Computerized tomography-guided radiofrequency ablation for osteoid osteoma: preliminary results

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Received: 20 September 2017
Revised: 20 October 2017
Accepted: 28 October 2017
Published: 17 November 2021

The Egyptian Orthopaedic Journal 2021, 56:162–167

Background

Osteoid osteoma (OO) is an osteogenic bone tumor. Clinically, it is characterized by night pain that improves with NSAID treatment. It appears in radiography as a small radiolucent nidus with sclerosis of the surrounding bone. Surgical excision is the classic treatment of choice. However, many noninvasive procedures have been used to avoid the morbidity associated with surgical treatment. The aim of this study was to evaluate the efficacy of modified technique of radiofrequency ablation (RFA) in the management of OO.

Patients and methods

A total of 37 patients with OO were treated with percutaneous computed tomography-guided RFA. Overall, 24 lesions were located in the femur, 10 in the tibia, two in the acetabulum, and one in scapula. The diagnosis was based on clinical symptoms, radiographs, computed tomography scan, and bone scintigraphy. Bone drilling was used to make a track to reach the nidus. The average follow-up period was 37 months.

Results

A total of 36 patients became pain free within a period of 12 h 3 weeks after the procedure. One patient experienced a milder form of pain. One patient had transient sciatica, which improved using corticosteroids and NSAIDs. Two patients had soft tissue infection treated using antibiotics. No recurrence was reported for at least 2.5 years.

Conclusions

RFA is a safe and effective treatment for OO lesions, especially for lesions, which is difficult to be managed surgically. The use of a bone drill facilitates the technique and decreases the operative time.

Keywords:
computed tomography guidance, nidus, osteoid osteoma, radiofrequency

Egypt Orthop J 56:162–167

1110-1148

Introduction

Osteoid osteoma (OO) is a benign bone tumor of childhood and adolescence [1] However, they may occur in the mature skeleton up to 70 years of age [2]. They constitute ∼10% of benign bone tumors. The tumors have little or no growth potential and rarely exceed 1.5 cm in diameter [3]. It is either diaphyseal or metaphyseal; epiphyseal lesions are very rare [4].

Histologically, OO is a circumscribed nodule of woven bone and osteoid (the nidus) surrounded by thickened cortical and trabecular bone and loose fibrovascular tissue (the reactive zone) [5].

It is associated with pain, which classically worsens at night and responds well to salicylates [2].

OO was diagnosed clinically and radiologically. Radiographs characteristically show a circular or ovoid lucency representing the nidus (usually <1.5 cm in diameter), with a variable degree of surrounding sclerosis [1] (Figs 1 and 2). Radionuclide bone scanning is sensitive but has low specificity. Computed tomography (CT) is more effective than magnetic resonance imaging for making diagnosis and localizing the tumors [6].

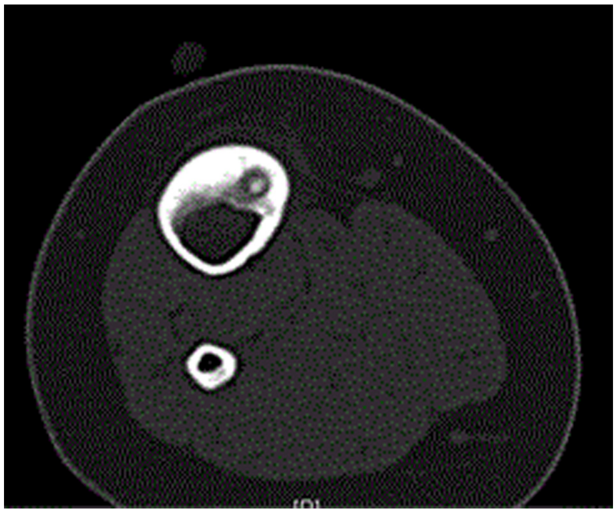
In addition to conservative long-term treatment with NSAIDs – which is problematic owing to the adverse effects – the surgical resection of the nidus and several recently introduced minimally invasive therapies are treatment options for OO [7].

Traditional surgical treatment can be challenging for both the patient and the surgeon. The tumor can be difficult to identify during surgery. The resection of weight-bearing bone may necessitate a prolonged period of restricted activities, and incomplete removal may lead to recurrence [8].

Figure 1

Radiography appearance of osteoid osteoma in right tibia.

Figure 2



Computerized tomography image of osteoid osteoma in tibia.

Several recently introduced minimally invasive therapies are treatment options for OO [7]. CT-guided percutaneous radiofrequency ablation (RFA) has been the most commonly used method since its introduction in 1992 [9], with success rates of 67–100% [10,11]. Another promising technique is interstitial laser ablation. Interstitial laser ablation can be performed using MRI guidance [12].

RFA is a technique whereby an alternating electrical current operating in the frequency of radiowaves (460–480 kHz) is emitted from the tip of an electrode or needle placed directly into the tissue. The alternating current causes the local ions to vibrate, producing heat and inducing cell death by coagulative necrosis [13].

The aim of our study was to evaluate the efficacy of our modified technique of RFA in the management of OO.

Patients and methods

Patients

In a prospective study, 37 patients (31 male (84%) and six females (16%) with OO were treated with CT-guided percutaneous RFA from June 2004 to December 2007. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Cairo University, Cairo, Egypt. Their average age at presentation was 16 years (range from 8 to 27 years). The lesions were 24 lesions in the femur, 10 lesions in the tibia, two lesions in the acetabulum, and one lesion in scapula. There were 19 diaphyseal lesions and 15 metaphyseal. Seven lesions were intra-articular, and all were metaphyseal. All tumors were less than 20 mm in diameter. The average duration of pain before treatment was 11 months (range: 2 months to 3 years). One patient had previous surgery for excision of OO, and the pain recurred after surgery with failure of nidus excision. Remaining patients were treated previously with NSAIDs with persistent pain. The duration of NSAID treatment was 6 months on an average (range from 2 to 30 months).

The diagnosis was based on clinical symptoms, radiographs, and CT scans. It was confirmed by technetium-99M HDP bone scintigraphy showing increased tracer uptake within the lesion and ruled out Brodie's abscess (showing less intense focal uptake; and only in the late phase) and synovitis in the intra-articular and pericapsular lesions.

The exclusion criteria included spinal OO and lesions that were not fully diagnosed as OO clinically and radiologically.

All patients were consented to undergo percutaneous RFA to obtain pain relief and ablation of the lesion.

Technique

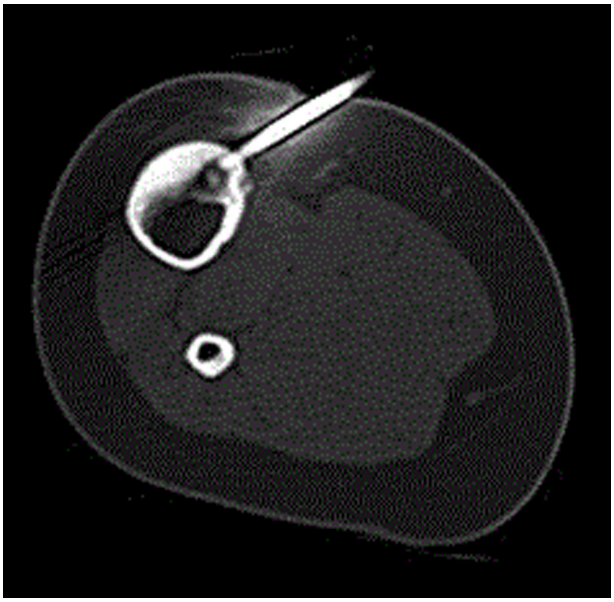
All procedures were performed jointly by an interventional radiologist and the orthopedic surgeon in the CT suite.

General anesthesia (except in one case, spinal anesthesia was used) was mainly used for a pain-free intervention and absolute patient immobilization.

In general, the patients were positioned for an easy and safe entrance of the RF probe vertically and through the shortest distance into the nidus.

The procedure was done through 0.5-cm skin incision. We modified the technique originally reported by Rosenthal *et al.* [9] as we used a bone drill (3.2 mm in diameter) to make a track to reach the nidus, shortening the duration of the procedure and being less traumatic to the bone and the surrounding tissues (Fig. 3). The approach of the lesions depends on its site, the safety of the track avoiding the neurovascular structures, and taking the shortest track to the nidus.

Figure 3



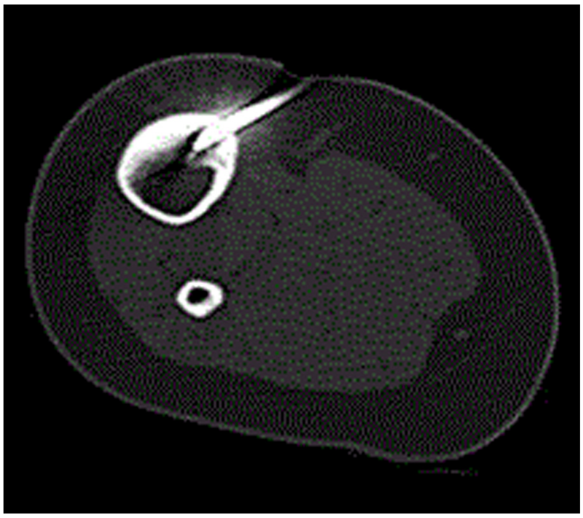
Bone drill used to reach the nidus with short time and minimal soft tissue injury.

The lesions were approached through the affected cortex, except in three cases in which the unaffected cortex was drilled to approach the nidus to avoid the neurovascular structures.

We also used an introducer sheath for soft tissue protection during the ablation procedure and the probe removal to increase the safety and protection of soft tissues from the risk of burns. Moreover, the introducer sheath marks the access to the drill hole after the drill is removed.

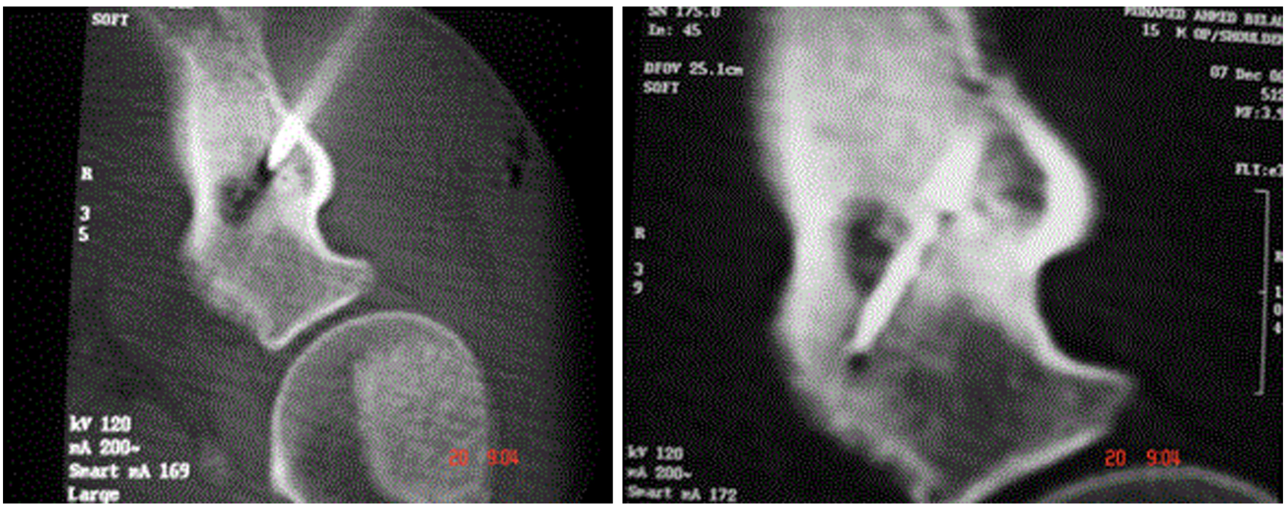
RF ablation was performed with a 1 or 2-cm expandable electrode according to the size and shape of the nidus (Figs 4 and 5). The electrode was connected to the radiofrequency generator (RITA

Figure 4



Expandable electrode inside the nidus.

Figure 5



Radiofrequency ablation for lesion in scapular neck.

generator 1500; RITA Medical Systems, Atlanta, Georgia, USA). The temperature at the tip was monitored throughout the procedure.

RF thermal ablation was performed in two to six consecutive cycles for each lesion. Each cycle took 2–6 min to reach gradually increased temperature from 80 to 110°C, guided by uniform temperature at end of the needle sensors and gradually increased impedance (460–1000 ohm). The circuit was automatically opened at impedance value of 1000 ohm. We started with a cycle for 2 min and the temperature at 80°C and then gradually increase the duration and temperature guided with the response as determined by the temperature retained in the lesion. The response was different in each case depending on patient age (younger patients need less temperature and duration), the site of lesion (epiphyseal needs less energy), the size of lesion, and the amount of surrounding sclerosis. Cool-down temperature protocol was used to evaluate the coagulative necrosis of the nidus. The procedure was terminated when the final retained temperature exceeded 56°C.

The average operative duration was 30 min (range: 20–50 min). At the end of the procedure, the incision was closed by sterile strips.

The patients were discharged from the hospital within 24 h and given prophylactic antibiotic treatment for 3 days.

All patients returned to daily activities and work after the procedures with full weight bearing. Sport activities were restricted for 1 month.

Follow-up

Patients were followed up after 2 days by phone for assessment of pain improvement. Wound healing and pain were assessed after 1 and 2 weeks in the outpatient clinic. Patients were followed up after 3, 6, and 12 months and then yearly, with assessment of pain according to visual analog scale. The follow-up period average was 37 months (range from 30 to 42 months).

Results

A total of 36 patients (97.3%) became pain free within a period of 12 h to 3 weeks after the procedure, with prompt return to normal activities. No recurrence was reported for at least 2.5 years.

The remaining patient had mild pain (visual analog scale: 1–2) and refused to repeat the procedure as the pain was mild and did not limit normal activities. His pain was relieved with sporadic medical treatment.

One patient (2.7%) with OO in the neck of femur had transient sciatica that improved using corticosteroids and NSAID for 4 weeks. Two patients (5.4%) had a skin burn over the ablation needle entry site presenting with skin erythema immediately after the procedure. This was followed by a small skin ulcer. They required a course of antibiotics for 10 days and wound dressings in the outpatient clinic. The ulcer healed with no skin graft needed. There were no fractures, hematoma formations, or vascular injuries during or after each procedure.

Discussion

OOs can be treated conservatively with NSAIDs because OOs may undergo spontaneous regression after several years; however, a significant number of patients are unable to continue taking anti-inflammatory medications, and the patients with persistent pain generally require surgical treatment [14].

Open surgical resection has been considered an efficacious treatment option for many years [15].

However, a complete surgical excision may result in the wide resection of normal bone to ensure completely excise of the tumor [16]. This causes structural weakening and requires a long period of limited weight bearing and activity restriction [17].

The main difficulty with this technique is in the intraoperative identification of the nidus, and misjudgment often results in failure of the procedure owing to incomplete resection. Incomplete removal usually results in a clinical recurrence [18].

For years, numerous methods have been used to better localize the lesion, thereby minimizing the amount of bone resection required. Examples of these methods include intraoperative radioisotope scans or CT localization of the nidus, but intraoperative scanning did not appreciably affect the amount of bone resected [19].

Various needle-guidance approaches have been described as minimally invasive and effective methods for the percutaneous treatment of the OOs, such as CT guidance [20–24], ultrasonographic guidance [25] or magnetic resonance guidance [26].

In this study, we modified the technique described by Rosenthal *et al*. [9] for approaching the nidus by using bone drilling to minimize the operative duration and to minimize soft tissues and bone trauma instead of using the manual bone trocar, which was used in the original technique. We also used an introducer sheath around the needle to protect the soft tissues, thus minimizing the risk of skin and soft tissue burns.

The average operative duration was 30 min. The operative duration was reduced owing to the use of pneumatic drilling instead of manual trocar to open a track in the sclerosis to reach the nidus, but the duration of the original technique was not mentioned in the literature for comparison.

CT does not show the extent of coagulative necrosis immediately after treatment, as water changes in the marrow are not perceived and there is usually little discernible change in the trabecular density. CT follow-up at 6 months revealed complete ossification in 53% (8 of 15), partial ossification in 20% (3 of 15), and no change in 27% (4 of 15) [27].Postoperative follow-up imaging is usually unnecessary, as the small ablated area does not cause significant bone weakening and there is no evidence of a direct relationship between radiological healing and symptomatic relief [8]. Thus, imaging is not required unless symptoms recur.

Overall, 97.3% of patients were pain free, which is comparable to the success rates reported by Woertler *et al*. [28] with clinically successful treatment in 94% of patients primarily and 100% of patients secondarily. Our recurrence rate of 2.7% is lower than those in other reports, which range from 5% to 35% [29–32], and higher than the recurrence rate reported by Cantwell *et al*. [33], as they reported no recurrence rate after RF ablation of OO.

Conclusion

RFA of OO had become established in recent years as the most effective standard method owing to its relatively low cost and high safety, along with efficacy proved in numerous clinical studies. Success and recurrence rates of CT-guided RF ablation are at least equivalent to those of conventional surgical excision methods, with lower complication rates, a shorter time of hospitalization, and faster convalescence. We believed that the use of bone drilling decreased the operative time, and the use of the introducer sheath decreased the incidence of soft tissue burns. Therefore, RFA is the modality of choice for treatment in most cases.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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