

Radiofrequency Ablation of Osteoid Osteoma in Atypical Locations

A Case Series

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Abstract

Background Osteoid osteoma has a nidus surrounded by sclerotic bone with a size usually less than 20 mm. Its diagnosis is made on typical presentation of nocturnal pain and imaging findings. Excision of the niduses, which are often small and difficult to precisely identify, sometimes may result in resection of surrounding normal bone. Minimally invasive percutaneous treatments have been used to try to minimize resection of normal bone. Although minimally invasive radiofrequency ablation generally relieves pain, its ability to relieve pain is less well known in locations other than lower extremity long bones.

Questions/purposes We determined the pain relief and complication rates after radiofrequency ablation of osteoid

osteomas presenting in atypical locations and followed patients to assess possible recurrence or late complications. **Patients and Methods** We retrospectively reviewed 21 patients with osteoid osteomas in unusual locations (eg, hip, radioulnar joint, and proximal phalanx) in whom we used radiofrequency ablation. Postoperative activities were not restricted for any of the patients. We assessed the time for patients to become symptom free, their activity status, and possible recurrence or complications. The minimum clinical followup was 12 months (mean, 27.8 months; range, 12–37 months).

Results All patients became symptom free within 24 hours to 1 week. During followup, none of the patients experienced recurrence or any major complications.

Conclusions Radiofrequency ablation for osteoid osteomas in unusual locations reliably relieves pain with few complications and recurrences at short-term followup.

Level of Evidence Level IV, case series. See Guidelines for Authors for a complete description of level of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

The work was performed at Noor Medical Imaging Center.

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Introduction

Osteoid osteoma (OO), a relatively common skeletal tumor, accounts for 11% of all benign bone tumors and mostly affects patients in the second and third decades of their lives [6, 12, 29]. OO characteristically has a nidus surrounded by sclerotic bone with a size usually less than 20 mm [16, 33].

The diagnosis of OO is made according to clinical, radiographic, and scintigraphic findings [2, 16]. Patients present with substantial nocturnal pain with a duration of months or years until the lesion is discovered [20]. The classic radiographic presentation is a small radiolucent, but sometimes centrally calcified geographic lesion in the

cortex of a long bone [1, 16]. The lesion is surrounded by an intense reactive sclerotic rim [28]. The best method for localization is bone scintigraphy [28]. The classic scintigraphic double-density appearance is very specific for OO and is used as a guide for CT study [15, 28]. CT is highly useful by clearly delineating the nidus from the surrounding sclerosis and periosteal reaction [1, 4]. OOs have been described in virtually all bones, but the typical locations of OOs are the long bones of lower extremities (especially femur and tibia), which comprise approximately 50% of the cases [12]. Among other bones, OOs involve upper limbs in 13% to 31% of cases and vertebrae in approximately 10% of cases [16, 28]. OOs of other sites have lower incidences.

The pain usually responds to aspirin or other NSAIDs [20, 38]. Other options include surgery and percutaneous interventions [16]. As the OO nidus is typically quite small and its precise identification during open surgery is often difficult, some normal surrounding bone also may be resected [35], depending on the surgical approach. Therefore, surgery frequently is accompanied by several-day inpatient treatment and patients may need to restrict their activities for a while or have a period of protected weightbearing [8, 16]. Long-term administration of NSAIDs, however, can lead to gastrointestinal side effects and patients do not tolerate it well [28, 35]. Through the years, several image-guided, minimally invasive interventions have been developed to treat OOs. CT-guided radiofrequency ablation (RFA) for OO [31], is one of the increasing numbers of minimally invasive alternatives to conventional operative procedures [10, 31, 38, 42]. In one study limited to OOs in the upper extremity, the authors [37] reported complete resolution of pain without additional treatment in 76% of patients, equal to the minimum rate reported in a series not limited to any specific locations [8]. However, the ability of RFA to relieve pain in locations other than lower extremity long bones is unknown; we suspect there is less experience with RFA and perhaps even a reluctance to choose this treatment option for such OOs. Moreover, surgical resection of the tumor in some of these locations, such as the hip, may follow with some complications [9].

We asked whether RFA would (1) provide reliable pain relief, (2) result in few complications, and (3) avoid recurrences in patients with OOs in locations other than the lower extremity long bones.

Patients and Methods

We retrospectively reviewed 137 patients referred for OO RFA between 2006 and 2008 and identified 21 (15.3%) as unusual cases (ie, not in lower limb long bones) (Table 1). The average age of the patients was 19 years (range,

10–30 years) (Table 2). All patients were referred for treatment based on their history and morphologic features typical of OO seen on radiographic and CT imaging. Their imaging features were reviewed once again and the location of lesions was confirmed by scintigraphy in all cases. In one case in which there was doubt about the diagnosis and exact location, we obtained MRI. Like some authors [16, 23], we believe the diagnosis of OO is mainly clinical and radiographic, and we did not perform regular biopsy for tissue confirmation, a practice consistent with other studies [14, 22, 23]. However, the practice of not performing a biopsy is not universal and others have performed tissue sampling before RFA [5, 11, 21, 24, 30, 31, 40, 43]. The duration of symptoms before the procedure varied from 8 months to 6.5 years. Fifteen of the 21 patients had taken aspirin for pain control, four of 21 had taken ibuprofen, and two of 21 had taken naproxen before we saw them. Although this medical management could partially or completely control the pain, becoming dependent on such drugs (otherwise symptoms would recur), along with their possible complications, made patients and their physicians decide to seek a definitive treatment. Only one patient had previous surgery for OO. Patients were informed about the open surgical alternative option, but as they had been referred for RFA, nobody opted for surgery. The followup was only clinical, with a minimum length of 12 months (mean, 27.8 months; range, 12–37 months). No patients were seen by us specifically for this study; we relied on data from charts and information from referring doctors. No patients were lost to followup. Our study had the institutional ethical board approval and informed consent for RFA was obtained from the patients or their parents.

All procedures were performed with the patient under general anesthesia in the CT room under aseptic conditions. An experienced interventional radiologist (SA) performed all RFAs with an anesthesiologist present during the entire operation. Lesions were localized precisely using a Somatom Plus 4 spiral CT machine (Siemens, Erlangen, Germany), with thin 2-mm sections (140 kVp, 200 mA) (Fig. 1).

If possible, the shortest distance through the bone was selected for access; otherwise, with attention to the regional anatomy, the technically attainable and safest needle pathway was chosen to avoid the major neural and vascular structures (Fig. 2). After skin preparation, an 11-gauge needle (RITA Medical Systems, Inc, Fremont, CA) initially was driven percutaneously toward the nidus under CT guidance. The needle served as a coaxial guide for further drilling and its external shaft was insulated to prevent tissue damage by radiofrequency propagation.

The track up to the nidus next was drilled and enlarged by a long (15-cm), 6000-rpm, 2-mm coaxial power drill

Table 1. Description of lesions for each patient

Patient number	Gender	Age (years)	Nidus diameter (mm)	Location	Site	Intraarticular nidus/joint effusion	Central sclerosis
Upper limb							
1	Male	21	8	Scapula (acromion)	Cortical	-/-	-
2	Male	11	6	Scapula (neck) (Fig. 2)	Medullary	-/-	+
3	Male	24	NA	Humerus	NA	NA	NA
4	Male	10	6	Humerus	Cortical	-/-	+
5	Male	30	4	Humerus	Cortical	-/-	-
6	Female	20	3	Ulna (radioulnar joint)	Cortical	+/-	-
7	Female	20	7	Third proximal phalanx	Cortical	-/-	+
Spinal vertebrae							
8	Female	17	10	C6 (Fig. 3)	Cortical	-/-	-
9	Male	16	8	L3	Cortical	-/-	+
Lower limb							
10	Female	19	9	Acetabulum	Cortical	-/-	+
11	Male	27	3	Acetabulum	Cortical	-/-	-
12	Male	21	11	Acetabulum (Fig. 4)	Cortical	+/+	+
13	Male	17	6	Talus	Cortical	+/+	+
14	Male	18	NA	Talus	Cortical	+/+	-
15	Male	18	8	Talus	Cortical	+/+	+
16	Male	18	NA	Talus	NA	NA	NA
17	Male	24	6	Talus	Subperiosteal	-/-	-
18	Male	22	NA	Talus	Cortical	NA	NA
19	Male	18	6	Talus	Cortical	+/+	-
20	Male	16	6	Talus (Fig. 1)	Medullary	-/-	-
21	Male	17	5	Second cuneiform	Cortical	-/-	+

NA = not available.

system (Proxxon, Berlin, Germany) and a control CT image was obtained. The power drill system can accurately and rapidly enter the dense cortical bone and sclerosis.

After drill removal, 6 minutes of RFA at 90°C was performed by one cool-tip straight rigid electrode with the 1-cm active tip placed in the center of the nidus and the relevant radiofrequency generator (Valleylab, Boulder, CO). No cooling technique was applied owing to small nidus sizes. The mean overall time of the procedure (including anesthesia) was 45 minutes (range, 35–60 minutes).

All patients were discharged on the same day after 3 to 5 hours of observation. Postoperatively, we recommended only the analgesic they had used preoperatively for symptom relief. This usually was aspirin or other NSAIDs. We did not restrict activities for patients after discharge including weightbearing or torque. They could go back to work or school the next day. There was no need for special therapy such as physiotherapy after RFA.

Patients were assessed by the referring orthopaedic surgeon at 1, 6, and 12 months. Patients were asked to

report any experience of pain recurrence after a pain-free period or any complications during the 1-year of regular observation and thereafter. Recurrence or complications were reported to us at scheduled contacts with the referring orthopaedic surgeons.

Several cases should be mentioned owing to somewhat unusual circumstances. Patient 6 had two locations radiographically similar to OO, one in the proximal portion of the ulna and one in the lateral condyle of the humerus, both on the same side. Only after scintigraphy could we determine the active lesion was the first one, which was located in the radioulnar joint. Patient 7 had undergone open surgery for her lesion before the RFA, and although the third proximal phalanx OO was quite easy to access, the surgery was unsuccessful. For Patient 8, because of the risky position of the lesion in C6 near the spinal canal (Fig. 3), we did not drill to avoid the risk of spinal cord injury and only the 11-gauge needle directly guided the radiofrequency needle into the lesion. Patient 12 had a lesion located in the hip under its articular surface (Fig. 4), which is a difficult position for surgical approach with possible

Table 2. Patient characteristics and clinical data

Characteristic	Value
Number of patients	21
Male	17 (81.0%)
Age (years)*	19.24 ± 4.65 (10–30)
Nidus diameter (mm)*	6.59 ± 2.24 (3–11)
Location	
Scapula	2 (9.5%)
Humerus	3 (14.3%)
Ulna	1 (4.8%)
Phalanx	1 (4.8%)
Vertebra	2 (9.5%)
Acetabulum	3 (14.3%)
Talus	8 (38.1%)
Cuneiform	1 (4.8%)
Site	
Cortical	16 (76.2%)
Medullary	2 (9.5%)
Subperiosteal	1 (4.8%)
Unknown	2 (9.5%)

* Values are expressed as mean ± SD, with range in parentheses.

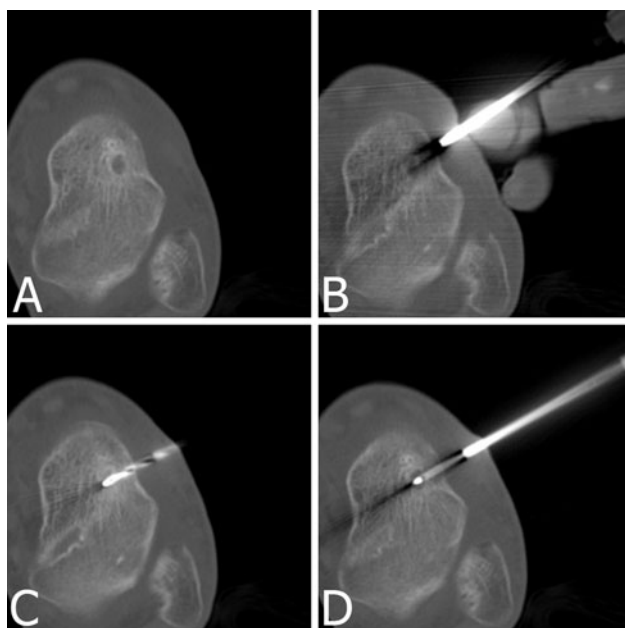


Fig. 1A–D RFA for a 6-mm-diameter OO of the talus in a 16-year-old boy is shown. CT scans show (A) the medullary nidus with surrounding sclerosis, (B) driving the coaxial guide toward the nidus, (C) drilling the track up to the nidus, and (D) the radiofrequency needle in the nidus.

postoperative complications. Patient 17 had an atypical OO without characteristic nidus and sclerotic rim. The diagnosis was made based on clinical history, MRI, and scintigraphy findings. These imaging methods also helped us to locate the lesion and perform RFA.

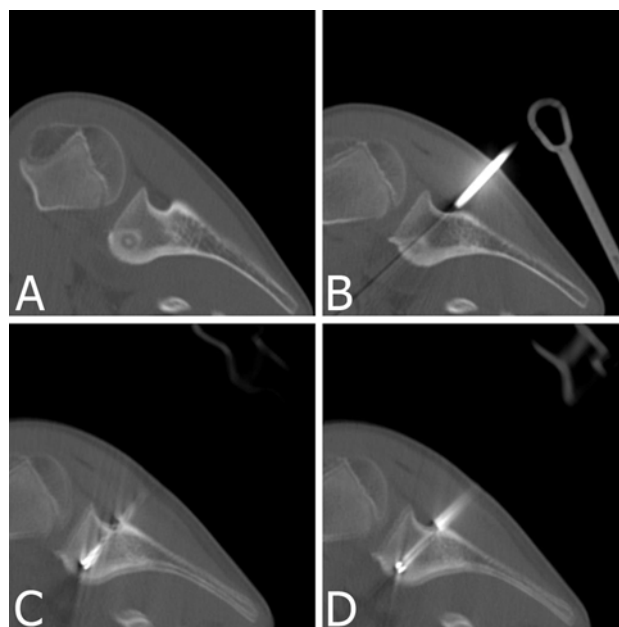


Fig. 2A–D RFA for a 6-mm-diameter OO in the neck of the scapula in an 11-year-old boy is shown. The posterior approach is used to avoid anterior neurovascular structures. CT scans show (A) the medullary nidus with surrounding sclerosis, (B) driving the coaxial guide toward the nidus, (C) drilling the track up to the nidus, and (D) the radiofrequency needle in the nidus.

Results

In all procedures, we could localize the nidus under CT guidance and ablate it. All patients had complete pain relief and returned to normal activity within 1 week.

No major complications were encountered after the procedure. There was only a minor complication in Patient 7 with phalangeal OO. She experienced a minimal skin burn around the RFA needle entry, which healed by local nonoperative care in a few days. There were no deaths and no anesthesia-related complications in this series. No fractures of weightbearing bones, no complications related to neurovascular injury, and other late complications occurred.

During the followup period, no patient had recurrence of symptoms.

Discussion

Several studies report the use of RFA for ablation of OO in usual and unusual locations [16, 23, 35, 38]. In one study limited to OOs in the upper extremity, the authors reported complete resolution of pain without additional treatment in 76% of patients [37]. Although minimally invasive radiofrequency ablation generally relieves pain, whether it reliably relieves pain in locations other than upper and

Fig. 3A–C RFA for a 10-mm-diameter OO of C6 in a 17-year-old girl is shown. (A) Because of the risky position, drilling was not performed, and (B) the coaxial guide provided the track for the radiofrequency needle. (C) The radiofrequency needle is shown in the nidus.

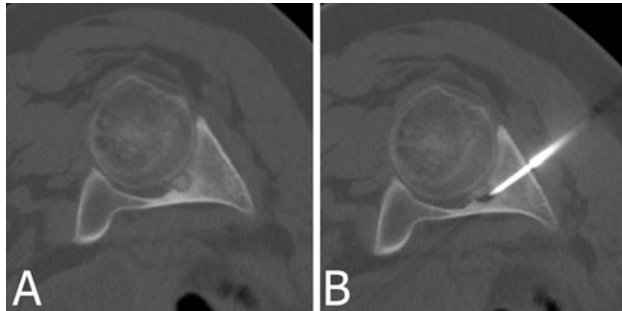
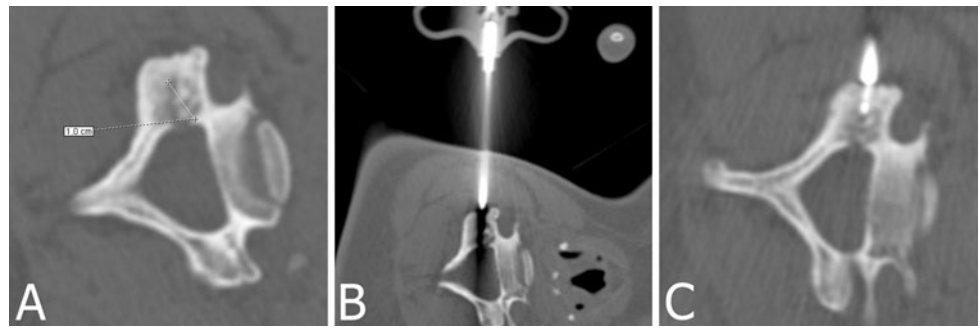


Fig. 4A–B (A) An intraarticular OO of the acetabulum with an 11-mm-diameter nidus and (B) the radiofrequency needle placed in its nidus are shown. Surgical treatment of this lesion is difficult with possible major disabilities.

lower extremity long bones is unclear. We therefore asked whether RFA would (1) provide reliable pain relief, (2) result in few complications, and (3) avoid recurrences in patients with OOs in locations other than the lower extremity long bones.

We acknowledge several limitations. First is the short followup duration. Although most recurrences occur during the first 7 months after primary RFA [40], one recurrence has been reported after RFA at 44 months [8]. Obviously some patients still might experience recurrence. Second, we did not confirm the diagnosis of OO through tissue biopsy and considered typical clinical and radiographic findings sufficient to make the diagnosis. Third, we did not see the patients during followup, and the followup data were collected through the scheduled contacts with the referring orthopaedic surgeons. However, the referring doctors were acquainted with the pretreatment course of the disease and could readily assess changes in symptoms.

One study found NSAIDs controlled symptoms in nine of nine patients and appeared to accelerate resolution of OOs (six of nine patients), with disappearance of symptoms at an average of 33 months (range, 30–40 months) [18]. Ilyas and Younger [17] reported symptoms resolved at an average of 30 months after initiating NSAIDs in nine of 11 patients. The two patients who discontinued

medical treatment in their series had gastritis because of the NSAIDs and could not tolerate them [17]. Although patients with OO initially are treated with a trial of NSAIDs, or more specifically aspirin [38], most patients have operations within 1 to 3 years from the start of symptoms because of pain and intolerance of prolonged consumption of NSAIDs [7]. Our data suggest all patients were free of symptoms without need for a second procedure during the short followup. Primary RFA has had success rates between 76% and 100% according to Cantwell et al. [8]. Open surgery traditionally has been the preferred treatment for OO [10] and reportedly provides pain relief without recurrence in 88% to 100% of patients [8]. This method has several disadvantages [8]. Several surgical methods including curettage, en bloc resection, and curettage with burr generally require longer inpatient treatment with longer anesthesia and more extensive tissue exposure, tissue damage, scarring, morbidity, and recovery time. If bone allograft is used, this will be added to the morbidity at the bone graft harvest site or the risk of infection from allograft bone material [8]. We discharged our patients on the same day of the procedure, with no activity limitation, casting, or absence from work or school. Rosenthal et al. [32] reported an average hospital stay of 4.7 days for open surgery. Patients also may require a period of protected weight-bearing (up to 3 months [44]), and they may experience pain arising from the resected lesion or graft donor sites. They also may need to restrict their normal activities for a prolonged time [18]. Other minimally invasive methods are CT- or fluoroscopy-guided percutaneous resections, which have success rates of 77% to 100% [8] (Table 3). These methods require greater tissue exposure than RFA [8], although insertion of the drill is guided by imaging. They cannot be used for superficial locations and adjacent to articular surfaces [8], which were among our unusual locations of OO. Percutaneous resection methods take approximately 1.25 to 4 hours to perform [39], which generally is longer than RFA, particularly in our series. Compared with RFA, postprocedural morbidity is greater [8].

Table 3. Case series of different treatment choices for osteoid osteoma*

Study	Procedure	Number of patients	Location [†]	Followup (months) [‡]	Success rate (%) (first attempt)	Complications
Sluga et al. [36] (2002)	Surgery (curettage)	81	Limbs	156 (24–444)	88	20% minor, 3% fracture, 35% minor and major
Sluga et al. [36] (2002)	Surgery (en bloc resection)	25	Limbs	156 (24–444)	95.5	32% minor, 4.5% fracture, 45.5% minor and major
Yildiz et al. [44] (2001)	Surgery (curettage)	80	Mixed	30 (12–96)	95	NS
Yildiz et al. [44] (2001)	Surgery (wide resection and bone graft)	24	Limbs	30 (12–96)	95	NS
Campanacci et al. [7] (1999)	Surgery (curettage by hand)	89	Mixed	72 (12–180)	100	0
Ward et al. [41] (1993)	Surgery (curettage with burr)	15	Mixed	32.5 (6–81.6)	100	NS
Sans et al. [34] (1999)	CT-guided percutaneous resection	38	Mixed	44 (12–78)	84	24% overall; 2 fractures, 1 chronic osteomyelitis; 6 minor
Parlier-Cuau et al. [25, 26] (1998, 1997)	CT-guided percutaneous resection	30	Mixed	24 (2–60)	100	7% minor skin burns
Kohler et al. [19] (1995)	CT-guided percutaneous resection	27	Limbs	24 (12–36)	89	4% transient extensor hallucis palsy
Assoun et al. [3] (1993)	CT-guided percutaneous resection	24	Mixed [§]	9.8 (3–24)	96	21% overall; 1 fracture, 1 iliopsoas hematoma, 1 deep venous thrombosis, 1 skin burn, 1 neurapraxia
Hoffmann et al. [16] (2009)	RFA	39	Mixed	30.5 (1–61)	92	5% major; soft tissue infection, broken drill; 5% minor; hematoma, prolonged 2-week pain
Martel et al. [23] (2005)	RFA	38	Mixed	NS (3–48)	97	5% minor; minimal skin burn, tendinitis of the bicipital tendon
Vanderschueren et al. [40] (2002)	RFA	97	Mixed	41 (5–81)	76	2% major; skin and fat necrosis, broken drill
Woertler et al. [43] (2001)	RFA	47	Mixed	22 (8–39)	94	0
Lindner et al. [21] (2001)	RFA	58	Mixed	23 (6–41)	95	1 minor; minimal skin burn
Rosenthal [30] (1997)	RFA	54	Limbs	NS	92.5	0
Current study	RFA	21	Mixed	26.3 (10–37)	100	4% minor; minimal skin burn

* Based on our search, some well-organized case series with higher numbers of patients for each method were included (> 10 patients for surgery and > 20 patients for other treatments); [†]locations addressed as mixed if lesions in the series were in limbs and axial skeleton; [‡]mean followup, range in parentheses; [§]23 in limbs, 1 in lumbar spine; ^{||}this percentage is among 38 patients and not including the case with the broken drill; NS = not stated; RFA = radiofrequency ablation.

All patients reported relief of pain by a maximum of 1 week after the procedure and we did not encounter any patients with recurrence of pain after the initial pain-free period. Vanderschueren et al. [40] reported 87% of their patients had symptom relief within 24 hours after RFA and the remaining 13% experienced relief within 2 weeks. The time for complete symptom relief as described by Woertler et al. [43] and Lindner et al. [21] was 1 week in all their 58 patients. de Berg et al. [11] described symptom relief in all 18 patients within 3 days. The interval between the procedure and becoming symptom free does

not appear to predict recurrence [8]. Persistence of symptoms greater than 1 month after RFA can be regarded as treatment failure and additional therapy may be considered [8]. With successful surgery, relief of symptoms occurs within 24 hours in 91% and within 48 hours in 9% of patients [44].

Complications such as skin burns and necrosis, fracture, and infection attributable to RFA have been reported [13, 34]; however, with the exception of a nonoperatively managed skin burn, none of our patients experienced these complications. Among surgical approaches, some such as

en bloc resection can lead to complications, including fracture, pain from implants, and infection in 9% to 28% of cases [27, 32, 36]. Other approaches bear different major and minor complication rates (Table 3). For CT-guided percutaneous resection, one case series reported a complication rate of 24% including two fractures, one focal chronic osteomyelitis, three skin burns, two hematomas, and one femoral cutaneous nerve damage [34].

We found RFA for OOs in locations other than lower limb long bones provided patients with pain relief with no major complications or recurrences. Our observations confirm previous reports for RFA in lower extremity long bones. Patients can be discharged on the procedure day with no need for activity restriction; therefore, in terms of disability and morbidity, RFA can be regarded as the preferred treatment.

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