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Radiofrequency ablation versus open surgical method (curettage) for the treatment of osteoid osteoma (clinical outcome)

Ameer Mahdi Hathaf [1], Adnan Essa Al-kilabi [2]

Abstract

Osteoid osteoma is a benign tumor formed of osteoid and woven bone surrounded by a halo of reactive bone. This lesion is most common in young patients. The classical surgical treatment for this tumor include curettage, en bloc resection and wide resection and have been applied for many years, the success of classical surgery has been reported as 88-100%. Minimally invasive method which is represented by radiofrequency ablation has been proven to be a safe and effective method. The objective of this study is to evaluate the clinical success of radiofrequency ablation in treatment of osteoid osteoma at various sites (except spine and pelvis) and comparing the results with open surgical curettage. Thirteen patients with Osteoid osteoma (7 female and 6 male). Their ages were between 7-36 years, the osteoid osteoma localized in extremities, (six were treated by x- ray guided radiofrequency ablation and seven treated by open surgical curettage) at Al-Sader medical city and the Iraqi specialized center in Al-Najaf city. From June 2018 to August 2019 with a follow up period ranged from 6-12 months. Pain severity were evaluated by using visual analogue scale before and after the procedure. The VAS scores for all osteoid osteoma patients treated either with radiofrequency ablation or with surgical excision significantly decreased except for one case treated with radiofrequency ablation in which recurrence had been reported. There was absence of few patients at time of six months follow up visit. There were no significant intraoperative complications, like pathological fracture. In conclusions; surgical curettage is potentially an effective method without any recurrence. RFA is a safe and effective minimally invasive treatment.

Keywords: Osteoid osteoma, Radiofrequency ablation, Surgical

*Corresponding Author: ameer.alshamarry@gmail.com
[1]Department of Orthopedics, Al Muthanna health directorate, Al-Rumitha general hospital
[2]Department of orthopedics, Medical college, Kufa University, Iraq
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Introduction

Osteoid osteoma is a benign osteogenic bone tumor that was first described by Jaffe in 1935 [1]. Ten percent of all osteoid osteomas are located in the spine, mainly in posterior elements of the lumbar and thoracic vertebral column [2-4]. Osteoid osteoma larger than 15 mm is denominated osteoblastoma. Osteoblastoma, sometimes denominated giant osteoid osteoma, is four times less frequent than osteoid osteoma, often is more expansive and has less sclerotic borders, and may have a more aggressive imaging and histological pattern when compared with osteoid osteoma [5]. The nidus of the osteoid osteoma consists of immature bone and is rich in blood vessels and nerve cells. These nerve cells produce prostaglandins, in particular prostaglandin E2, presumably causing the characteristic nocturnal pain which is the most common clinical symptom reported (up to 80%–100%), which responds rapidly within 20 to 30 minutes to non-steroidal anti-inflammatory drugs (NSAIDS) [6]. Painful osteoid osteoma may be found in the epiphysis, metaphysis, or diaphysis, and may involve the cortex or cancellous bone [7]. Painful scoliosis is a common presentation (63%–70%) of spinal osteoid osteoma which is due to soft tissue and muscle irritation and finally induced asymmetrical spasm [8, 9].

Pathologic characteristics

Osteoid osteoma is composed of osteoid and woven bone, both of which can be seen as interconnected trabeculae, sheets, or isolated islands. The trabeculae can be thin or broad, well formed, or haphazard. Plump osteoblasts are usually obvious at the edge of the osteoid (osteoblastic “rimming”). The tissue between the osteoid elements is composed of loose fibrovascular tissue.

Skeletal distribution

Osteoid osteoma may occur in virtually any bone, although clearly there is a predilection for the lower extremity, with 50% or more of lesions occurring in the femur and tibia. The majority of lesions arise in the cortex of long bones, where the lesion is usually diaphyseal or metadiaphyseal. The remaining lesions, approximately 30% are equally distributed among the spine, hand, and foot [10- 12]. When osteoid osteoma occurs in the spine, the most commonly affected area is the lumbar spine, typically the neural arch [13,14]. Lesions limited to the vertebral body are unusual [14]. Other atypical locations include the skull, ribs, ischium, mandible, and patella [11]. Intra articular lesions are most commonly encountered in the hip. Epiphyseal lesions have been reported but are rare [15, 16].

Radiologic features

The radiologic appearance of cortical osteoid osteoma arising in the shaft of a long bone is characteristic. The osteoid osteoma, which may be radiolucent or contain a variable amount of mineralization (sometimes being quite radiopaque), is often referred to as the “nidus,” because it is the focus of the underlying pathologic process and is usually centrally positioned within an area of dense fusiform reactive osteosclerosis. This sclerosis is reversible and may regress after surgical removal of the osteoid osteoma [17]. Interestingly, Jaffe and Lichtenstein first used the term nidus to describe lesions that were radiopaque, referring to a “dense circular nidus which may stand out from the neighboring opaque bone [reactive sclerosis] by a narrow zone which is more permeable to the rays” [18].

Treatment

In the treatment of this tumor, classical surgical methods such as curettage, en bloc resection and wide resection have been applied for many years and the success of classical surgery has been reported as 88-100%. However, new treatment methods were needed due to excessive complications such as avascular necrosis of the femoral head and fractures. Due to the high rate of complications (20-45%), long surgical duration and frequent problems such as tissue damage, scar, and morbidity of classical surgery, there has been a rapid transition to minimally invasive treatment methods [19]. In radiofrequency ablation (RFA) treatment, the cells of the tumor are thermally inactivated by the help of electrodes shaped like needles. This electrode is placed in the center of the tumor with the help of CT images by opening a pathway in the bone.

Patients and methods

This was a case series study conducted at Al-Sader Medical City and the Iraqi specialized center in Al-Najaf city. The patients operated on from June 2018 to August 2019 with a follow up period ranged from 6-12 months. A total of 13 patients (7 female and 6 male) with osteoid osteoma those selected by simple random sampling. Six treated by RFA and seven treated by open surgical approach (Curettage). They were 7 - 36 years of age with mean of 17 years old. The osteoid osteoma localized in extremities in all patients. Written informed consent was obtained from all participants after the nature of the procedure had been fully explained.

Patients that underwent RFA

Six patients with Osteoid Osteoma (4 female, 2 male; median age 15 years; range, 8–36). The osteoid osteoma, lesions were localized in the extremities. Diagnosis of osteoid osteoma was proven by the combination of clinical presentation and plain X-ray, CT scan. All patients were operated by the same surgical team at the Iraqi specialized center.

Pre procedural Preparation screening:

1. Thorough history and physical examination
2. Radiographs
3. Basic investigations including hemoglobin level, renal function test, blood sugar, blood group and RH and virology screen
4. Neurological examination and pain evaluation by using (visual analogue scale) ** were performed for each patient
5. Consent was taken

**Visual analogue scales have been proved to be satisfactory in the measurement of pain. VAS is a continuous rating scale usually 10 centimeters (100 mm) in length.

For pain intensity, the scale is most commonly anchored by “no pain” (score of 0), “worst imaginable pain” (score of 10 [100-mm scale]).

No pain 0 (0–4 mm), mild pain 2-4 (5–44mm), moderate pain 5-7 (45–74 mm), and severe pain 8-10, (75– 100 mm). Higher scores indicate greater pain intensity [20].

Patients that underwent RFA

Technique

All patient underwent general anesthesia by the anaesthiologist. The skin was disinfected using 10% povidone iodine solution, sterile drapes were applied, through small skin incision less than 1 cm kyphoplasty drill was used in order to precisely localize the nidus and guided by X-ray as shown in figure 1.

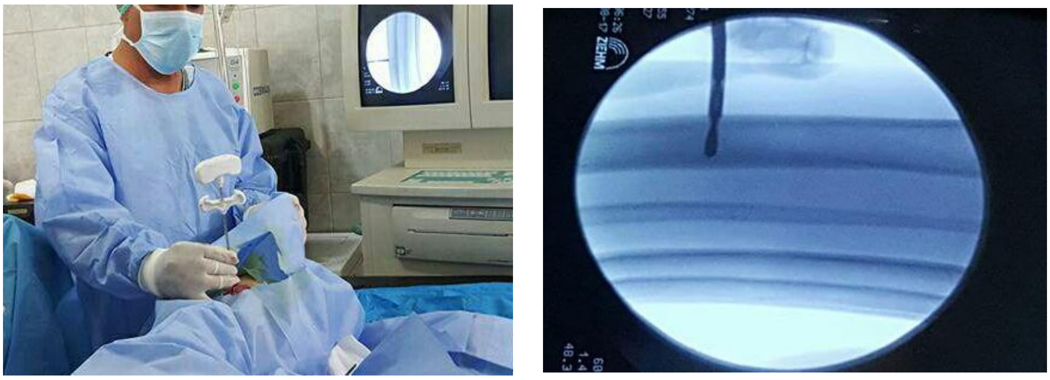

Figure1.

Localization of nidus

Sleeve was inserted. Afterward Radiofrequency insulated cannula 22-G 10cm in length was introduced through the sleeve at the site of the lesion as shown below as in figure 2.

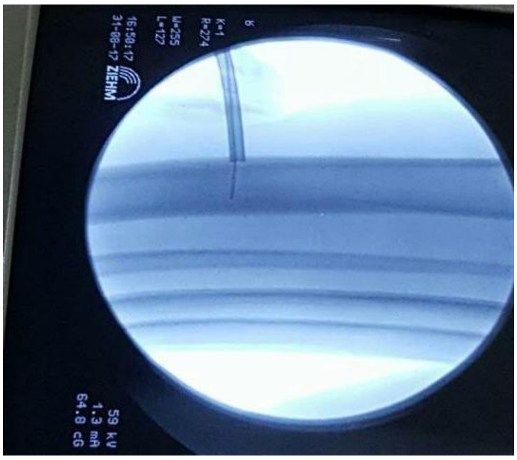

Figure 2.

Radiofrequency insulated cannula insertion through the sleeve at site of lesion.

The lesion was heated at 90 °C for 6 minutes. The average time of the ablation was approximately 20 minutes. After ablation, the RF was removed, a compressive sterile dressing is applied.

After care: Analgesia was given in the 1st 24 hrs and then avoided to assess pain post intervention. Antibiotic (cefetriaxone vial 1g) was given for 1 day to all patient.

Follow up: Neurological examination and pain evaluation using the visual analogue scale (VAS) were performed for each patient before discharge, at 5 days, 2 weeks, 3 months and 6 months after the procedure.

Patients that underwent open surgical technique

Seven patients with osteoid osteoma (3 female, 4 male; age range, 7–32; median age 20). The osteoid osteoma lesions were localized in the extremities. Diagnosis of osteoid osteoma was proven by the combination of typical clinical presentation and plain X-ray, CT scan. All patients were operated by the same surgical team at Al-Sader Medical City.

Pre procedural Preparation screening:

Thorough history and physical examination.

Radiographs, CT scan.

Basic investigations including hemoglobin level, renal function test, blood sugar,virology screen, blood group and RH.

Preparation of blood.

Neurological examination and pain evaluation were performed for each patient.

Consent was taken.

Technique

All patients were operated under general anesthesia and given 1-gram ceftriaxone intravenously half-hour before skin incision. The skin is prepared by using povidone iodine 10%. Sterile drapes were applied. After localization of nidus by x-ray about 10 cm skin incision was made. The fascia was exposed and incised in line with skin incision. Soft tissue dissection and protection of surrounding blood vessels. The surgical approach should expose the bone which is close to the nidus. The surface is cleaned off periosteum. In the diaphysis the nidus is beneath the apex of the fusiform elevation of the cortex. The exact location of the nidus was then determined by x-ray. The reactive bone, usually (sclerotic and covering the nidus) is removed gradually. Removal of the reactive bone should be done with caution in order not to destroy or miss a very small nidus. The nidus was exposed as completely as possible and then curetted out of its bed. The pathologist is then able to examine the nidus and not simply pieces of the reactive bone which have been removed. The walls of the nidus are burned out for 1 to 2 mm in all directions. Wound was washed with NS fluid and closed layer by layer and covered with a sterile dressing.

Figure 3.

Removal of the bone covering the nidus

Figure 4.

Nidus curettage

After care

Antibiotic regimen with ceftriaxone 1gm IV once daily for 3 days then change to oral antibiotic in form of Suprax cap 400 mg once daily for 7 – 10 days, in addition analgesia were given in the 1st day post operation then avoided to assess pain. Changed dressing after 3 days and removed stitches or staples after 2 weeks. Protected weight bearing for patients with lower limbs osteoid osteoma.

Follow up

Neurological examination and pain evaluation using the visual analogue scale (VAS) were performed for each patient before discharge, at 5 days, 2 week and 3 months after the procedure.

Result

There were 13 patients in the current study. Their age varied from 7 to 36 years old (mean 17 years). Gender distribution showed female predominance (7 female and 6 males) forming 54.54% and 45.45% respectively. All patient was pain-free following ablation as well as after three months except one patient who experience pain during 3nd month then underwent surgical approach while the patients with surgical curettage show no recurrence and also they were pain-free following surgical curettage as it shown in table 1 and 2.

Table 1.

Patients that underwent RFA

Case Number	Sex	Age (years)	location	Symptom	VAS score BP	VAS score AP	Time of hospitalization	Recurrence	Follow-up time (months)
1	F	8	Left Mid shaft tibia	Local pain	8	0	1 Day	No	3, 6
2	F	13	Left Upper shaft of fibula	Local pain	10	0	1 Day	No	3, 6
3	F	9	Rt. Upper shaft of tibia	Local pain	9	0	1 Day	No	3
4	M	17	Rt. Mid shaft of Fibula	Local pain	8	0	1 Day	No	3
5	M	22	Lt. femur	Local pain	9	7	1 Day	Yes	3, 6
6	F	36	Rt. Proximal shaft of ulna	Local pain	9	0	1 Day	No	3, 6

AP, after procedure; BP, before procedure; F, female; M, male; RF, radiofrequency; VAS, visual analogue scale.

Table 2.

Patients that underwent open surgical curettage.

Case number	Sex	Age (years)	location	Symptom	VAS score BP	VAS score AP 2wks	Time hospitalization	Recurrence	Follow-up time months
1	M	7	Rt. Femoral neck	Local Pain	10	0	3 Days	No	3
2	M	26	Rt. mid shaft radius	Local Pain	7	0	2 Days	No	3, 6
3	F	20	Lt. Femoral shaft	Local pain	9	0	2 Days	No	3, 6
4	F	12	Rt. tibial shaft	Local pain	8	0	3 Days	No	3, 6
5	M	15	Lt. tibial shaft	Local Pain	9	0	2 Days	No	3
6	F	32	Rt. Proximal shaft of ulna	Local pain	9	0	2 Days	No	-
7	M	23	Rt. Femoral shaft	Local pain	7	0	2 days	No	3

AP, after procedure; BP, before procedure; F, female; M, male; VAS, visual analogue scale.

Table 3.

Summery of patients' data.

Variable		curettage	Radiofrequency ablation
Patient		7	6
Gender	Male	4	2
	Female	3	4
Age (mean) (years)		20 (7 -32)	15 (8 – 36)
Operation time (min.)		60-90	20-30
Duration of hospitalization (days)		2-3	1
Recurrence		0	1
Location	Femur	3	1
	Tibia	2	2
	Fibula	0	2
	Radius	1	0
	Ulna	1	1

Discussion

The aim of osteoid osteoma treatment is to make patient pain free and to remove the nidus entirely [21]. RFA and open surgical treatment have equivalent treatment outcome [22]. Current study results showed that treatment outcome were not equivalent, curettage showed 100% success regarding pain reduction but pain recurrence had been reported in our result regarding one patients treated with RFA.

The traditional treatment method for osteoid osteoma is surgical removal of the nidus. But this method has some disadvantages such as difficulty in localizing the nidus, longer operative time requirement and more blood loss in comparison to minimally invasive method, the possibility of damaging nearby structure, longer hospitalization period and the risk of postoperative complication which include susceptibility for pathological fracture because of wide resection area [23].

In the current study, regarding patients treated with open surgical approach we had difficulty in 2 cases in localizing the exact site of the nidus because of their anatomical site (femoral neck, posterolateral aspect of proximal tibia).

The operative time requirement in this study was about (60- 90) minutes which is longer than minimally invasive method RFA. Most of cases tourniquet was used to reduce the possible intraoperative blood loss, and hemostasis had been done after removal of tourniquet at the end of operation. There was no injury to the surrounding structures because of careful approach. The average time of hospitalization was (2-3) days for postoperative care and treatment. No fracture had been reported in our result regarding osteoid osteoma patients treated with surgical curettage.

In the current study no recurrence had been reported regarding osteoid osteoma patients treated with surgical curettage. Etemadifar MR et al. reported no recurrence rate study conducted in Iran 2015 [24]. Göksel F et al. reported 18.1% recurrence rate for RFA study conducted in Turkey 2019 [25].

In order to ensure that the nidus is completely excised without recurrence, surgical treatment of osteoid osteoma should be performed by perfect exposure and curettage the nidus with gradual removal of minimal reactive bone.

Primary clinical success which is defined as pain relief after one RFA or surgical intervention without the need for pain medication within the following 6 months [26]. In current study the result regarding OO patients treated with surgical curettage primary clinical success had been reported. While in patients treated with RFA primary clinical success had been reported in 5 of 6 patients because one of them had been complained of pain after 3 months. Minimally invasive method which is represented by radiofrequency ablation has been proven to be a safe and effective method in the treatment of osteoid osteoma [27]. This method has many advantage such as more precisely in localizing the nidus, shorter operative time and less likely to cause blood loss, shorter hospitalization. All these advantages lead to increase application of RFA over time [28]. Best choice for treatment of osteoid osteoma located in extremities and deep anatomical locations is by RFA [26, 29].

In current study six patients underwent radiofrequency ablation. The average time of ablation was (20-30) minutes without significant intraoperative blood loss and all of them discharged from hospital at same day of procedure.

RFA has some risk of thermal damage to adjacent neurovascular structures regarding the spine, RFA treatment is limited or sometimes contraindicated [30]. In current study there was no spinal osteoid osteoma.

Osteoid osteoma close to the skin, such as osteoid osteoma located in the tibial bone have a higher risk of skin and soft tissue burn after RFA [31]. We had two case of tibial osteoid osteoma treated with RFA without skin and soft tissue burn. Saline solution was spilled on the skin during thermal application to avoid such complication.

Some studies reported complications such as skin burn, soft tissue and fat necrosis, infection, vasomotor instability, tendinitis, and hematoma [32-34]. In current study, there was no such complication in all patients. Most patients experienced pain relief within the first week after RFA. Patients were able to bear weight immediately and return to normal daily activities, even sports.

There was one recurrence 16% of osteoid osteoma patients treated with RFA in current study. ZG et al. reported 10% recurrence rate for RFA study conducted in Belgica 2011 [35] and Göksel F et al. reported 15.3% recurrence rate for RFA study conducted in Turkey 2019 [25]. Failure was attributed to inadequate ablation this required additional intervention with surgical curettage. Complete surgical excision is the classic treatment if the conservative treatment fails and the pain persists [32].

The diagnosis of patients with suspected osteoid osteoma based on typical clinical symptoms and radiological findings. We did not routinely take a biopsy specimen before ablation or surgical curettage, in spite of easily biopsy that can be accomplished during the initial puncture process. So, histological verification for osteoid osteoma patients treated with surgical curettage done post-operative.

Limitations

Number of patients which includes only 13 patients and that follow-up was not possible in two of them, typical clinical symptoms and radiological findings considered sufficient to make diagnosis this leading to absence of histological verification of the osteoid osteoma prior to intervention and the short follow-up period.

Conclusion

Surgical curettage is potentially an effective method without any recurrence. RFA is a safe and effective minimally invasive treatment.

Conflict of Interest

The authors declare that there is no conflict of interest.

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