these 10 patients.

None of the tumors had been surgically treated before. All patients were medicated with nonsteroidal anti-inflammatory drugs.

All patients referred spontaneous onset of back pain that was described as severe, sharp and typically more intense at night or when at rest. Aspirin or ibuprofen provided relief in all patients.

Plain radiography, bone scintigraphy, computed tomography (CT) and magnetic resonance imaging (MRI) were performed in all patients. Lesions were undetectable on plain radiographies. CT was performed with a 16-MDCT scanner (LightSpeed, General Electric Healthcare, Milwaukee, Wis). Osteoid osteoma was detected as a well-defined round lucency measuring from 4 to 10 mm, suggesting the diagnosis with reasonable probability. Increased isotope uptake was seen in all cases. MR images were acquired with a 1.5T scanner (Signa Horizon, GE Healthcare). T1-weighted and STIR images showed a large amount of edema surrounding the nidus. MR data were not included in our analysis.

Diagnosis was stated by means of typical clinical and imaging data, as reported by most authors [3–5,7–10]. Therefore histopathological examination was not considered.

CT has been the standard imaging technique for evaluating the location and size of the nidus of the osteoid osteoma, and for establishing whether the cortex remains intact between the nidus and the spinal canal (Fig. 1). When cortical bone integrity was not clearly demonstrated by imaging modalities, surgical excision was the treatment of choice.

Before undergoing RF ablation, written informed consent was obtained from each patient. All candidates were informed of alternative treatments. Patients underwent RF ablation for the first time. Procedures were carried out under general anaesthetic in the CT room. The patient was placed in a prone position and a posterior approach was used. We performed the procedure in the spine using the same technical steps described by Pinto et al. [6]. After location of the nidus, an 11G-bone biopsy needle (Biopsybell, Medical Devices) was introduced into it, then the drill was removed and exchanged for an 18G RF electrode. Special care was taken to avoid entering the spinal canal or neural foramina. We used a 10 mm exposed non-cooled-tip electrode (Radionics, Burlington, MA), instead of the traditional non-cooled 5 mm electrode [9]. After checking not only that the electrode was adequately placed (Fig. 2) but also that the exposed tip did not touch the penetration cannula, the electrode was connected to a radiofrequency generator (RFG-3C, Radionics, Burlington, MA) and two grounding pads were placed over the skin of the patient, close to the entry point, to decrease the density of the electrode field and to reduce the risk of skin burns.

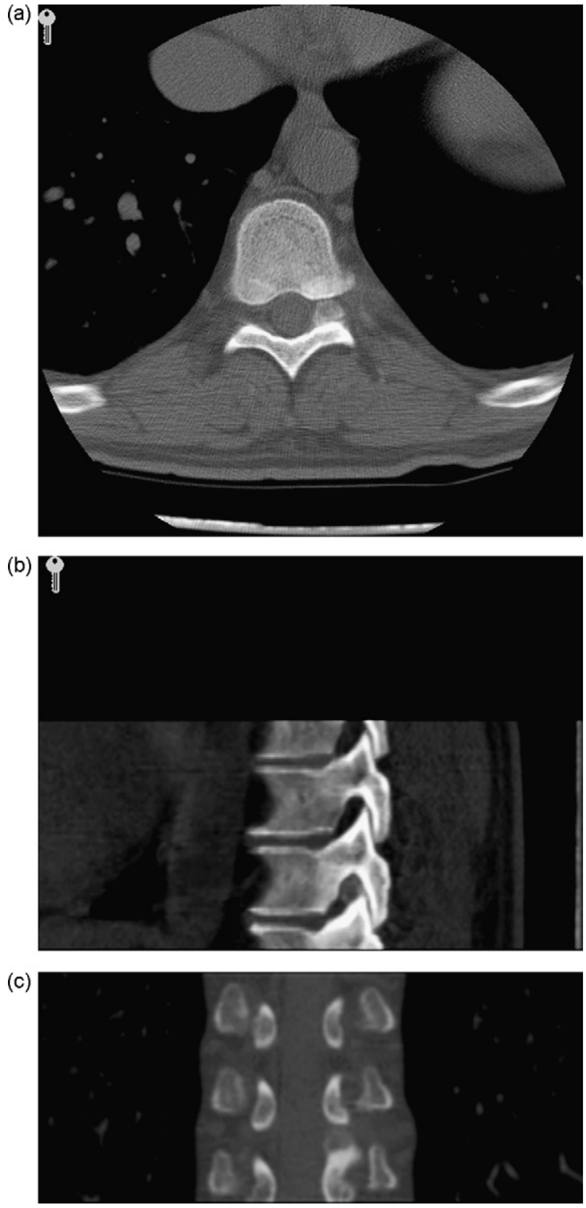

Fig. 1. Axial plane (a), sagital (b) and coronal (c) reconstruction showing a radiolucency with surrounding sclerosis in the left superior articular facet of T10. Lesion is inside the foramina and in contact with the nerve root. Cortical bone is preserved (case no. 8).

Radiofrequency-activation time was 4 min providing that the core temperature reached a minimum range of 90 °C and could be extended up to 6 min if less than this temperature were reached. This situation was achieved three times. The occupancy time of the CT room ranged from 90 to 120 min.

Patients were discharged from the hospital within the following 24–36 h without any neurological deficits. Nevertheless,

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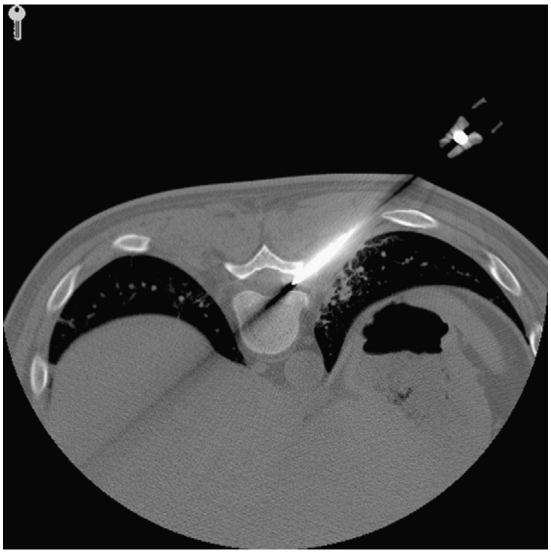

Fig. 2. Transverse CT scan shows the RF electrode within the nidus.

they were informed that in the case of any pain recurrence they should contact our department as soon as possible.

Patients were allowed full body movement and function without limitation after the procedure.

Complete pain relief was a necessary condition in order for the ablation to be considered a success.

Pain was evaluated with a visual analog scale (VAS). To this end, the patients were interviewed face-to-face or over the phone 24 h after their discharge from the hospital. Pain reduction was the main criterion for evaluating the effectiveness of CT-guided RF ablation. All cases were followed up with fortnightly visits during the first 2 months. The VAS score was assessed and potential complications like skin burns, soft-tissue haematoma, infection or neurological deficits were monitored by means of patient examination. All patients underwent CT and bone scintigraphy imaging (Fig. 3) 2 months after the procedure. Further clinical visits were performed every 6 months. We assumed that healing could be confirmed after completing a follow-up of 24 months and no more controls were performed. At that time, CT and bone scintigraphy examinations were repeated.

3. Results

Table 1 presents our data. One osteoid osteoma was located in the cervical spine, four in the thoracic spine and the remaining five in the lumbar region. The pedicle was involved in three cases, the pars interarticularis and superior facets in four cases and the laminae in the other three cases.

The size range of the lesion was 3–14 mm (range, 7.5 mm) and the distance between the nidus and the adjacent spinal cord or nerve root was 2–12 mm (range, 5 mm).

In seven patients pain disappeared post-RF ablation within 10–15 days (VAS score of 0). One patient reported complete pain relief a month after the procedure had been performed.

Persistence of pain (VAS score more than five) was observed in two patients. The RF ablation was repeated in these cases, achieving successful results in both patients. Our primary

Fig. 3. Patient remains pain-free after 6 months. Osteoid osteoma has been replaced by sclerotic bone. Transverse (a), sagital (b) and coronal (c) images.

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Table 1
Main characteristics, treatment and evolution

Patient	Sex	Age	Nidus size (mm)	Distance to nearest neural structure (mm)	Ablation procedure no.	Location	VAS score BP[a]	VAS score AP[b]	Time required to be pain-free	Repeated RF ablation	Follow-up
1	Male	43	6	12	1	Superior facet L4	8	0	1 month	–	24
2	Male	26	14	9	2	Pedicle L4	10	7	No after 2 months	Yes	–
2					3		7	0	15 days	–	24
3	Female	17	7	4	4	Pedicle L3	8	0	Same day	–	24
4	Female	6			5	Laminae L1	8	0	2–3 days	–	24
5	Male	37	11	3	6	Pedicle T4	9	0	10–15 days	–	24
6	Male	28	9	4	7	Laminae T12	7	0	10 days	–	24
7	Male	37	13	5	8	Superior facet T1	9	6	No after 2 months	Yes	–
7					9		6	0	15 days	–	24
8	Male	39	8	2	10	Superior facet T10	8	0	Same day	–	12
9	Male	29	3	4	11	Superior facet L1	8	0	15 days	–	9
10	Female	41	4	7	12	Laminae C5	7	0	15 days	–	6

[a] Before the procedure.
[b] After the procedure.

and secondary clinical success rates were 80 and 100%, respectively.

After the procedure, no complications such as bleeding, nerve injury or skin burns were observed in any of our patients.

The minimum and maximum follow-up periods were 6 months and 24 months, respectively (mean, 19.5 months). Seven patients had no recurrence of pain after 24 months. In these cases, repeated bone scintigraphy was normal and CT showed complete or partial sclerosis of the nidus. The other three patients remained pain-free after 12, 9 and 6 months.

4. Discussion

Several advances in the treatment of osteoid osteoma have been made in the last decade. CT-guided RF ablation has been proven to be an accepted, safe, minimally invasive, and cost-effective treatment for this benign but painful tumor [2–10].

Sometimes, this tumor regress over time and therefore conservative therapy appears to be a reliable option [11]. However, the duration and possible side effects of this treatment make this procedure unpopular among patients, especially the youngest. In the presence of pain or increasing pain osteoid osteoma should be treated more aggressively.

Until recently, the complete surgical excision of the nidus was the treatment of choice for symptomatic osteoid osteoma. The difficulty in locating the tumor intraoperatively and the potential postoperative complications derived from a wide bone excision in order to find the nidus has determined the use of other minimally invasive techniques like RF ablation [2–10].

Little is published in the literature about this procedure applied to this type of tumors located in the spine. The first case that we have found of an osteoid osteoma located in the lumbar region and treated successfully with RF ablation in 1998 is attributed to Osti and Sebben [12]. With CT guidance they inserted a 2-mm guiding cannula into the centre of the nidus and a 1 mm electrode was introduced in this cannula. The cannula covered all but the last 5 mm of the entire length of the electrode. Their technique is very similar to ours although we used a 10 mm exposed non-cooled-tip electrode. Osti et al. reported a 16-month follow-up without recurrence of pain.

Cove et al. [13] reported two RF ablation procedures with the same technique. At 2-year follow-up both patients were free of symptoms.

Samaha et al. [14] reported three cases of osteoid osteoma in different locations of the spine which were treated successfully with RF ablation. There was no evidence of recurrence after a mean follow-up period of 17 months. They were located in the cervical, thoracic and lumbar spine, respectively. Their paper concludes that RF ablation of osteoid osteoma in the spine is a recommendable procedure, even in those very close to the spinal canal, but larger series of patients treated with RF ablation are needed.

Sutphen and Murakami [15] attempted the ablation of a cervical vertebral body lesion using a rare and difficult technique. Because of its difficult-to-treat location and the risk of thermal damage to neural or vascular structure, they decided that the safest access to the tumor was a transthyroid needle approach. A 7-mm exposed tip was positioned across the lesion and heated

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to 90° for 4 min. The patient was pain-free within a month. No symptoms had recurred by the 4-month follow-up.

We used the same technique chosen by these four authors and our results are in agreement with the outcome of the studies and case reports cited above.

Many radiologists do not perform RF ablation on patients with spinal osteoid osteoma because of the risk of neural system damage [2]. They believe that cortical bone is not a reliable heat insulator and advise that the electrode should be at least 10 mm away from major nerves.

Experimental studies with animals using CT-guided percutaneous RF ablation in the spine have been published in an attempt to demonstrate that they can be treated with radiofrequency ablation without neurotoxicity. Dupuy et al. [16] in their published study first described the use and complications of RF ablation in the vertebral bodies of five adult pigs and went on to treat successfully with RF ablation a patient with vertebral body metastasis and another one with an osteoid osteoma in the T11 pedicle.

This study showed that in cases where preserved cancellous bone or cortical bone is present between the lesion and the spine, a margin of safety will be provided with no cytotoxic temperature elevations in the spinal canal. An additional factor that may account for the local heat decreases is the presence of a rich epidural venous plexus and the cerebrospinal fluid circulation.

Nour et al. [17] experimented by ablating the vertebral spine of 10 pigs. They used the RM to achieve the correct placement of the biopsy needle and the electrode and to monitor the complications of the procedure. They argued against the insulating effect of cortical bone after using RF in the pedicles and in the most posterior part of the vertebral body. Neurological damage and muscle edema were found histologically. So they concluded that the safety of the technique depends on which part of the vertebra is ablated.

Another therapeutic method used for the treatment of osteoid osteoma is interstitial laser ablation. Some authors have published studies trying to prove that this method is a feasible and safe treatment for this tumor. Gangy et al. [18] reported a large series of 114 patients with osteoid osteoma cured by thermal ablation by mean of laser. Twelve lesions were in the spine. CT guidance and a diode laser with a 400-μm optical fibre were used. The charge to be delivered to the nidus was chosen in accordance with the latter's size but, in most cases, constituted a maximum of 1200 J. The needle was positioned in the centre of the nidus, at least 8 mm from neurological structures. In five cases the nidus was nearer and they used a slow epidural or periradicular infusion of normal saline to avoid neural thermal damage. In our experience, in order to prevent thermal damage the presence of an intact cortex could be more significant than the distance between the lesion and neural structures.

The experience of some authors [12–13,16] just in experimental studies [14,19], and our own results as presented here, consistently demonstrate that radiofrequency ablation is a safe technique as long as patients are correctly selected; that means excluding those in which we cannot assure complete cortex indemnity and lack of contact with neural structures [14].

In these cases extreme precautions should be taken, placing the needle as far away as possible from neural elements and using the shortest time possible to prevent thermal damage to the spinal cord and nerve roots. Unlike Gangi et al. [18], we do not consider it necessary to administrate a cooling solution to the surrounding region because, like Dupuy et al. [16] we assume that cerebrospinal fluid circulation helps to decrease local temperature during RF ablation, acting as an insulator between the lesion and the nervous system.

Gangi et al. [18] considered that all osteoid osteomas should be treated either with RF ablation or laser ablation, rather than with surgical or percutaneous resection. No studies were found comparing these two techniques.

5. Conclusion

The clinical cases that we have presented show that CT-guided percutaneous RF ablation of vertebral osteoid osteoma is a safe and effective method that should be considered the procedure of choice in the majority of cases. The technique might be contraindicated when no intact cortex is evident between the nidus and the neural structures.

Larger series are needed to evaluate the efficacy and safety of this method and to support its use in the management of all osteoid osteomas despite their location.

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