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Osteoid Osteoma; A Diagnostic Protocol and Treatment with Computed Tomography-Guided Radio Frequency Ablation in a Series of 36 Patients

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Abstract

Background and Purpose: Osteoid osteoma (OO) constitutes 10–12% of all benign bone tumors making it one of the most commonly occurring bone tumor. Radiofrequency ablation (RFA) offers a minimally invasive day care treatment option where in the tumor cells in the nidus are thermo-coagulated. The purpose of this study was to highlight the diagnostic protocol of OO and evaluate the safety and efficacy of RFA in its treatment.

Materials and Methods: A total of 36 patients (26 male, 10 female patients; mean age 10.33 years; age range 4–20 years) who underwent computerized tomography (CT) guided RFA treatment for OO of various anatomical locations were included in this study. Patients underwent radiography and CT evaluation for diagnosis. When classical symptoms were absent and CT was inconclusive, patients underwent further evaluation with magnetic resonance imaging (MRI) and nuclear scan. Features suggestive of OO in any two of these investigations were considered confirmatory and such patients were offered RFA. Patients were assessed for abolition of pain after treatment and complications if any were recorded.

Results: The intra nidus location of probe which was considered as technical success was noted in all patients. There was significant improvement in pain after RFA. Visual analog scale score improved from 7.2 preoperatively to 0.6 and 0.0 at 3 months and 6 months, respectively. Two patients of tibia OO had superficial skin burns that healed within 2 weeks. One patient sustained tibia fracture at RFA site after a fall and but was pain free after 20 weeks. At the latest follow-up of 28 months (range 14–56 months), there were no recurrences.

Conclusion: Diagnosis of OO may be challenging at times and additional investigations like MRI/nuclear bone scan along with radiography and CT aid in making an appropriate diagnosis. CT-guided RFA of OO is a safe, effective, and minimally invasive treatment modality with low complication rates.

Keywords: Osteoid osteoma, Computed tomography guided, Radiofrequency ablation, Minimally invasive, Day care.

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Introduction

Osteoid osteoma (OO) is the most common benign bone tumor which predominantly affects young males in their second or third decade of life [1]. It constitutes 10–12% of benign bone tumors and 2–3% of primary bone tumors [2]. OO can occur in multiple locations, but are more frequently seen in the

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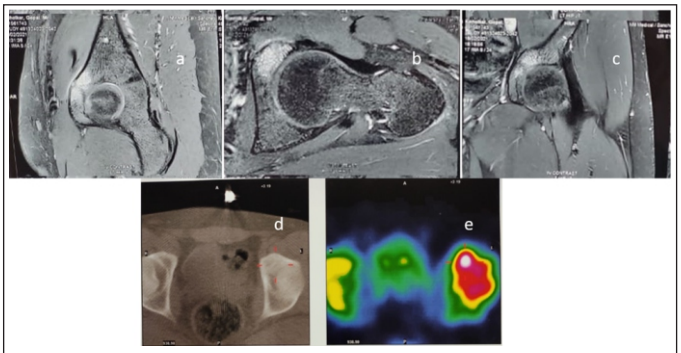

Figure 1: Combination of additional investigations like magnetic resonance imaging (a-c), computerized tomography (d), and nuclear bone scan (e) showing features of osteoid osteoma in anterior wall of acetabulum.

diaphysis of long bones of lower extremity. The characteristic symptom of OO is pain which is worse at night and relieved by nonsteroidal anti-inflammatory drugs (NSAIDs) [3]. Radiologically, the presence of a nidus surrounded by reactive sclerotic bone is pathognomonic of OO. Histologically, these tumors are characterized by increased osteoid tissue formation surrounded by a vascular fibrous stroma and perilesional sclerosis [4]. Unusual presentations of OO such as intra-articular or epiphyseal location, lesions at the extremities with atypical clinical and radiological features which can lead to diagnostic dilemma [5]. Such cases may need additional investigations to arrive at proper diagnosis of OO.

The classical treatment options of OO which includes curettage, en bloc resection or wide resection are associated with complication rates of 20–45%, increased morbidity, longer hospital stay and rehabilitation [6]. In contrast, computerized tomography (CT)-guided radiofrequency ablation (RFA) offers a minimally invasive treatment modality which has low complication rates and contributes to quicker recovery of the patient [7]. For above reasons, RFA is currently considered as preferred treatment of choice for OO. The purpose of our study was to highlight the diagnostic protocol for OO with atypical presentation and to evaluate the efficacy and safety of CT guided RFA in its treatment.

Materials and Methods

This was a retrospective review of patients who were diagnosed to have OO at various anatomical locations and underwent CT-guided RFA. After institutional ethical board clearance, electronic medical records of patients with OO treated at our institution from 2014 to 2020 were collected and analyzed. A total of 36 patients (26 males, 10 females; mean age -10.33 years; and age range 4–20 years) were included in this study. Patients who had symptoms of pain, restriction of joint motion, limitation of activities underwent radiography, and CT evaluation for diagnosis. In cases, where classical symptoms such as nocturnal pain, relief of pain with NSAIDs were absent

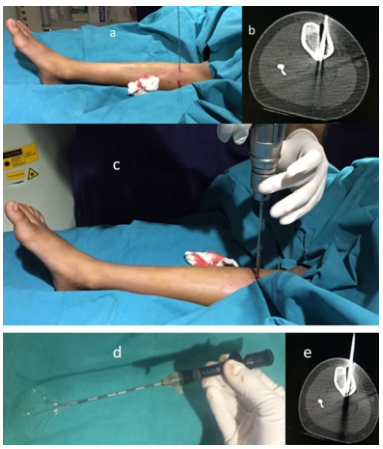

Figure 2: Computerized tomography (CT)-guided introduction of guide wire for osteoid osteoma lesion in tibia (a and b), drilling over guidewire (c), radio frequency probe (d) and confirmation of probe tip under CT guidance (e).

and the CT scan was inconclusive, further evaluation with magnetic resonance imaging (MRI) and nuclear scan was performed (Fig. 1). Features suggestive of OO in any of these additional investigations were considered confirmatory and RFA treatment was offered.

Operative Technique

Patients were positioned on CT scan table under appropriate anesthesia. Earthing pads were applied ensuring good skin contact. The involved site was painted and draped. The entry point was decided according to position of the lesion, adjacent neurovascular structures, and ease of access to the nidus. A guidewire was advanced into the lesion under CT guidance and its position confirmed in all three planes of CT imaging. A 4 mm drill bit was used along the guidewire to make a tract into the nidus. The RFA probe was then inserted and intra-lesional location of probe was confirmed by CT (Fig. 2). The tip of the probe was inserted deep enough to prevent thermal burns. The probe was then connected to the radiofrequency generator and

Figure 3: (a) Radiofrequency ablation machine setting showing temperature range of different tips of probe inside lesion, (b) Charred probe tip following completion of ablation

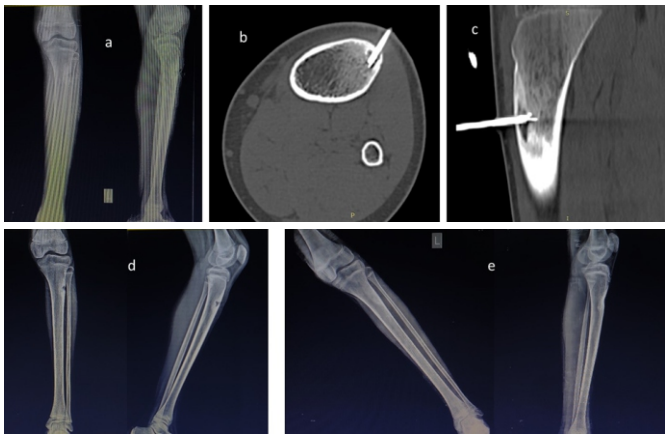

Figure 4: (a) Osteoid osteoma lesion in the proximal tibia in anteroposterior and lateral view radiograph, (b-d) its treatment with radiofrequency ablation and (e) healing of lesion at 12 weeks follow-up radiograph.

target temperature was set at 90°C for up to 5 min to ensure coagulative necrosis of nidus (Fig. 3a and b).

As defined by Society of Interventional Radiology guidelines [8], the procedure was considered technically successful if the tip of the probe was correctly placed into the nidus and the lesion was heated for the required amount of time. The procedure was considered effective when visual analog scale (VAS) score was <2 following RFA [8]. Patients were allowed to return to daily routine activities with guarded weight bearing in the immediate post-operative period but sports activity, heavy weight lifting, and vigorous activities were restricted for 6–8 weeks to avoid stress fractures. The patients were reviewed at 2 weeks, 3 months, 6 months, and 1 year following the procedure.

Visual analog scale was used to assess severity of pain before and after RFA.

Results

Thirty-six patients were available for outcome analysis in which 26 were male and 10 were female. Mean age at time of diagnosis was 10.33 years (4–20 years). Mean duration of symptoms prior to RFA was 7.1 months (2–24 months). All 36 patients were available for follow-up for a minimum of 12 months (14–56 months) (Table 1). Pain at night which was relieved by NSAIDs was the prominent symptom in majority of patients. 12 out of 36 patients did not report diurnal variation of symptoms. Muscle wasting, limitation of joint motion along with restriction of activities were other notable associated symptoms (Table 2). In 11 patients, there was diagnostic doubt at the time of referral to our tertiary care center. They underwent additional investigations in the form of MRI/nuclear bone scan. Technical and clinical success was achieved in all patients. Patients became symptom-free between 1 and 6 weeks after RFA.

The mean pre-operative VAS score was 7.2 (4–10). This decreased to 1.1 at 1 month, 0.6 at 3 months and 0 by 6 months or at latest follow-up. There were no recurrences at latest follow-up of 28 months (14–56 months) (Fig. 4). Two patients with tibial OO developed superficial skin burns that healed within 2 weeks with local application of antiseptic cream (Fig. 5). One patient sustained a tibia shaft fracture at the RFA site due to a fall while playing football at 3 weeks post-procedure. This was treated with an above-knee cast and the fracture healed uneventfully (Fig. 6 and Table 3).

Figure 5: Complication of superficial skin burn following radiofrequency ablation of osteoid osteoma of tibia.

Discussion

OO which was originally described by Jaffe in 1935 is one of the most common benign bone tumors [9]. It is frequently seen in young individuals with a male to female ratio of 2:1. The most commonly used surgical management techniques include open excision of the lesion, CT-guided percutaneous excision and CT-guided RFA [4]. Proper identification of the tumor intraoperatively and complete excision are essential steps to prevent recurrence. Conventional surgical techniques including en-bloc excision of the tumor, cortical shaving or

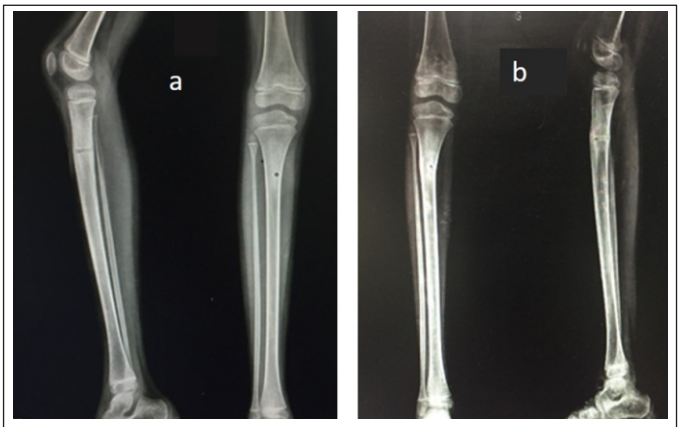

Figure 6: (a) Radiograph showing complication of proximal tibia fracture at radiofrequency ablation site following a fall. (b) Fracture union with cast immobilization.

Table 1: Patient details	
Patient (number)	36
Gender (male/female)	26/10
Mean age (years)	10.33 (4–20)
Mean duration of symptoms before RFA (months)	7.1 (2–24)
Mean follow-up (months)	28 (14–56)
Location of lesion	
Femur	12
Tibia	11
Fibula	4
Radius	2
Others	7
RFA: Radiofrequency ablation	

Table 2: Clinical manifestations	
Symptom variety	**Number of patients**
Night pain relieved by NSAIDs	24
No diurnal variation in pain	12
Refractory to NSAIDS/Allergic to NSAID	04/01
Muscle wasting	6
NSAIDs: Non-steroidal anti-inflammatory drugs	

Table 3: Complications	
Recurrence	0
Superficial skin burns	2
Fracture at RFA site	1
RFA: Radiofrequency ablation	

curettage of the nidus cavity lead to prolonged hospital stay, restriction of activities and need for additional stabilization thereby adding to the cost of treatment and resulting in increased morbidity [10, 11, 12].

CT-guided RFA is a minimally invasive alternative to address these challenges. A radiofrequency probe is carefully inserted into the nidus to cause thermo-ablative necrosis [13]. The tip of the probe must be insulated to prevent injury to the soft tissues adjacent to the OO [14]. Rosenthal et al. in their landmark study comprising 263 patients with mean age of 19 years, follow-up of 24 months have reported excellent outcomes (91% clinical success), faster recovery and low complication rate [12]. Peyser et al. recommend RFA in pediatric OO patients as a safe and effective technique following their study in 22 subjects with mean age of 13 years 6 months. The only procedure-related complication observed in their study was superficial skin infection in tibial diaphyseal OO which resolved with antibiotic treatment [14]. Similar results and recommendations have been confirmed by others [13, 15].

To confirm the diagnosis of OO in patients with atypical presentations, we relied on positive findings of OO in at least two of three modalities, namely, CT, MRI, and nuclear scan. Nuclear scan was found to be a crucial modality in atypical cases where plain radiography was unremarkable. Scintigraphy showed a focal hot spot, reflecting increase uptake of radiotracer at the nidus and allowed precise localization prior to intervention. MRI detects marrow and soft-tissue edema but is less sensitive than CT in localizing a small nidus. Superficial skin burns are a concern with this procedure and it was noted in two patients with tibial OO. There was one instance of a pathological tibial fracture at the RFA site which went on to unite with non-operative management. It is advisable to avoid strenuous exercises and contact sports for 2–3 months after the procedure to prevent such an eventuality. The other possible complications of RFA are cannula/probe tip breakage, intra muscular hematoma, abscess, reactive arthritis and numbness [16]. We did not encounter any of these in our series. The good clinical results noted in this study can be ascribed to precise RFA probe positioning with CT guidance.

Compared to CT-guided RFA, Stealth navigation with 3D imaging offers the additional advantage of lower radiation exposure [17]. Newer methods such as high-intensity-focused ultrasound (HIFU) and MR-guided-HIFU are reported to be noninvasive and radiation free methods in the management of OO [18, 19, 20]. In view of these emerging alternatives, the radiation dose received by patients during CT-guided RFA and its potential long-term effects should be recognized.

The limitations of this study are retrospective study design, small sample size, and short period of follow-up. There was no histopathological confirmation of the lesion following the procedure.

Conclusion

Diagnosis of osteoid osteoma may become challenging at times and a combination of investigations may show confirmatory evidence in cases with unusual presentations. CT-guided RFA is a safe, effective and minimally invasive treatment modality with low complication rates.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil; **Source of support:** None

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