SCIENTIFIC RESEARCH

RADIOFREQUENCY ABLATION IN THE TREATMENT OF OSTEOID OSTEOMA: A CASE SERIES

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SUMMARY

Objective: Radiofrequency ablation (RFA) has emerged as a minimally invasive therapeutic option for osteoid osteoma (OO). Although extensively studied worldwide, data on its effectiveness and safety in Vietnam remain limited. This study presents a case series evaluating the technical success, clinical outcomes, and complications of RFA in OO treatment.

Materials and Methods: Four male patients with OO underwent RFA over a three-month period. Lesions were located in the femur (n = 2) and tibia (n = 2). Two patients underwent primary RFA, while two received RFA after failed surgical treatment. Pain relief, recurrence rates, and complications were assessed over a 2-4 month follow-up period.

Results: Three out of four patients achieved complete pain relief without recurrence or complications. One patient experienced recurrent pain four months post-procedure.

Conclusion: RFA is a safe and effective minimally invasive treatment for OO, offering immediate symptom relief with a low recurrence rate. Further studies with larger sample sizes and longer follow-up are warranted to confirm these findings.

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I. INTRODUCTION

Osteoid osteoma (OO) is a benign and painful bone tumor that predominantly affects young individuals between 5 and 30 years of age. It accounts for approximately 10–12% of all benign bone tumors and is most commonly found in the lower extremity, particularly the femur and tibia. Clinically, OO is characterized by persistent, localized pain that worsens at night and is significantly relieved by nonsteroidal anti-inflammatory drugs (NSAIDs), particularly aspirin. Radiographically, it presents as a small, well-defined nidus—typically less than 15 mm in diameter—surrounded by a reactive sclerotic bone. Although the tumor itself is not malignant, the associated pain and inflammatory response can significantly impair a patient's quality of life.

Several treatment modalities are available for OO, ranging from conservative management with NSAIDs to surgical excision and minimally invasive techniques. Long-term NSAID use can provide symptom relief but has potential gastrointestinal side effects, renal impairment, and poor patient adherence. Traditional surgical resection, including curettage and en bloc resection, has been a mainstay of treatment; however, it is associated with several drawbacks, such as extensive bone removal, prolonged recovery time and increased risk of fractures. On the other hand, minimally invasive procedures, particularly radiofrequency ablation (RFA), have gained acceptance as a preferred treatment approach.

RFA was first introduced by Rosenthal as a minimally invasive, image-guided technique for treating OO. The procedure involves the percutaneous insertion of a radiofrequency electrode into the nidus under computed tomography (CT) guidance, followed by thermal ablation to destroy the tumor. Over the past few decades, multiple studies have demonstrated RFA's efficacy, reporting success rates exceeding 90% with minimal complications and a significantly reduced recovery period compared to surgery. Patients typically experience rapid pain relief within days, and most can resume normal activities shortly after the procedure. Furthermore, RFA has been shown to preserve surrounding bone integrity, reducing the risk of post-treatment fractures and long-term structural compromise.

Despite the widespread global adoption of RFA, research on its application in Vietnam remains limited. Given the increasing recognition of this technique for OO, further evaluation of its effectiveness and safety in the Vietnamese population is essential. This study aims to assess the technical success, clinical outcomes, and complications associated with RFA in the treatment of OO. By providing a comprehensive analysis of patient responses and procedural outcomes, this research seeks to contribute valuable insights into the role of RFA in managing OO within a local clinical context.

II. MATERIALS AND METHODS

Patient Selection

Patients were selected based on a history of typical osteoid osteoma (OO)-related pain, characterized by nighttime pain that was relieved by NSAIDs. Radiographic confirmation of OO was required through either X-ray or CT scan. Patients with recurrent OO following prior surgical intervention were also included in the study.

Procedure

The procedure was performed under CT guidance to ensure precise targeting of the lesion. A 14G bone biopsy needle was initially inserted into the nidus, followed by electrode placement using the Starmed system. Radiofrequency ablation (RFA) was then initiated, with ablation considered complete upon reaching the "roll-off" point, which indicates sufficient tissue necrosis and impedance changes suggesting effective treatment. The entire procedure was conducted under local or general anesthesia, depending on patient tolerance and lesion location.

Technical success was defined as accurate electrode placement at the nidus center and maintenance of the target temperature for sufficient time to achieve necrosis. Patients were monitored postoperatively and discharged within 24 hours. They were advised to resume daily activities as tolerated, with restrictions on high-impact activities for at least one week.

Outcome Assessment

Pain levels were assessed using a numerical pain scale (1-10) at baseline and postoperatively at 12 hours, 24 hours, and at 2- and 4-month follow-ups. Additional assessments

included patient-reported functional outcomes and the need for analgesics post-procedure. Any complications such as infections, fractures, neurovascular injury, or skin burns were documented.

III. RESULTS

Four patients (male, 5-31 years old) were included in the study. The clinical characteristics of all patients are shown in Table 1. All patients underwent successful electrode placement with maintenance of target temperature throughout the procedure. The average duration of intervention was one hour, including pre-procedural imaging and post-procedural monitoring.

All patients reported immediate and significant pain relief post-procedure, with an average decrease of at least 80% in pain scores within the first 24 hours. At the 2- and 4-month follow-ups, pain relief remained sustained in one patient. No procedural complications, including infections, fractures, or skin burns, were observed.

One patient experienced pain recurrence two months post-treatment, with progressive worsening. By the fourth month, NSAID use was required for pain management. This patient had a history of prior surgical intervention and a 10mm nidus size, both of which are recognized risk factors for incomplete ablation and recurrence.

IV. DISCUSSION

O, first described by Jaffe in 1935, is a benign but painful bone lesion characterized by a central nidus surrounded by reactive sclerosis. It accounts for approximately 10% of all benign bone tumors, with a predilection for young individuals. The most commonly affected sites include long bones, particularly the femur and tibia, comprising nearly 50% of cases.

Various treatment modalities exist, ranging from conservative management with NSAIDs to surgical excision and minimally invasive techniques such as RFA, laser ablation, cryotherapy, and microwave ablation. RFA has gained widespread acceptance due to its minimally invasive nature, high efficacy, and low complication rates.

Surgical treatment, while effective, has been associated with recurrence rates ranging from 9-28%, particularly in lesions located in anatomically challenging regions. Recurrence can occur even a decade post-surgery. In contrast, RFA has demonstrated a recurrence rate of up to 11%, with one study reporting recurrence as late as 44 months post-treatment. Factors such as larger nidus size (>10mm) and non-cortical lesion location have been identified as independent predictors of recurrence.

In the present study, our cohort of patients undergoing RFA experienced immediate and significant pain relief following the procedure, a finding consistent with the rapid disruption of the nidus's nociceptive signaling. This relief was sustained in the majority of cases over the observation period, affirming RFA's role as a reliable intervention for symptomatic control.

However, one patient exhibited recurrence, a case notable for both a larger nidus and a history of prior surgical intervention. This observation suggests that previous manipulation of the lesion site—potentially altering local tissue architecture or vascularity—may complicate subsequent ablation efforts, reducing the likelihood of complete nidus eradication.

For such refractory cases, repeat RFA offers a feasible salvage option, though alternative modalities like laser ablation or cryotherapy may also warrant consideration, particularly if technical or anatomical factors preclude optimal RFA delivery. The choice of subsequent intervention should be guided by a multidisciplinary assessment, weighing lesion characteristics, patient preferences, and institutional expertise.

This study is limited by a small sample size and a relatively short follow-up period. Larger, multicenter studies with extended follow-up are necessary to further evaluate long-term outcomes and identify predictors of treatment failure. Future research should also explore optimization of ablation parameters, alternative energy modalities, and patient selection criteria to improve efficacy and minimize recurrence rates.

V. CONCLUSION

RFA is a minimally invasive treatment for OO, providing immediate pain relief with low complication and recurrence rates. Further research is warranted to strengthen these findings and optimize treatment protocols.

Table 1. Patients' characteristics

	Gender	Age	Location	Hospital Stay (days)	Nidus Size (mm)	Prior Treatment	Needle Type	Complications	Response to Treatment	Follow-up Time (months)	Recurrence
1	Male	15	Tibia	1	10	Surgery (2x)	Starmed	None	Immediate pain relief	5	Recurrence at 2 months, worsening at 4 months requiring NSAIDs
2	Male	31	Femur	1	4	None	Starmed	None	Immediate pain relief	5	None
3	Male	5	Femur	1	8	Surgery (2x)	Starmed	None	Immediate pain relief	2	None
4	Male	25	Femur	1	5	None	Starmed	None	Immediate pain relief	2	None

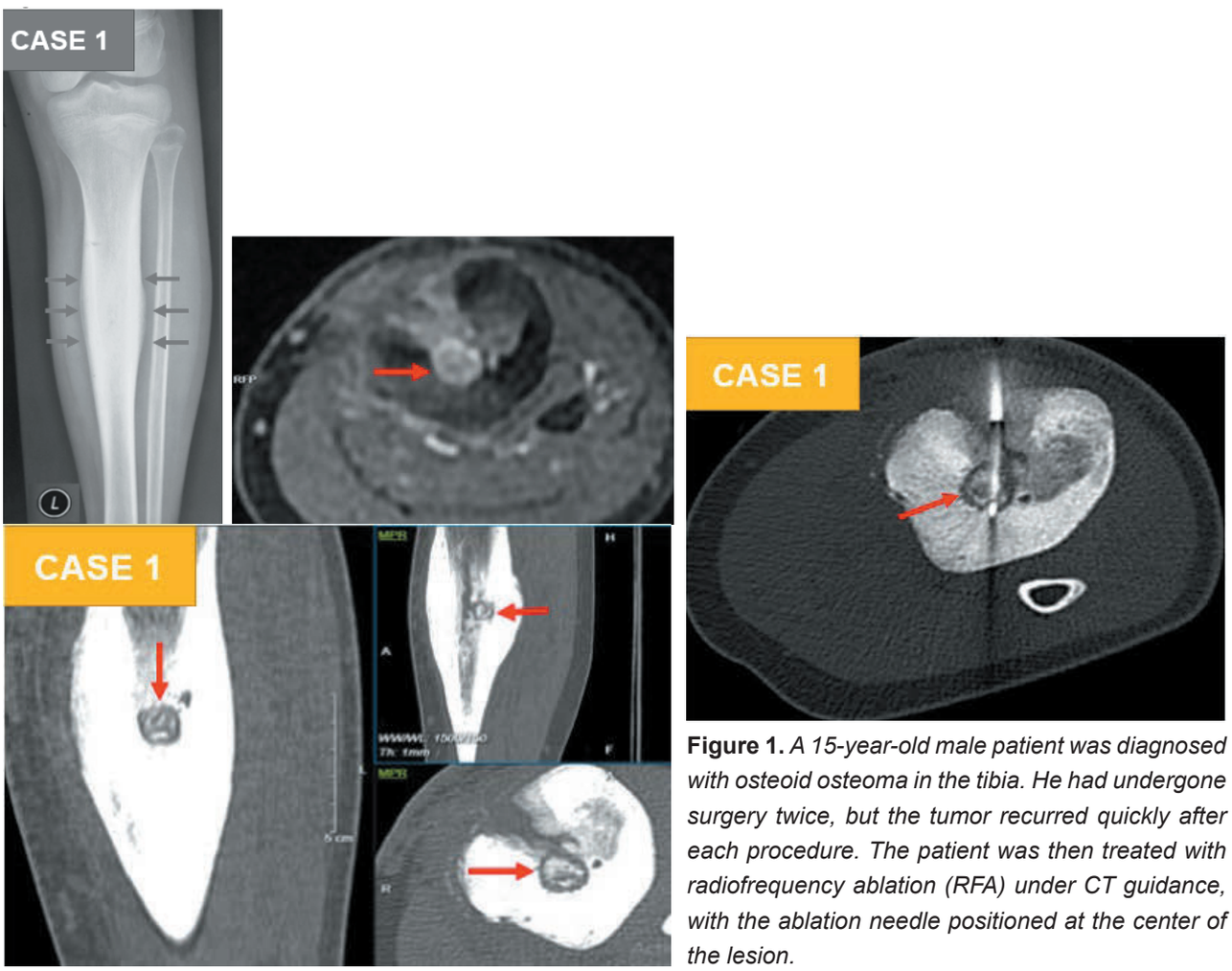

Figure 1. *A 15-year-old male patient was diagnosed with osteoid osteoma in the tibia. He had undergone surgery twice, but the tumor recurred quickly after each procedure. The patient was then treated with radiofrequency ablation (RFA) under CT guidance, with the ablation needle positioned at the center of the lesion.*

Figure 2.

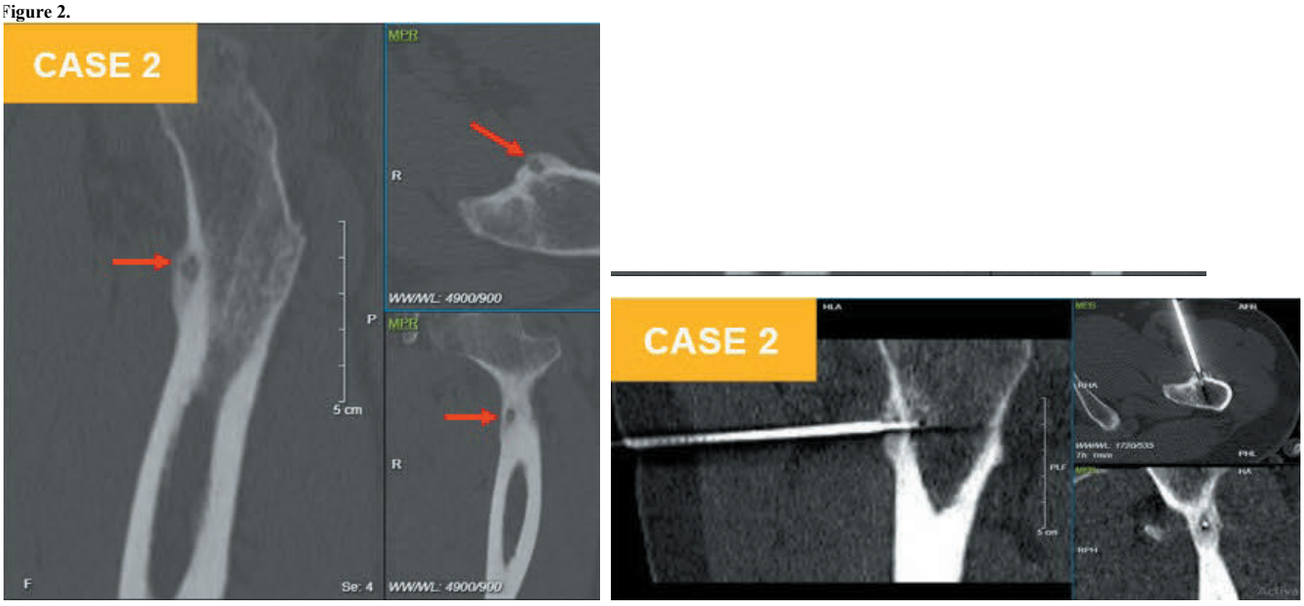

Figure 2. *A 31-year-old male patient experienced left hip pain for 3 months. A CT scan was performed, leading to a diagnosis of osteoid osteoma. The patient underwent treatment with radiofrequency ablation (RFA) under CT guidance. The ablation needle was positioned at the center of the lesion.*

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