Follow-up of thirty-three computed-tomography-guided percutaneous radiofrequency thermoablations of osteoid osteoma

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Abstract

Purpose This study aimed to determine the mid- and long-term success and complication rates of radiofrequency ablation (RFA) in treatment of osteoid osteoma (OO). Furthermore we were interested in the value of bone biopsy when using a core-drill before the radiofrequency ablation. **Methods** We retrospectively analysed data of 33 patients (33 osteoid osteomas, 22 males, 11 females) who underwent computed-tomography (CT) guided radiofrequency ablation between 1998 and 2005. The patients had a mean age of 20 years (range, five to 50 years). They were monitored for a mean follow-up of 92 months (range, 60–121 months). **Results** Lesions were located as follows: 11 cases in the proximal femur, five in the femoral shaft, six in the tibia, one in the calcaneus, two in the metatarsals (second and fourth metatarsals), one in the os cuneiforme mediale, six in the humeral and one in the ulnar shaft. Within the presented time frame 32 of 33 patients were successfully treated and had no more complaints. In one of 33 patients relapse occurred after 28 months and RFA was repeated. There were no complications associated with the procedure. Biopsy obtained prior to thermocoagulation with the help of a core-drill was able to prove diagnosis in all patients (100%). **Conclusions** These results indicate that the presented technique of CT guided RFA combined with the use of a

core-drill for biopsy prior to RFA treatment is a highly effective, efficient, minimally invasive and safe method for the treatment of OO, yielding a success rate of 97% combined with a 100% histological verification of the diagnosis after a minimum follow-up period of five years.

Introduction

The osteoid osteoma (OO), first described by Bergstrand in 1930, was defined by Jaffe in 1935 as a primary benign osteoblastic tumour [1]. According to the WHO guidelines it consists of an osteolytic defect with sharp margins, measuring 0.5–2 cm in size. Various imaging modalities, such as radiography, bone scintigraphy and magnet resonance imaging (MRI) enable diagnosis. Computed tomography (CT) is highly useful by depicting the nidus as well as the surrounding sclerosis and periosteal bone reactions [2, 3]. Osteoid osteoma comprises 10% of all benign bone tumours [4] and is associated with pain, which classically worsens at night and responds well to salicylates. Even though 75% of all OO are diagnosed in children and young adults, they may occur in the mature skeleton up to 70 years of age [5]. Frequently, OO is located in the cortex of long bones. Frequent sites are femur or tibia (50%), while 10% occur in vertebrae [1]. The central nidus contains osteoblasts and osteoid with nerves and vessels in the periphery of the lesion. For the treatment of OO surgery, conservative treatment with nonsteroidal anti-inflammatories and percutaneous interventions are potential options. Surgery is frequently associated with major morbidity and a prolonged period of recovery (especially after en-bloc resection of osteoid osteoma in weight bearing bones), while long-term

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drug administration may result in gastrointestinal side effects and is not well tolerated by patients.

Rosenthal was the first to describe radiofrequency ablation (RFA) as a minimally invasive option for the treatment of OO [6, 7]. In recent years, the use of computed tomography (CT)-guided percutaneous radiofrequency thermoablation (PRT) has been reported with good results and this has been shown to have similar recurrence rates to open surgery but with fewer complications and shorter periods of hospital stay [7, 8]. Several studies have been published describing the outcome and side effects of RFA. However, few large series have been published and mid- and long-term follow-up studies describing this method are rare [7]. Therefore the purpose of our study is to report our experience of the technical and clinical success, complications, histological results and especially long-term outcome after an observation period of up to ten years after RF ablation of OO.

Materials and methods

All patients diagnosed as suffering from osteoid osteoma who were treated by the method described were retrospectively evaluated. Between 1998 and 2005, 33 patients with 33 osteoid osteomas (22 males and 11 females) were treated. The diagnosis was established from patients' histories, X-rays, bone scintigraphy depicting a hot spot and CT scans (Figs. 1, 2, 3 and 4). The distribution of tumour location was as follows: 11 cases in the proximal femur, five in the femoral shaft, six in the tibia, one in the calcaneus, two in the metatarsals (second and fourth metatarsals), one in the os cuneiforme mediale, six in the humeral and one in the ulnar shaft.

In all patients the nidus was not larger than 10 mm in diameter. Patients' ages ranged between five and 50 years with an average age of 20 years.

The procedures were carried out by an interventional radiologist and orthopaedic surgeon in the CT room. After general or spinal anaesthesia, the patient was positioned on the CT bed and the lesion was confirmed by CT imaging. The entry point on the skin was marked and aseptic preparation was done. A small skin incision was made at the entry point and blunt dissection was done to prevent neurovascular injuries. Then a thin K-wire was advanced to the bone and tapped gently with a mallet until it advanced into the nidus after reconfirming the position of the nidus by CT imaging. In all cases a hand-driven, 5-mm diameter core-drill was then used over the K-wire to create a small diameter canal that reached the nidus. Soft tissue protection was achieved by one or two small Langenbeck retractors. As the drill was hand-driven no additional cooling procedures were needed. At this point the nidus was

Fig. 1 Preoperative anteroposterior X-ray of the left tibia (male patient, 13 years old). Significant reactive sclerosis on the medial aspect of the tibia (Radiograph obtained 4/2006)

removed with the core-drill and the specimens gained were sent for histological examination. After that a straight electrode was placed through the canal (Fig. 5). Then thermal ablation was done at 95–100°C for an average of 1.5 min (range, one to two minutes). After the procedure, a sterile compression dressing was applied.

Fig. 2 Preoperative sagittal CT scan image depicting the nidus (CT scan obtained 4/2006)

Fig. 3 Corresponding, preoperative MRI scan (sagittal, T2 weighted) depicting significant oedema in the area of the surrounding sclerosis (MRI scan obtained 3/2006)

Tissues were preserved in a 4% buffered formalin solution and decalcified in 10% formic acid. They were then embedded in paraffin wax and cut to obtain 4- μ m thick sections. The sections were stained with hematoxylin and eosin and were subjected to microscopic analysis (Figs. 6a, b).

Computed tomography reconfirmed that the nidus was in fact removed. The skin wound was closed with a single suture.

Fig. 4 Preoperative bone scan (4/2006) showing intense radioisotope uptake in the medial aspect of the tibia, presenting a punctum maximum in the area of the nidus

Fig. 5 Intraoperative CT scan (4/2006) showing the intralesional position of the radiofrequency probe

Fig. 6 a, b Histology slides revealing an interlacing network of osteoid trabeculae and a richly vascular stroma

Follow-up was performed clinically after six weeks and one year postoperatively. For the study a clinical and radiological follow-up was done after a period of at least 60 months (mean, 92 months; range, 60–121 months) (Fig. 7).

Results

We performed biopsy during all PRT procedures in 33 patients and gained definitive diagnosis in all 33 (100%) patients. All histological examinations revealed an interlacing network of osteoid trabeculae with variable mineralisation and richly vascular stroma, a finding consistent with osteoid osteoma.

The procedure was technically successful in all cases. After PRT, 25 patients reported immediate pain relief, five patients within the first day and three patients during the second day. The mean admission period from PRT to discharge was two days (range, one to five days). There were no intra- or postoperative complications. All patients with osteoid osteoma in the lower extremities were limited to partial weight bearing for six weeks (26 cases).

During the minimum follow-up of five years, one patient (3%, osteoid osteoma of the humerus) showed a recurrence 28 months after the index procedure and we performed a successful repeat thermoablation; at the final follow-up (60 months after repeat thermoablation) the patient was free of symptoms. All other 32 patients were pain free at the last follow-up and showed no signs of recurrence.

Discussion

The natural history osteoid osteoma is self-limiting and oral administration of NSAIDs can be recommended if the diagnosis is not in doubt. With increasing pain and associated insomnia, many patients seek definitive treatment traditionally achieved by open surgical resection of a bone block containing the nidus and the sclerotic reactive

bone. The main difficulty with this technique is in the intraoperative identification of the nidus, and misjudgment often results in failure of the procedure due to incomplete resection. Incomplete removal usually results in a clinical recurrence [9]. Attempts to overcome this problem have led to the development of numerous methods to improve intraoperative localisation of the nidus [9–14]. Moreover, the removal of large portions of cortical bone weakens the affected long bone considerably and for long periods of time. In view of these disadvantages, the trend is now changing worldwide toward minimally invasive procedures to reduce failure rates and avoid potential complications [9].

The diagnosis of osteoid osteoma mainly relies on history and radiological information. In contrast to the majority of published PRT series [7–9, 14–17, 18, 19] a biopsy was obtained during all procedures; furthermore, all histological examinations confirmed the diagnosis of osteoid osteoma. This is certainly attributable to the fact that easily accessible locations were chosen for this specific form of treatment and the biopsy was gained with a core drill. During the time frame chosen three osteoid osteomas of the thoracal and lumbar spine were treated by open resection and one case situated in the dens axis [13] was treated successfully by oral administration of NSAIDs. Generally, histological confirmation with minimal-access techniques has been reported to be only available in approximately 36–75% of cases [5–8]. Peyser et al. [18] obtained a definite diagnosis in 15 (46.9%) and in the largest series published by Rosenthal et al. [15] nearly 30% of all biopsies did not confirm the diagnosis of OO. Akhlaghpour et al. [20] histologically evaluated drill fragments obtained during radiofrequency ablation and reported a 69.2% rate of specimens confirming the diagnosis of osteoid osteoma. These fragments were obtained during the drilling process using a standard machine-driven drill compared to our method of using a hand-driven core drill with a 5-mm diameter. Other studies even describe the true positive rate to be as low as 36% [2–9].

Fenichel et al. [9] reported a 77% success rate at confirming the histology when using a cannulated curette.

Primary PRT has, in series totalling over 200 patients, had a success rate of 76–100% [8]. In our series, we gained a success rate of 97% (32/33) and an average of two days of hospital stay and no complications. These results are comparable with other good results. Rosenthal et al. [21] compared the results of open versus percutaneous treatment of osteoid osteoma; 68 were treated with open techniques and 33 were treated with percutaneous radiofrequency ablation. Those patients treated with radiofrequency ablation were followed up for an average of 3.4 years and had a 12% recurrence rate. The investigators stated that there was no statistical difference in the recurrence rates between the

Fig. 7 Postoperative anteroposterior X-ray of the left tibia (4/2011, 5 years after RFA). Significant reduction of the reactive sclerosis on the medial aspect of the tibia; the patient is free of any symptoms

two methods. Other authors have reported similar good results and short hospital stays for those patients treated with PRT [5, 7, 8, 22, 23].

With regard to one recurrent case, it is generally said that recurrence after surgical therapy can occur up to 13 years after surgery [5–8]. Our case of recurrence in the humeral bone occurred 28 months postoperatively, a finding inconsistent with the reports of Cantwell et al. [5] and Sung et al. [8] who reported that on average recurrences after PRT occur within the first seven months after surgery. Repeat PRT treatment in the recurrence case was successful and the patient was pain free at the final follow-up 60 months after repeat PRT. As we are only able to present one recurrence within a minimal follow-up period of 60 months, a control period of five years seems sufficient. Furthermore, we think that when the patient is free of symptoms conventional X-rays or other diagnostic measures are not necessary to obtain accurate follow-up results.

To the authors knowledge this is one of the largest series with a minimal follow-up of five years (mean, 92 months). The technique of obtaining a CT-guided biopsy with a core drill followed by thermocoagulation resulted in a success rate of 97%; furthermore, 100% of the biopsies obtained were conclusive and proved the diagnosis.

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