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Percutaneous Computed Tomography-Guided Excision of Osteoid Osteoma

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ABSTRACT

Objective: Osteoid osteoma (OO) is a common benign bone tumor typically affecting individuals under 25, characterized by localized pain responsive to non-steroidal anti-inflammatory drugs. Complete nidus removal is the primary treatment goal. While computed tomography (CT)-guided percutaneous excision is popular, trephine excision offers a cost-effective alternative, allowing histopathological confirmation. This study aimed to evaluate the clinical and radiological outcomes of CT-guided percutaneous nidus excision using a trephine.

Materials and Methods: This retrospective study included 24 patients (18 males and 6 females; mean age 15.3 years) diagnosed with OO who underwent CT-guided percutaneous nidus excision using standard orthopedic trephines. Pain severity (Visual Analog Scale [VAS]/faces pain scale), operation time, hospital stay, technical success (complete nidus removal), clinical success (pain resolution without recurrence), and complications were recorded. A paired t-test compared pre- and post-operative pain scores (significance at $p<0.05$).

Results: The mean pre-operative VAS score significantly decreased from 7.72±1.97 to 0.79±1.84 postoperatively ($p<0.001$). Technical success was achieved in 23/24 patients (96%). Clinical success was observed in 21/24 patients (87.5%), with three recurrences potentially linked to marking errors or larger nidus sizes. No intraoperative neurovascular injuries or fractures occurred. Post-operative complications included two deep infections and one delayed fracture. Histopathological confirmation of OO was obtained in 20/24 cases (83%).

Conclusion: CT-guided percutaneous trephine excision is an effective and safe treatment modality for OO, demonstrating high technical and clinical success rates with a low incidence of major complications and allowing for histopathological diagnosis. Further prospective studies with larger cohorts are warranted.

Keywords: Bone neoplasms, Computed tomography, Osteoid osteoma, X-ray

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INTRODUCTION

Osteoid osteoma (OO) is a benign osteoblastic bone tumor, accounting for approximately 11–12% of all benign bone tumors.[1,2] The lesion, known as the nidus, typically measures <2 cm in diameter and is surrounded by a reactive sclerotic zone.[3] OO most commonly affects individuals under the age of 25, and the clinical presentation often follows a characteristic pattern. Patients frequently report localized pain that intensifies at night or with activity,[4] and this pain generally exhibits a marked response to non-steroidal anti-inflammatory drugs.[5,6]

The primary objective in the treatment of OO is the complete removal or destruction of the nidus.[7] While various surgical options have been described, computed tomography (CT)-guided percutaneous excision has gained popularity due to its minimally invasive nature and reliable outcomes.[1] Among the percutaneous approaches, radiofrequency ablation (RFA) is widely used; however, it has several limitations, including its proximity to neurovascular structures, high cost, and the inability to obtain tissue for histopathological evaluation.[2,8,9] CT-guided trephine excision offers a cost-effective alternative that allows for both targeted removal and histopathological confirmation of the lesion. In addition, it can be performed using standard orthopedic instruments without requiring specialized equipment. The marking of the nidus is conducted in the CT suite, thereby reducing radiation exposure to the surgical staff.[1,10]

The present study aimed to examine the clinical and radiological outcomes of patients who underwent percutaneous nidus excision using a trephine following CT-guided nidus localization. We hypothesized that CT-guided percutaneous excision is an effective treatment modality for OO, providing high success rates with a low incidence of complications.

MATERIALS AND METHODS

Study Design and Setting

This retrospective study included patients diagnosed with OO who underwent CT-guided percutaneous nidus excision. Data collection was performed following approval from the institutional clinical research ethics committee (decision number: 2015/108). A total of 35 patients were screened between (insert time frame if available), and relevant clinical and radiological data were reviewed retrospectively.

Participants

Of the 35 patients initially evaluated, 11 were excluded due to one or more of the following: Previous surgical intervention for OO, follow-up duration <6 months, failure to attend follow-up visits, or refusal to participate. In addition, patients with comorbid conditions such as diabetes mellitus or immunodeficiency were excluded to ensure homogeneity of the study cohort. Ultimately, 24 patients (18 males and six females) were included. Informed consent – written or verbal – was obtained from all participants, and the study was conducted in accordance with the Declaration of Helsinki.

Radiological Diagnosis

The diagnosis of OO was based on clinical history and imaging findings. In patients presenting with typical symptoms, bilateral plain radiographs were initially obtained (Fig. 1). If solid cortical thickening was noted, thin-slice CT was subsequently performed. On CT, lesions demonstrating a lytic focus approximately 0.5–1 cm in diameter surrounded by reactive sclerosis were interpreted as indicative of the nidus.

Surgical Procedure

All patients received prophylactic intravenous cefazolin (20 mg/kg) approximately 30 min before the intervention. The procedure was performed in two stages using standard orthopedic tools: a trephine (Fig. 2), a guide wire, and a rechargeable drill (Bosch PSR Li-2). In the first stage, the nidus was localized and marked under CT guidance (Sensation 64; Siemens Medical Solutions, Forchheim, Germany) using a K-wire under local anesthesia (Fig. 3). In the second stage, performed in the operating room under regional or general anesthesia, the nidus was excised percutaneously using a trephine with a round-tipped edge (Fig. 4). Trephines of varying diameters (7 mm, 9 mm, and 11 mm) were selected based on the esti-

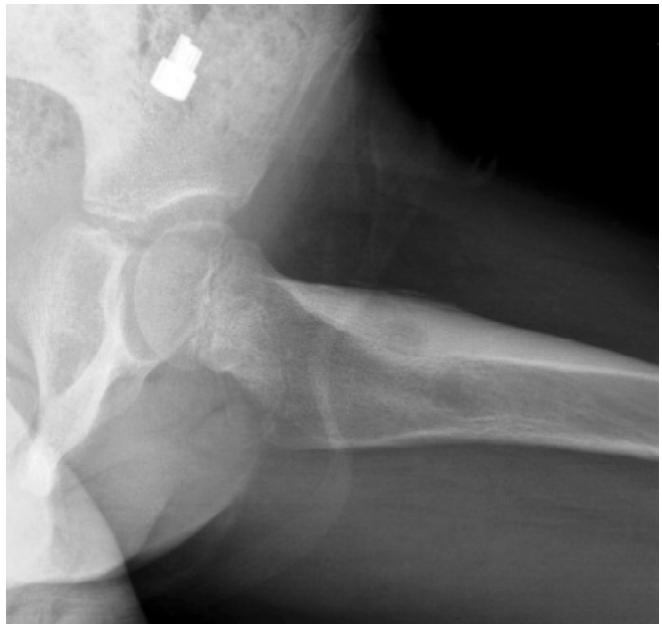

Figure 1. Pre-operative X-ray (lateral view) shows cortical thickening and nidus (arrow) localization.

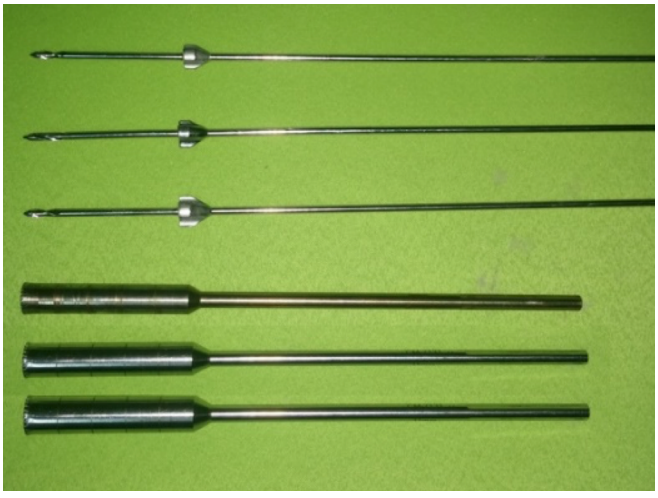

Figure 2. Trephine (round reamer) and guide wire of different diameters (7, 9, 11 mm) used in the procedure. For easy removal of the material in the reamer, there is a block on the guide wire with the width of the inner diameter of the trephine.

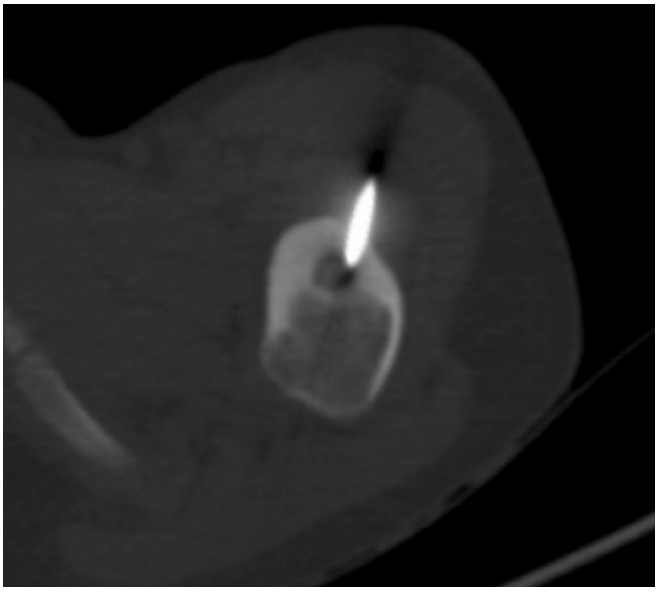

Figure 3. Nidus marked with K-wire under computed tomography guidance.

mated size of the nidus (Fig. 2), minimizing unnecessary resection. A low-speed drill was used to reduce thermal necrosis, and saline irrigation was applied for cooling. The drilled area was curetted to prevent leaving residual nidus tissue near the incision. All excised samples were sent for histopathological evaluation (Fig. 5).

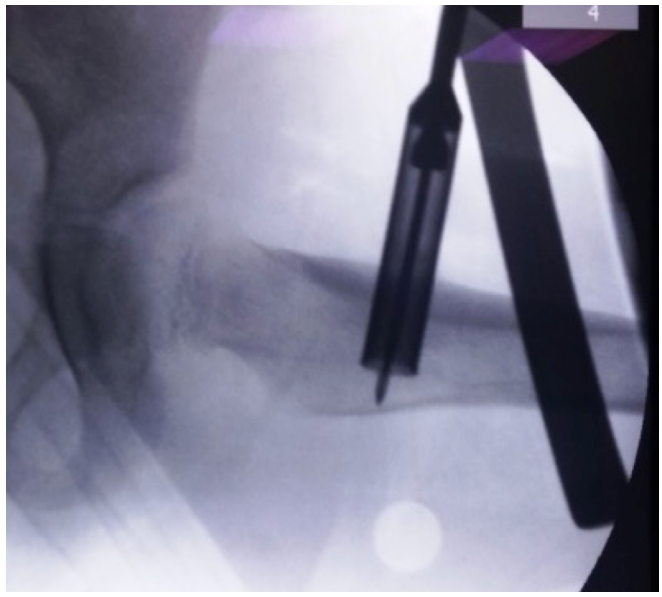

Figure 4. Intraoperative scope image: It covers the entire trephine nidus of the appropriate size, which is sent with a drill percutaneously over the guide wire.

Outcomes and Definitions

All patients underwent clinical assessment at their final follow-up. Demographic data (age and sex), affected extremity, follow-up duration, operation time, hospital stay, recurrence, and post-operative complications were recorded. Lesion location was categorized into subperiosteal, cortical, endosteal, or medullary types according to the classification by Kayser et al.[9] Pain severity was measured using the Visual Analog Scale (VAS) in 23 patients both preoperatively and postoperatively, where 0 indicated no pain and 10 indicated worst pain. In one pediatric patient (aged 4 years), pain was evaluated using the faces pain scale, which is particularly effective in children and individuals with communication difficulties.[11] Technical success was defined as complete nidus removal using trephine, whereas clinical success referred to complete pain resolution without recurrence during follow-up.[1] Post-operative radiological evaluations were conducted using plain X-rays (Fig. 6).

Ethical Considerations

All procedures were approved by the relevant institutional ethics committee (decision number: 2015/108), and patient consent was obtained in compliance with ethical standards.

Statistical Analysis

The statistical evaluation of the research data was performed using IBM Statistical Packages for the Social Sciences Statistics version 21.0 for Windows (Armonk, NY: IBM Corp.). Descriptive

statistics were used to summarize demographic and baseline characteristics, including age (mean±standard deviation, range), follow-up duration (mean±standard deviation, range), and the interval from symptom onset to diagnosis (mean±standard deviation, range). Categorical variables such as sex and lesion localization were presented as frequencies and percentages. A paired t-test was utilized to compare pre-operative and post-operative pain intensity scores as measured by the VAS, with statistical significance set at $p<0.05$. Procedural data, including the duration of nidus marking, surgical operation time, and hospital stay, were also summarized using descriptive statistics (mean±standard deviation, range). Technical and clinical success rates, as well as the incidence of post-operative complications and recurrence, were reported as percentages.

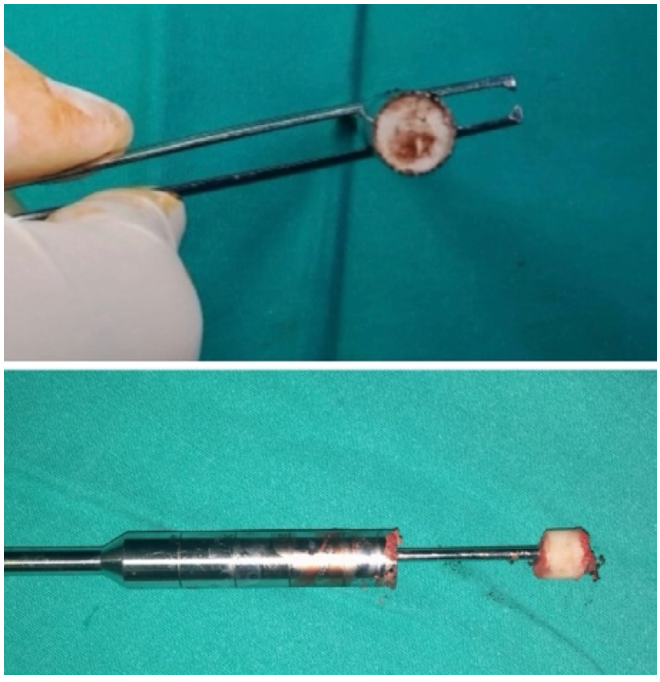

Figure 5. Nidus enbloced with a trephine. The nidus (arrow) is removed undamaged by the sclerotic tissue around it.

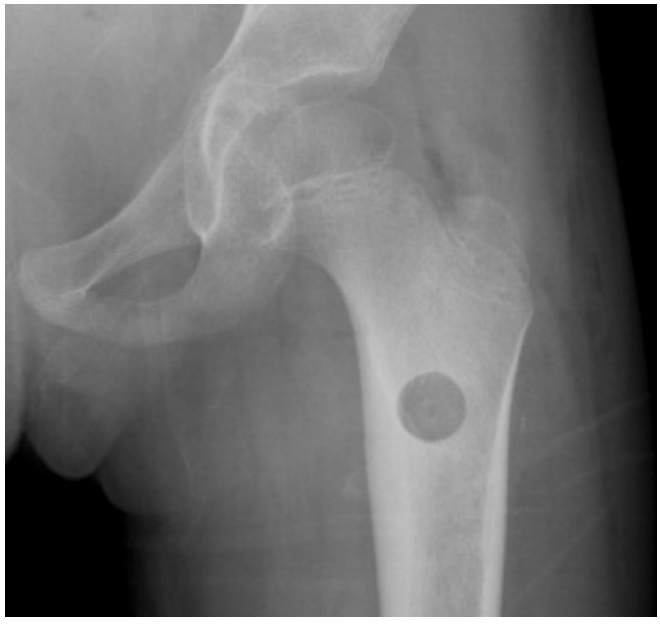

Figure 6. Post-operative direct X-rays show the extracted nidus.

RESULTS

Demographic and Baseline Characteristics

The mean age of the patients was 15.3 years (range: 4–27 years) (Fig. 7), and the mean follow-up duration was 18.2 months (range: 11–25 months). The mean interval from symptom onset to diagnosis was 11 months (range: 2–54 months). Lesion localization was as follows: tibia in 50% of patients (n=12), femur in 37.5% (n=9), fibula in 4.2% (n=1), metacarpals in 4.2% (n=1), and iliac crest in 4.2% (n=1) (Fig. 8).

Procedural Data

The mean duration for nidus marking under CT guidance was 14±3 min (range: 10–25 min), and the mean surgical operation time was 44.37±14.39 minutes (range: 25–90 min). The average hospital stay was 1.16±0.38 days (range: 1–2 days) (Table 1).

Clinical and Technical Outcomes

Pain intensity was assessed using the VAS. The mean pre-operative VAS score was 7.72±1.97 (range: 2–10), which significantly decreased postoperatively to 0.79±1.84 (range: 0–6) ($p<0.001$). Night pain associated with OO resolved completely within the first 24 h in 22 patients (92%). In one patient, com-

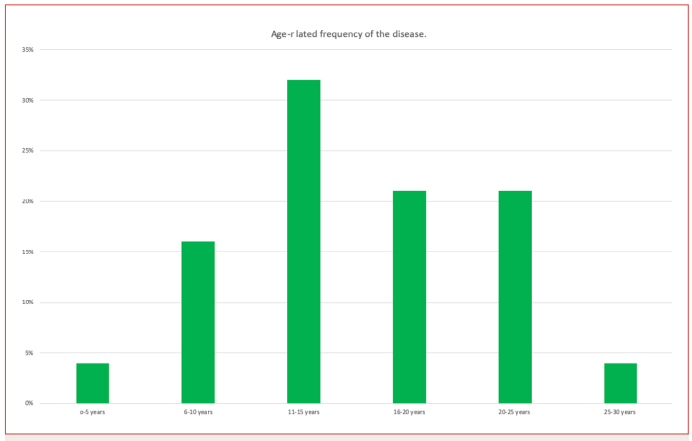

Figure 7. Age-related frequency of the disease.

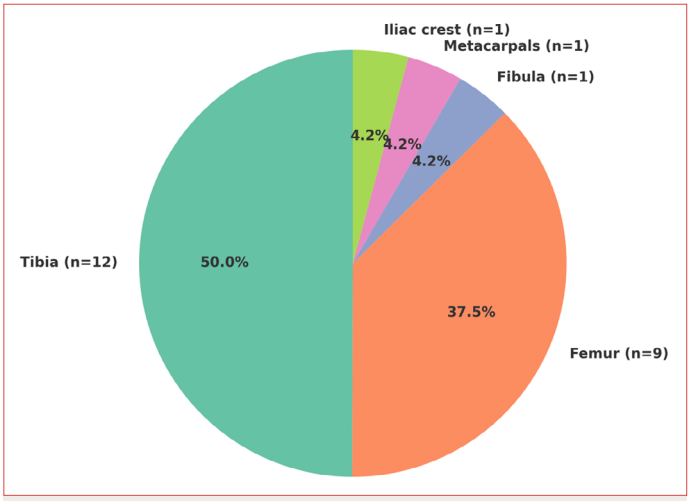

Figure 8. Distribution of lesions by anatomical location.

plete pain relief was achieved within 5 days. However, one patient continued to experience pain postoperatively. Upon review, this case was found to involve an inaccurate marking, resulting in incomplete nidus excision. Histopathological confirmation of OO was achieved in 83% of patients (n=20). Technical success – defined as complete nidus removal – was achieved in 23 out of 24 patients (96%). Clinically, successful outcomes – defined as the resolution of symptoms without recurrence – were observed in 21 patients (87.5%), whereas 3 patients (12.5%) experienced clinical failure. Among these, two patients exhibited recurrence: one with tibial diaphyseal involvement at 4 months and another with femoral diaphyseal involvement at 3 months postoperatively. Both cases had niduses with larger diameters (20 mm and 22 mm), suggesting incomplete excision due to instrument limitations.

Complications

No intraoperative complications, such as fractures or neurovascular injuries, were observed. One patient developed an incomplete tibial fracture during a sports activity 3 months postoperatively, which was managed conservatively with a long leg cast. The fracture united uneventfully after 2 months of immobilization. Deep surgical site infections occurred in two patients with tibial involvement. One case was treated with surgical debridement and antibiotics, whereas the other responded to antibiotic therapy alone. In both cases, the wounds healed without recurrence of infection until the final follow-up (Table 2).

Table 1. Patient demographics and operative data

Parameter	Mean±SD (range)	Notes
Mean age (years)	15.3 (4–27)	Patients' age range
Follow-up period (months)	18.2 (11–25)	Post-operative follow-up duration
Duration until diagnosis (months)	11 (2–54)	From onset of symptoms to diagnosis
CT marking time (minutes)	14±3 (10–25)	Time taken for CT-guided marking
Operation time (minutes)	44.37±14.39 (25–90)	Time from start to end of surgery
Hospital stay (days)	1.16±0.38 (1–2)	Days spent in the hospital post-surgery

CT: Computed tomography.

Table 2. Clinical outcomes and complications

Parameter	Mean±SD (Range)	Notes
Pre-operative VAS score	7.72±1.97 (2–10)	Indicates initial pain severity
Post-operative VAS score	0.79±1.84 (0–6)	Significant reduction in pain ($p<0.001$)
Clinically successful outcomes (%)	87.5% (n=21)	Patients with complete pain resolution
Clinically unsuccessful Outcomes (%)	12.5% (n=3)	Incomplete nidus removal or recurrence
Recurrence rate	8.3% (n=2)	Found in larger nidus sizes (20–22 mm)
Complications	3 cases	1 fracture, 2 infections

VAS: Visual analog scale.

DISCUSSION

This study demonstrated that CT-guided percutaneous excision using a trephine exhibited high technical (96%) and clinical (87.5%) success rates in the management of OO. Furthermore, the histopathological diagnosis rate achieved with this method was 83%, and the incidence of complications was notably low. Specifically, a significant reduction in post-operative pain scores (VAS score: from 7.72 to 0.79) was observed. These findings suggest that CT-guided percutaneous excision represents an effective and safe treatment modality for OO.

The primary objective in the surgical treatment of OO is the marginal or wide en bloc excision of the lesion, which can be accomplished through either open or closed techniques.[12] Open surgery is associated with a higher risk of bone loss and complications, with literature reporting complication rates ranging from 25% to 45%. Consequently, the preference for open surgery has diminished in favor of less invasive approaches.[3] Percutaneous techniques result in less bone loss and facilitate access to anatomically challenging regions. Minimally invasive methods such as RFA, laser photocoagulation, and CT-guided percutaneous excision are frequently favored, wherein the nidus is coagulated and excised using chemical or physical agents.[13] One percutaneous approach involves marking and drilling the nidus under CT guidance. This procedure can expose the operating room staff, patient, and physician to prolonged radiation.[9,14] To mitigate radiation exposure, Fenichel et al.[15] conducted a study involving 18 cases, utilizing a specifically designed cannulated trephine for en bloc excision of the nidus, which resulted in an increased rate of pathological diagnosis. Consistent with the aim of lower cost and high pathological diagnosis rates, we also employed this method, utilizing cannulated trephines of varying diameters for the excision of niduses of different sizes.

The principal complaint of patients with OO is pain.[16,17] Clinical improvement is typically observed rapidly and significantly following the excision of the nidus. In a study by Ofluoğlu et al.,[18] the pre-operative mean VAS score was reported as 7.9±1.2, whereas the post-operative VAS score was 0.3±0.6, with pain resolution occurring on average within 4 days. However, this duration can occasionally extend up to 1 month. Prolonged pain may indicate incomplete excision of the nidus.[19] In our study, rapid and significant pain relief was observed in all patients except one who experienced a marking error. Postoperatively, pain was completely resolved within the first 24 h in 22 cases (92%), whereas in one case, complete resolution took 5 days. Retrospective examination revealed that the patient with persistent pain had undergone incomplete excision due to a marking error. Clinically successful outcomes were achieved in 21 patients (87.5%), with 3 patients (12.5%) experiencing unsuccessful outcomes, primarily attributed to marking errors.

A significant advantage of the percutaneous excision method is its capacity to provide sufficient and reliable tissue samples for pathological examination. The literature suggests that ablation techniques, particularly RFA, have been inadequate for obtaining pathological diagnoses.[2,8] As methods such as RFA aim to destroy the nidus through coagulation, a solid sample for histological evaluation may not be obtained. Conversely, CT-guided percutaneous excision ensures complete removal of the nidus, leading to a higher rate of reliable pathological diagnoses.[20] The agreement rate for pathological diagnoses using ablation techniques is reported to range from 30% to 60%.,[20,21] whereas this rate varies from 83% to 100% for the CT-guided percutaneous excision method.[8,22] In our study, a significant majority (83%) of cases utilizing this method achieved histopathological confirmation, supporting its reliability. The failure to obtain a diagnosis during pathological examination may result from mechanical damage to the nidus during excision or thermal effects caused by the rotation of the trephine.

Recurrence rates for OO vary considerably depending on the treatment modalities employed. Open surgery is less frequently preferred today due to its high recurrence rates, reported in the literature to range from 4.5% to 23%.[23] In the study by Yang et al.,[22] the recurrence rate for conventional open surgery was significantly higher than that for CT-guided minimally invasive surgery. Furthermore, the minimally invasive method resulted in shorter hospital stays, less bone loss, and reduced surgical duration. Percutaneous ablation methods, particularly RFA, have been shown to significantly lower recurrence rates. Success rates for percutaneous RFA treatments are reported to be between 88% and 95%, with recurrence rates below 5%.[24-27] However, some studies have indicated higher than expected recurrence rates; for instance, Shields et al.[25] reported a rate of 16.3%. The use of RFA under CT guidance allows for precise targeting of the nidus, contributing to better outcomes and lower recurrence rates.[3] In a study by Lindquester et al.,[26] the failure rates for percutaneous RFA and cryoablation were found to be similar (averaging 5.6%), and a second ablation successfully treated 71.2% of recurrences. Similarly, low recurrence rates (0–12.5%) have been reported for CT-guided percutaneous excision.[9,28] In our study, clinically successful outcomes were achieved in 21 patients (87.5%), whereas 3 patients (12.75%) experienced post-operative recurrence. Our retrospective analysis identified a marking error in one patient, and the recurrences in the other two patients were likely due to the larger diameters of their niduses (20 mm and 22 mm). Considering that the maximum diameter of the trephines we used was 11 mm, complete excision may not have been possible, and adequate curettage may not have been performed after excision. In addition, if the marking coincided with the periphery of the

nidus rather than the center, the nidus may not have been completely removed. Although the success rates of our method are comparable to the widely used RFA, trephine excision is considerably more economical.[29]

Perioperative fractures, prolonged hospital stays, and delays in clinical improvement are the main complications associated with open surgery. Complication rates for RFA treatments are reported to range from 0% to 15%,[24,30] and the long-term side effects remain poorly understood.[13,14] In a study by Sans et al.,[31] two of the 38 patients treated with RFA developed pathological fractures postoperatively, and one case experienced chronic osteomyelitis. For CT-guided trephine percutaneous excision, complication rates range from 0% to 24%, with reported complications including post-operative fractures, hematomas, infections, nerve damage, and osteomyelitis. Raux et al.[32] reported femoral fractures in two patients, yielding an average complication rate of 4.7%. In addition, a study by Reverte et al.[29] evaluating 54 cases found that major complication rates and technical problems were more frequently observed in RFA cases compared to those treated with CT-guided percutaneous excision. In our study, deep infections occurred in two cases, and one patient developed a fracture 3 months after surgery. The infections were treated with appropriate antibiotic therapy and wound care, while the fracture was managed with plates and screws.

This study has several limitations. First, its retrospective design and relatively small sample size (n=24) may restrict the generalizability of the findings. Future studies with larger cohorts and longer follow-up periods are needed to provide more robust data regarding the long-term outcomes and recurrence rates associated with CT-guided percutaneous trephine excision. Second, all procedures were performed at a single center by an experienced orthopedic team, which may introduce selection bias; results may differ when performed by surgeons at other centers or with varying levels of expertise. In addition, while the study focused on clinical success and radiological outcomes, it did not comprehensively assess patient-reported quality of life and functional recovery, which are important for understanding the overall impact of the treatment. Finally, the absence of direct comparisons with other treatment methods, such as RFA, limits the ability to definitively assess the superiority of one technique over another. Future prospective studies are essential to validate the comparative efficacy and safety of these treatment methods.

CONCLUSION

CT-guided percutaneous excision with a trephine is an economical and reliable method that offers high success rates and a low risk of complications and facilitates histopathological diagnosis in the treatment of OO. This method is advantageous in terms of diagnostic accuracy, particularly when compared to other minimally invasive methods such as RFA. However, limitations such as the retrospective design and small sample size highlight the necessity for prospective studies with larger cohorts in the future. Furthermore, randomized controlled trials comparing this method with other minimally invasive techniques can provide more precise results regarding the effectiveness and safety of treatment options.

DECLARATIONS

Ethics Committee Approval: The study was approved by Dicle University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (No: 2015/10, Date: 23/01/2015).

Informed Consent: Written or verbal - was obtained from all participants.

Conflict of Interest: The authors declare that there is no conflict of interest.

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Authorship Contributions: Concept – MAÇ, CA; Design – MAÇ; Supervision – CA, AD; Fundings – CA, AD; Materials – YM, RA; Data collection &/or processing – ESY, YM; Analysis and/or interpretation – MAÇ, YM; Literature search – RA, ESY; Writing – MAÇ, ESY; Critical review – RA, AD.

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