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Original Article

Efficacy of Retrograde Bone Grafting for Cystic Osteochondral Lesions of the Tibial Plafond: A Retrospective Study

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ABSTRACT

Objective: This study evaluated the clinical and radiological outcomes of patients with cystic osteochondral lesions of the tibial plafond (OLTP) treated with retrograde cancellous bone grafting.

Materials and Methods: A retrospective review was conducted on patients who underwent surgery for OLTP at our institution from 2012 to 2023. Eleven patients (7 females, 4 males; mean age 41.9 years) were included. Preoperative, intraoperative, and postoperative data were analyzed, including radiological assessments using direct radiography, CT, and MRI. The surgical technique involved retrograde cancellous bone grafting, with postoperative rehabilitation and follow-up evaluations using the AOFAS score.

Results: The mean clinical follow-up period was 75.7 (median: 79, range: 12-137) months. The mean preoperative AOFAS score improved significantly from 56.0 to 89.3 (p=0.003). Radiological follow-up showed cyst consolidation in seven patients, while four experienced recurrences (36.3%). Recurrence was associated with persistent communication between the cyst cavity and the joint space.

Conclusion: Retrograde cancellous bone grafting significantly improves clinical outcomes in patients with cystic osteochondral lesions of the tibial plafond, as demonstrated by a marked increase in postoperative AOFAS scores compared to preoperative values. However, a high recurrence rate of 36.3% highlights the need for advancements in surgical techniques to achieve complete healing. Successful outcomes hinge on the effective obliteration of the communication between the cyst and the ankle joint space.

Keywords: Ankle, Bone cysts, Osteochondral lesions, Retrograde grafting, Tibial plafond

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INTRODUCTION

Osteochondral lesions of the tibial plafond (OLTP) are less common compared to those of the talus and can occur as isolated lesions or coexist with osteochondral lesions of the talus (OLT). The incidence of OLTP in the general population remains poorly defined. Mologne and Ferkel [1] reported OLTP in 2.6% of 880 patients undergoing ankle arthroscopy, while Elias et al. [2] found a 15.2% incidence in 250 ankle MRI examinations. Advances in diagnostic imaging and ankle arthroscopy

have improved the recognition and understanding of OLTP, revealing that they are not as rare as previously thought and can coexist with talar osteochondral lesions as kissing lesions.

OLT lesions are classified into various grades, with cyst formation classified as Grade 5 according to the Hepple classification [3]. For high-grade cystic lesions, it is recommended to address both the cystic component and the cartilage lesion simultaneously. Common treatments include antegrade or retrograde curettage and grafting of the cyst or filling with an osteochondral plug. While there are numerous studies on OLT treatment, limited studies exist on OLTP, and no consensus has been reached on treatment principles. The literature also presents confusion regarding the definition of high-grade lesions with cyst formation, with some authors treating these as intraosseous ganglion cysts due to their gelatinous fluid content and identical histopathological characteristics.

This retrospective study aims to assess the outcomes of patients treated for cystic osteochondral lesions of the tibial plafond (OLTP) with retrograde cancellous bone grafting. The procedure is hypothesized to be an effective treatment for OLTP, leading to significant improvements in clinical outcomes and functional scores. A comprehensive analysis of preoperative, intraoperative, and postoperative data, including radiologic assessments, was conducted to evaluate the efficacy of this approach. The study seeks to contribute to the ongoing discussion on optimal management strategies for OLTP.

MATERIALS AND METHODS

Patients and Study Design

A retrospective review was conducted using the digital patient database at the authors' institution between 2012 and 2023 to identify patients who underwent surgery for OLTP. The medical records, follow-up notes, and operative notes were extracted, and the demographic and clinical characteristics of the patients were compiled. All preoperative, postoperative, and follow-up radiologic examinations of the patients were obtained using PACS, including direct radiography, CT, and MRI. Eleven patients were identified over an 11-year period. Patients with a less than one-year radiologic follow-up period, those who declined to participate in the study, and those with incomplete medical information were excluded. The study was conducted following the principles of the Declaration of Helsinki and was approved by the institutional ethics committee (date and issue: date: 13.06.2024, number: 9/17). Informed consent was obtained from all patients.

Surgical Technique and Postoperative Rehabilitation

All procedures were performed under spinal anesthesia with the patient in a supine position, utilizing a thigh tourniquet for control. For medially located lesions, a 3-4 cm longitudinal incision was made over the medial malleolus. A cortical window was created to access the cyst, which was evacuated, and the sclerotic bone exposed by curettage. The cyst was then filled using cancellous bone autograft harvested from the anterior iliac crest and packed with an impaction technique. In one case, a synthetic bone graft was used due to patient preference. To prevent medial malleolus fracture and provide stability, a single titanium screw was placed. For centrally located lesions, an anterior approach was employed, involving the creation of an anterior tibial cortical window. In one instance, an anterior tibial osteotomy was performed for better access to the cyst, and screws were used to fix the osteotomy after grafting. In patients with both tibial and talar lesions (kissing lesions), a biplanar chevron medial malleolar osteotomy was performed. The tibial cyst was addressed through the osteotomy, while the talar lesion was treated with mosaicplasty, using an osteochondral plug harvested from the lateral trochlear region of the knee. After grafting and mosaicplasty, the medial malleolus was fixed with compression screws.

Postoperatively, all patients were immobilized in a below-knee splint for three weeks to ensure soft tissue healing. Active and passive ankle exercises were initiated after this period, with gradual weight-bearing as tolerated. Full weight-bearing and return to daily activities were allowed following radiological confirmation of healing, typically 6-8 weeks after surgery.

Radiological Evaluations

Before surgery, all patients underwent anteroposterior and lateral ankle radiography, ankle computerized tomography (CT), and magnetic resonance imaging (MRI). The cyst volume was measured using CT, and the location of the lesion was evaluated using the nine-zone anatomic grid scheme described by Elias et al. [2]. Direct radiographs were used for postoperative follow-up, but CT or MRI was also ordered to detect recurrence in suspicious cases.

Clinical Evaluations

All patients were invited to the hospital for the final follow-up. However, only nine responded to the invitation and completed their clinical and radiologic follow-up. Three patients who lived out of town were interviewed over the phone, and their final radiologic follow-ups were obtained digitally from other hospital archives. Ankle function was evaluated using the AOFAS score, and all complications during the follow-up period were recorded.

Statistical Analysis

Continuous variables were presented as mean, median, standard deviation, and range, while categorical data were presented as frequency and percentage. The Related Samples Wilcoxon Signed Rank Test was used to compare the preoperative and postoperative functional scores with a significance level set at $p<0.05$.

RESULTS

Patient Demographics and Clinical Characteristics

There were 11 patients (7 females, 4 males) with a mean age of 41.9±12.5 years (median: 39, range: 23-60). Four patients had lesions in their right ankle, while seven had lesions in their left ankle. Detailed demographic and clinical characteristics are presented in Table 1.

Preoperative Radiological Findings

Direct radiography revealed the cyst as an oval osteolytic lesion surrounded by a thin sclerotic margin in all patients. The cyst was typically located between the medial malleolus and tibial plafond in 9 out of 11 patients and in the midline just above the subchondral bone of the tibial plafond in two patients. In one case, the cyst caused thinning of the medial malleolus cortex (Fig. 1). On CT examination, the findings were consistent with the direct radiographic observations, showing the lesion as cystic and surrounded by a sclerotic rim. Eight cysts were uniocular, while three were multiocular. The mean cyst volume was 555.8±324 mm^3 (median: 523 mm^3, range: 129-1080 mm^3). The cyst cavity communicated with the ankle joint through a small hole in the subchondral bone (Fig. 2). MRI examination further characterized the cysts. T2-weighted and Proton Density Weighted (PDW) sequences highlighted the fluid within the cysts and adjacent bone marrow edema as hyperintense areas. T1-weighted images revealed hypointense cystic areas with potential cartilage and subchondral bone interface irregularities (Fig. 3).

Clinical Outcomes

All patients experienced an uneventful postoperative period with no wound healing problems or infection. However, one patient (Case #4) developed reflex sympathetic dystrophy in the 6th week postoperatively, which was successfully treated with physical therapy. The mean clinical follow-up period was 75.7±44.9 months (median: 79, range: 12-137). The mean preoperative AOFAS score was 56.0±13.7 (median: 52, range: 29-75) and significantly improved to 89.3±8.6 (median: 90, range: 73-100) ($p=0.003$) (Table 2). Screw removal was necessary in three cases (Cases #6, #7, and #8) due to implant-related discomfort.

Radiological Outcomes

The average radiologic follow-up period was 55.1±39.3 months (median: 47, range: 12-130). Recurrence of the cyst was detected in 4 patients (36.3%) at the last follow-

Table 1. Demographic and clinical characteristics of patients

Case No.	Age	Sex	Side	Zone	Volume (mm^3)	Uni/Multiocular	Surgical Approach	Graft Choice	Screw Fix.	F/U (Months)	
										Rad.	Cl.
1	36	F	R	4	584	Uniocular	Medial	Autograft	Yes	12	12
2	35	F	L	4	422	Multiocular	Medial	Autograft	Yes	79	79
3	42	F	L	5	129	Uniocular	Anterior	Autograft	No	32	32
4	39	F	L	4	1080	Uniocular	MMO	Allograft	Yes	74	86
5	25	M	R	2	240	Uniocular	MMO	Autograft	Yes	47	70
6	23	F	L	4	628	Uniocular	Medial	Autograft	Yes	63	120
7	51	M	L	4	1026	Multiocular	Medial	Autograft	Yes	130	137
8	59	M	R	4	523	Uniocular	Medial	Autograft	Yes	26	130
9	38	F	L	4	311	Uniocular	Medial	Allograft	No	108	108
10	53	M	L	5	890	Multiocular	Anterior	Autograft	Yes	15	38
11	60	F	R	4	281	Uniocular	Medial	Autograft	Yes	21	21

Cl: Clinical; F/U: Follow up; F: Female; Fix: Fixation; L: Left; M: Male; R: Right; Rad: Radiological.

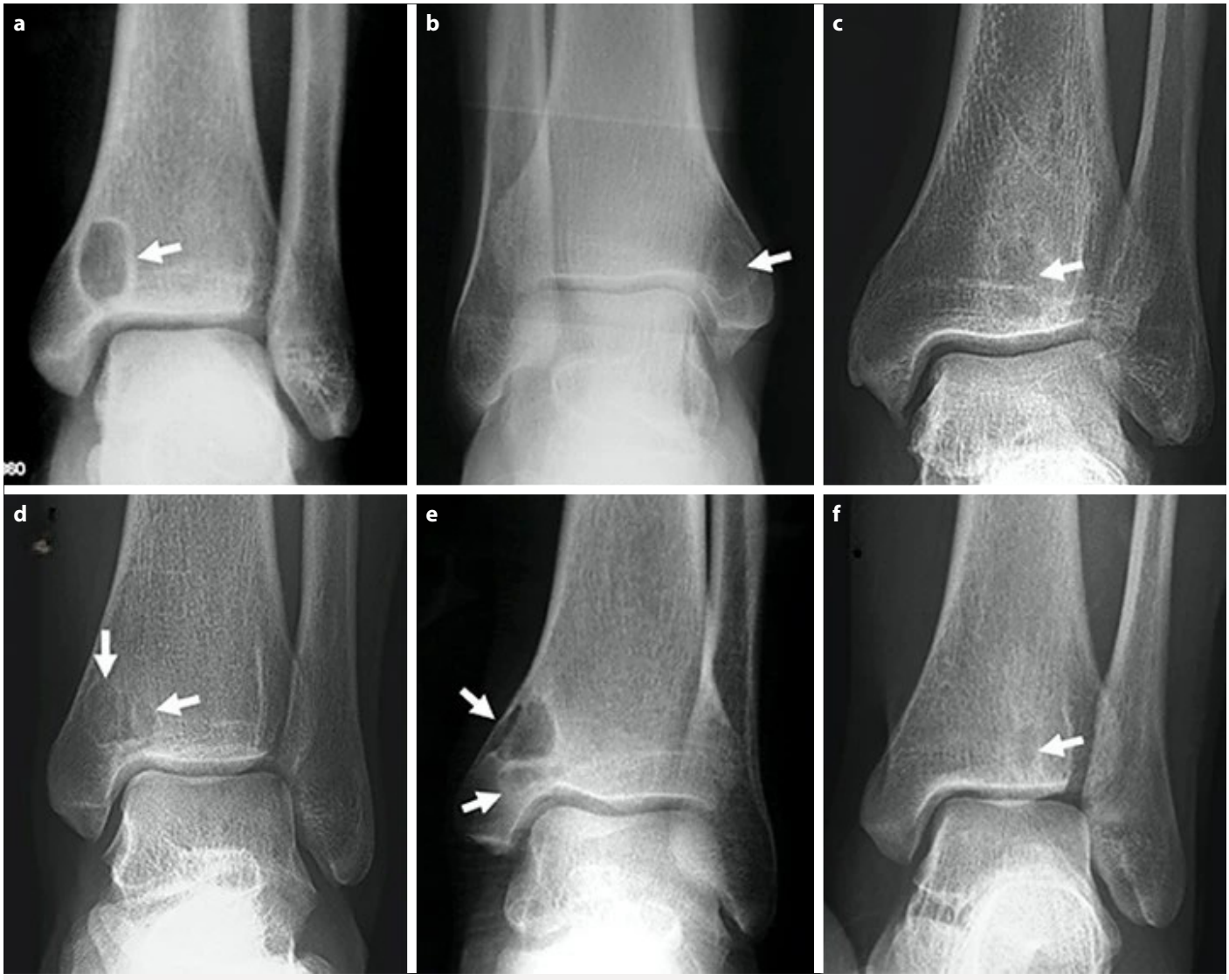

Figure 1. Direct anteroposterior ankle radiographs of six different patients showing the osteochondral lesions of the tibial plafond **(a-f)**. In each case there was an oval osteolytic lesion in the bone. The lesion was characterized by a clear, defined boundary and is surrounded by a thin sclerotic margin, indicative of a cystic structure (white arrows).

up, while the cyst was completely consolidated in seven patients (Fig. 4). Among the two patients with recurrence, a CT scan was performed at the last follow-up, revealing that the communication between the cyst cavity and joint space persisted (Fig. 5).

DISCUSSION

This study analyzed the radiologic and clinical results of retrograde grafting of large cystic OLTP. Despite a high rate of radiological recurrence (36.3%), the improvement in postoperative AOFAS scores from a mean of 56.0 to 89.3 signifies a substantial clinical benefit of this treatment modality. The reduction in cyst volume and pressure as well as the decrease in reactional bone marrow edema surrounding the cyst may have contributed to the improvement in functional scores, particularly the pain. Recurrence of the cyst might be attributed to the inadequate healing of the existing communication between the cyst cavity and the adjacent joint space. Consequently, a pivotal aspect of the surgical intervention involves the deliberate obliteration and subsequent healing of this connection.

One of the most notable radiologic findings in this study is the evident communication between the cyst cavity and the joint space. The use of 3D CT examination facilitated the identification of the presence and location of the

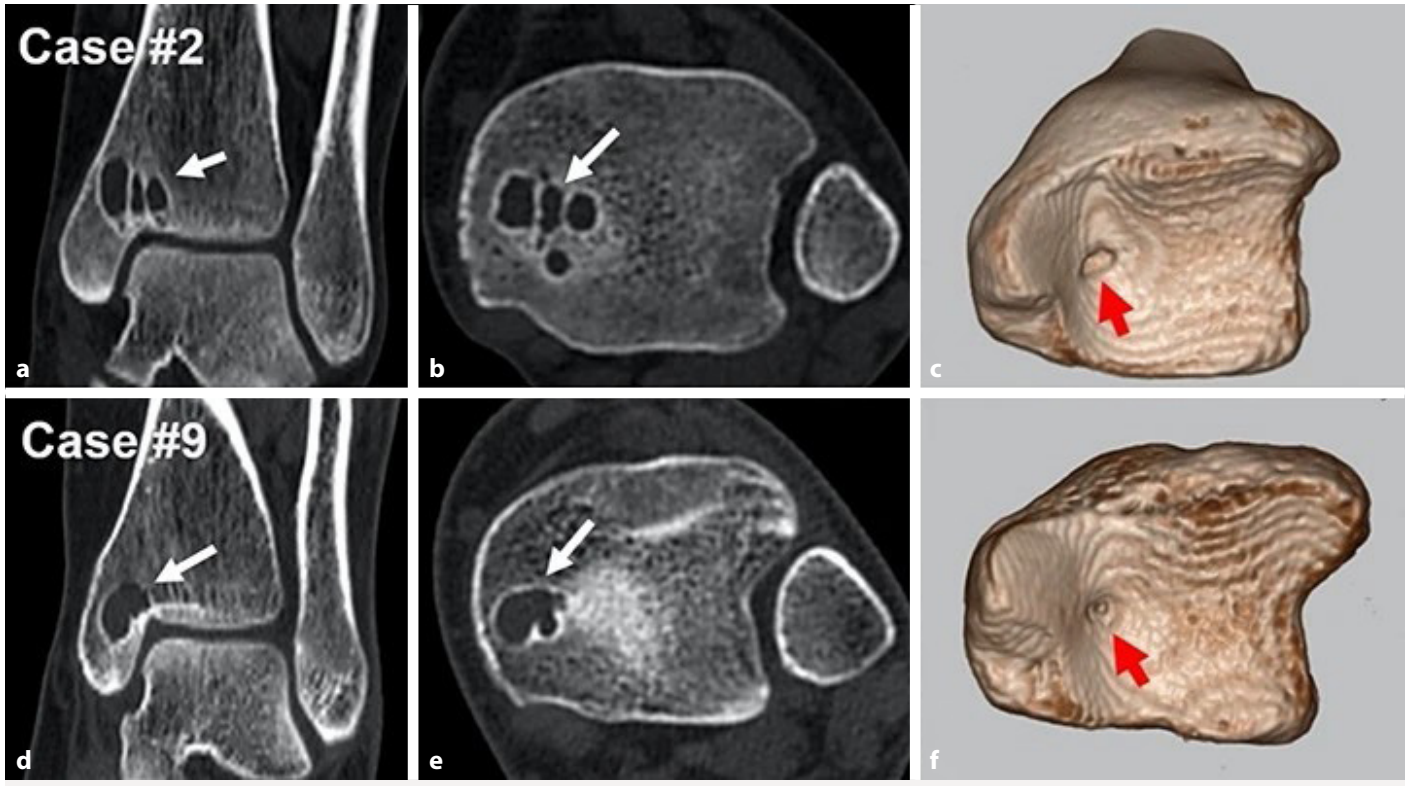

Figure 2. CT images of cystic lesions in two different cases. Case #2: **(a)** Sagittal view showing a multiocular cyst (arrow) with a sclerotic rim. **(b)** Axial view of the same cyst, highlighting multiple compartments (arrow). **(c)** 3D reconstruction demonstrating a small hole (red arrow) in the subchondral bone, allowing communication with the ankle joint. Case #9: **(d)** Sagittal view displaying a uniocular cyst (arrow) with a sclerotic margin. **(e)** Axial view of the cyst, confirming its single compartment (arrow). **(f)** 3D reconstruction revealing a small hole (red arrow) in the subchondral bone, similar to Case #2.

communication. This finding also clarifies the pathomechanism of these cysts and has been cited in previous studies. Loesch et al. [4] reported a case in which a peri-articular bony cyst failed to consolidate after curettage and bone grafting due to communication with the ankle joint, allowing synovial fluid to seep into the cyst. They proposed that the presence of synovial fluid, which contains anti-angiogenic factors that inhibit bone healing, is a crucial factor in the failure of consolidation and recurrence of the cyst. Similarly, Coulier et al. [5] described a case with fistulous gas communication between the ankle joint and the ganglion cyst of the medial malleolus. Finally, Büchler et al. [6] discussed the treatment of five intraosseous ganglion cysts in the distal tibia using an arthroscopically assisted technique. Arthroscopic examination showed that all the treated intraosseous lesions were connected to the joint despite various locations in the distal tibia. The consistent finding of a small area of soft and fissured cartilage with an underlying defect of the subchondral bone, which provides direct access to the subchondral cyst, supports the theory that these cysts originate from the joint. In summary, cyst recurrence is primarily caused by communication between the cyst cavity and the joint space, which allows synovial fluid to enter the cystic structure. This infiltration is facilitated by a 'check-valve' mechanism, where the fluid is pumped into the cyst during joint movements but prevented from flowing back into the joint. This mechanism increases internal pressure and promotes cyst enlargement. The seepage of synovial fluid promotes the growth of the cyst and delivers anti-angiogenic factors that impede healing. To prevent recurrence, it is crucial to identify and obliterate the joint connection, allowing for the generation of scar tissue that can seal the pathway. This enables proper healing and prevents the fluid dynamics that underpin cyst persistence or recurrence. Likewise, in two cases of recurrence that underwent postoperative CT examination, subchondral communication remained unhealed in our series. Our findings align with previous studies, such as Loesch et al. [4], who similarly identified the persistent communication between the cyst and joint space as a major contributor to recurrence. Their observation that synovial fluid seeping into the cyst prevents healing resonates with our results,

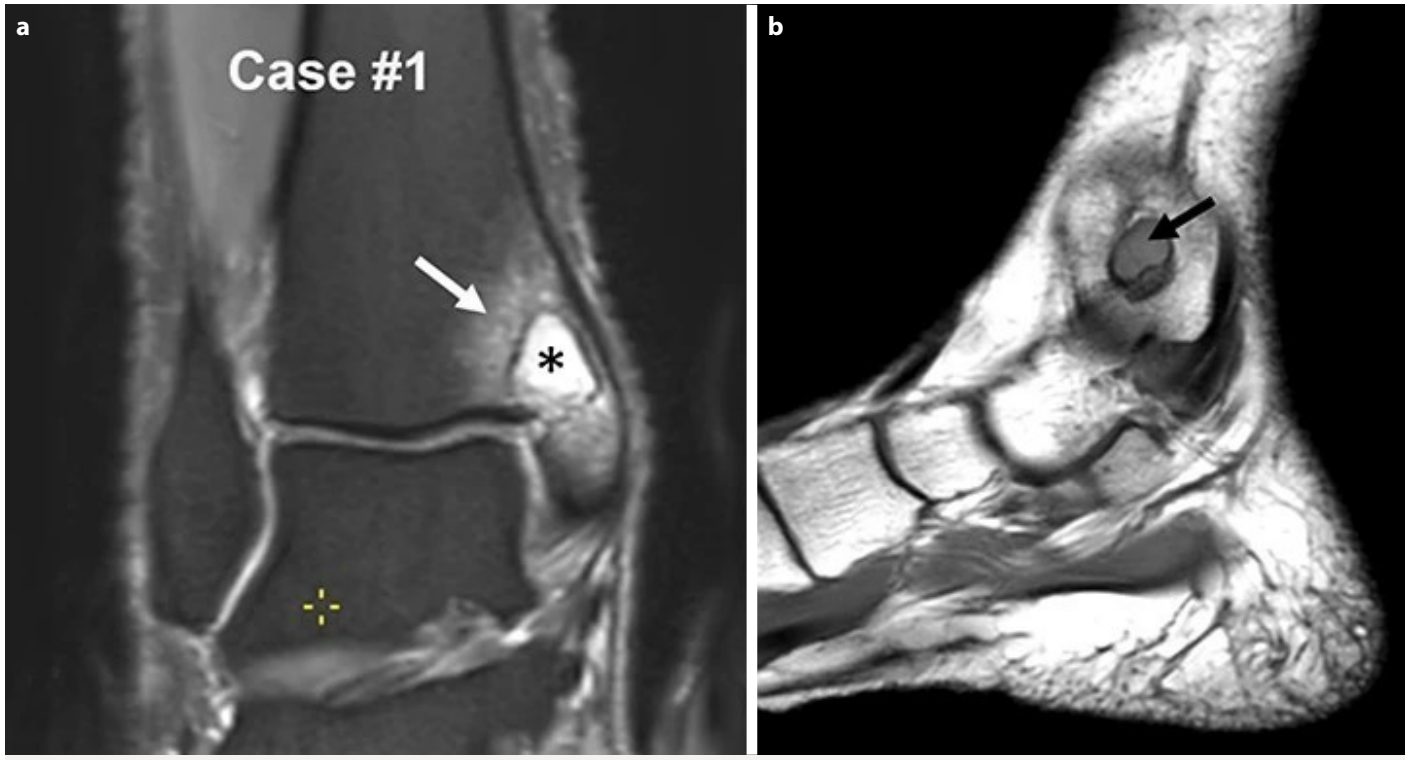

Figure 3. MRI examination highlighting cystic lesions and adjacent bone marrow edema. Case #1: **(a)** Coronal T2-weighted image showing a hyperintense cystic lesion (asterix) with adjacent bone marrow edema (white arrow). **(b)** Sagittal T1 weighted image displaying the hyperintense fluid within the cyst (black arrow), indicating the cystic nature of the lesion and associated bone changes.

Table 2. Clinical outcomes and recurrence

Case #	Preoperative AOFAS score	Final Follow-Up AOFAS score	Recurrence
1	52	90	No
2	48	90	Yes
3	49	82	No
4	29	88	No
5	45	100	No
6	68	100	No
7	58	90	Yes
8	75	100	No
9	70	80	Yes
10	70	90	No
11	52	73	Yes

AOFAS: American Orthopedic Foot and Ankle Society.

highlighting the importance of achieving a complete closure of this pathway during surgery. Despite this, our study shows that even when radiological recurrence occurs, patients can still experience significant functional improvements, suggesting that retrograde cancellous bone grafting offers durable symptom relief and improved quality of life.

The literature on the treatment of osteochondral lesions of the tibial plafond presents a range of approaches, each with its own merits and limitations. In our extensive literature review, only 20 previous studies and case reports could be identified (Table 3) [1,4,6–23]. Compared to previous studies on osteochondral lesions of the tibial plafond (OLTP), our study provides valuable insights into retrograde cancellous bone grafting as a treatment option.

In terms of surgical techniques, various approaches have been explored in the literature. Arthroscopic techniques, such as those employed by Hayashi and Tanaka [20], provide a less invasive option with faster recovery times and reduced postoperative complications. However, these are often associated with fibrocartilage formation, which may not offer the same long-term durability as native hyaline cartilage. Similarly, Desai et al. [15] and Cuttica et al. [12] found that while arthroscopic debridement and microfracture led to early functional improvements, recurrence rates remained

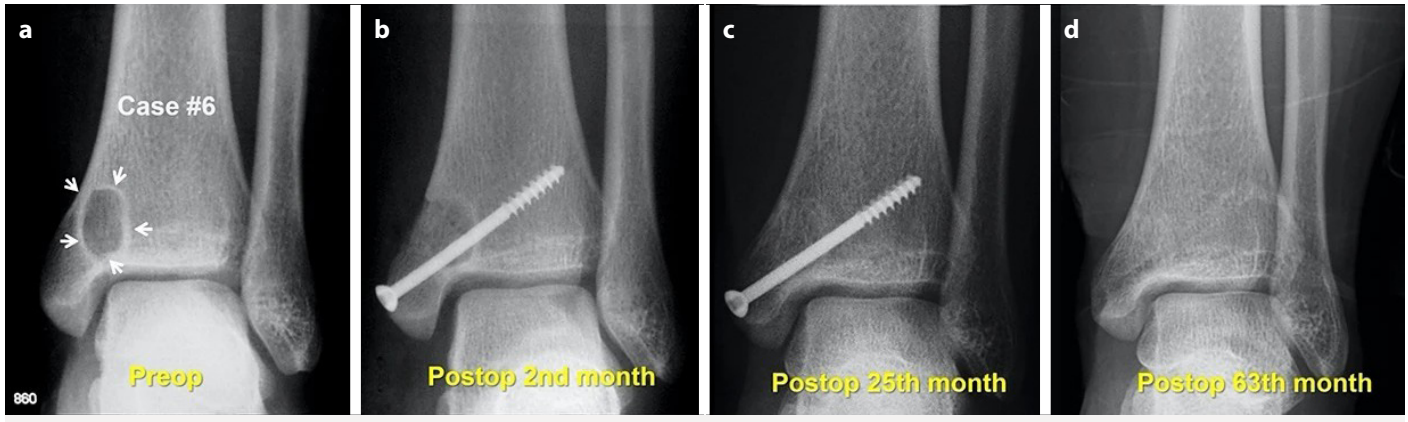

Figure 4. Radiographs showing the consolidation of a cyst in a patient over time. Case #6: **(a)** Preoperative anteroposterior radiograph indicating the cystic lesion (arrows). **(b)** Anteroposterior radiograph at 2 months postoperative, showing the initial healing. **(c)** Anteroposterior radiograph at 25 months postoperative, with further consolidation of the cyst. **(d)** Anteroposterior radiograph at 63 months postoperative, demonstrating complete consolidation of the cyst and successful long-term healing.

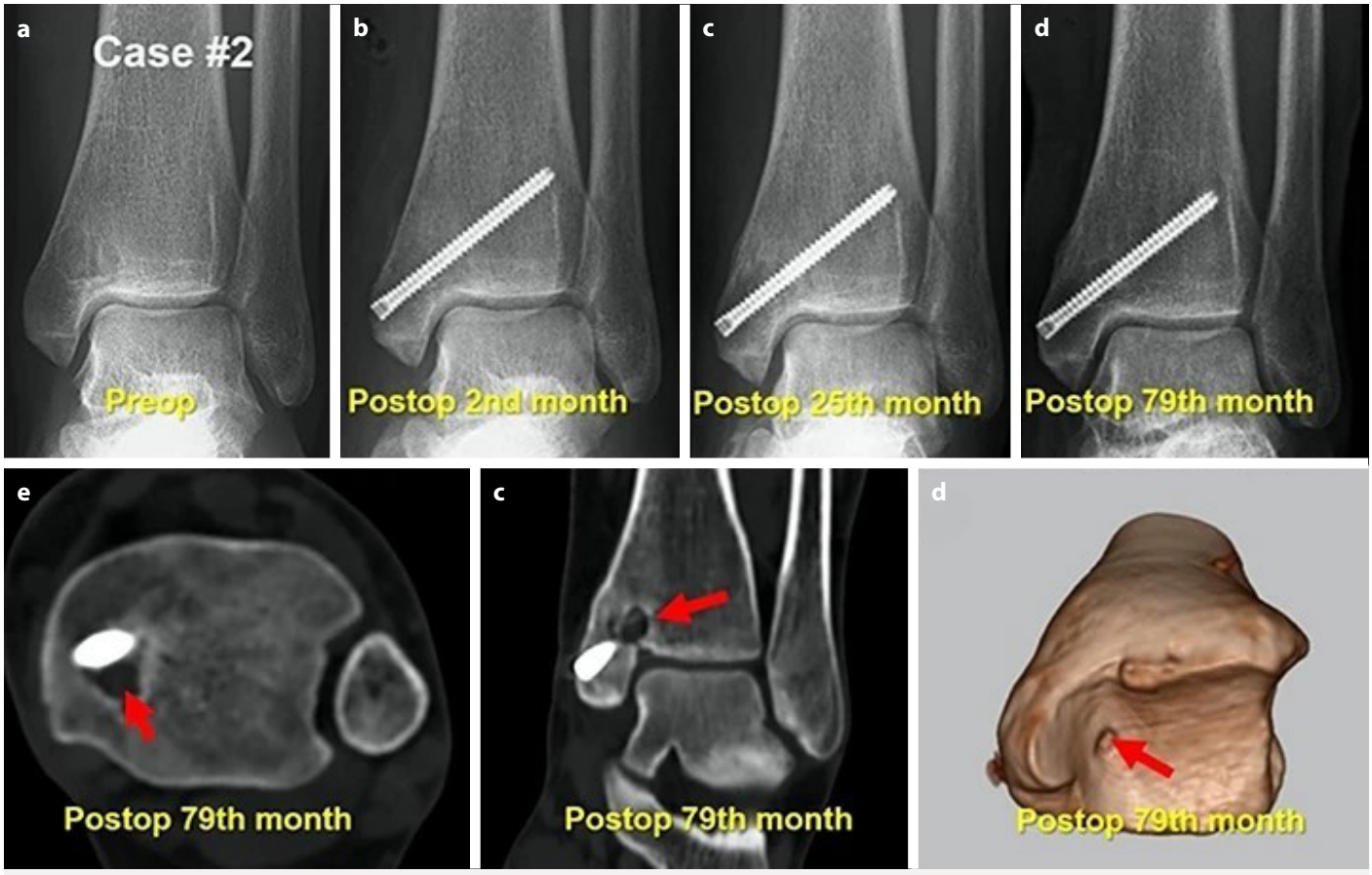

Figure 5. Radiographs and CT scans demonstrating the recurrence during the follow-up. Case #2: **(a)** Preoperative anteroposterior radiograph showing the cystic lesion. **(b)** Anteroposterior radiograph at the 2nd postoperative month. **(c)** Anteroposterior radiograph at 25th postoperative month. **(d)** Anteroposterior radiograph at 79 postoperative months. **(e)** Axial CT scan at 79 months postoperative showing recurrence of the lesion (red arrow). **(f)** Coronal CT scan at 79 months postoperative highlighting the same recurrent cyst (red arrow). **(g)** 3D reconstruction at 79 months postoperative illustrating the persistent communication (red arrow).

Table 3. Previously reported studies and case reports on OLTP

Author	Year	Patients	Cystic cases	Treatment	Functional Outcome	Recurrence
Andrews et al. [7]	1991	1	1	BMS	Two years postoperatively he is doing well with no residual symptoms.	-
Ferkel et al. [8]	1999	3	3	Bone graft and curettage	Satisfactory long-term result	-
Sopov et al. [9]	2001	1	1	Conservative	Good	NR
Mologne and Ferkel [1]	2007	17	2	BMS	AOFAS score from 52 to 87	1
Buchler et al. [6]	2009	5	5	BMS and bone graft	AOFAS scores from 73 to 94	-
Pearce et al. [10]	2009	1	1	BMS and synthetic graft.	AOFAS scores from 66 to 90	-
Aurich et al. [11]	2011	3	NR	MACI	AOFAS from 58.6 to 80.4	-
Cuttica et al. [12]	2012	13	3	BMS	AOFAS from 35.2 to 50.4	3 patients
Ross et al. [13]	2014	31	NR	BMS	FAOS pain score from 50.5 to 74.2	NR
Loesch et al. [4]	2015	1	1	Arthroscopy-assisted medial malleolar osteotomy curettage and grafting	Very good	-
Sedeek et al. [14]	2015	1	1	Bone graft and curettage	no pain or limitation of movement at the last visit (2 years postoperatively)	-
Desai [15]	2016	1	0	BMS and Allograft Cartilage Matrix	Very good	-
Okamura et al. [16]	2017	2	1	Retrograde OATS	Very good	-
Baldassarri et al. [17]	2018	27	2	BMDCT bone marrow-derived cell transplantation	AOFAS score from 52.4 to 80.6	two had incomplete lesion repair
Mohapatra et al. [18]	2018	1	1	Bone cement and curettage	No signs of recurrence and is completely relieved of pain and limping.	-
Lee et al. [19]	2019	16	NR	BMS	All functional scores showed significant differences clinically and statistically at the final follow-up.	-
Hayashi et al. [20]	2019	1	NR	Arthroscopic Antegrade Cancellous Bone Autotransplantation	Satisfactory clinical results	-
Nery et al. [21]	2021	1	1	Retrograde arthroscopic-guided OATS	Excellent clinical and radiological midterm results	-
Mei et al. [22]	2022	18	18	Curettage and Bone graft	AOFAS ascore from 78.2±13.7 to 97.3±4.5	-
Wei et al. [23]	2023	40	0	BMS	AOFAS score increased from 57.5to 88	-

BMS: Bone marrow stimulation (microfracture); NR: Not reported; AOFAS: American Orthopaedic Foot and Ankle Society; MACI: Matrix-Associated Chondrocyte Implantation; FAOS: Foot and Ankle Outcome Score; OATS: Osteochondral Autograft Transfer System; BMDCT: Bone Marrow-Derived Cell Transplantation.

high, and fibrocartilage formation was a common issue. This is consistent with our finding while retrograde cancellous bone grafting is more invasive, it provides superior long-term functional outcomes for large cystic lesions, even when radiological recurrence is present.

Studies utilizing synthetic osteochondral grafts, such as those by Pearce et al. [10], also report favorable clinical outcomes but still face challenges with recurrence, mirroring our results. Okamura et al. [16], who used retrograde osteochondral autograft transfer, similarly observed that while clinical improvements were evident, recurrence persisted in some cases. These findings highlight that the type of graft used—whether autograft, allograft, or synthetic—may have little impact on recurrence if the connection between the cyst and the joint space is not properly closed.

The biomechanical complexity of the tibial plafond, compared to osteochondral lesions of the talus (OLT), further complicates treatment. Büchler et al. [6] and Mologne et al. [1] both observed that OLTP tends to have higher recurrence rates than OLT, likely due to the unique loading patterns and cartilage characteristics of the tibial plafond. This difference emphasizes the need for tailored surgical strategies to address the biomechanical demands of the tibial plafond, rather than directly applying techniques developed for OLT. In addition to biomechanical factors, patient-specific considerations such as lesion size, location, and the presence of kissing lesions also play a role in determining the most appropriate treatment modality. Studies like those by Ross et al. [13] and Andrews et al. [7] highlight the importance of customizing surgical interventions based on these factors to optimize outcomes. This is particularly relevant in our series, where larger, more complex cystic le aggressive surgical approach to ensure functional improvement.

Strengths and Limitations

One significant limitation of the present study is its retrospective nature and the constrained sample size. However, only 11 cases were admitted over a decade at a high-volume university hospital, highlighting the rarity of these lesions and the challenges in accruing a larger cohort. Additionally, the absence of a control group further limits the ability to compare outcomes with alternative treatment modalities. It is important to recognize that the variability in surgical techniques, including the choice between allograft and autograft or the decision to use additional screw fixation, introduces confounding factors that could influence the results. Despite these limitations, the study has some strengths, such as the long duration of follow-up and the use of advanced imaging techniques both before and after the operation, which enhance the reliability of the findings.

CONCLUSION

This study demonstrates that retrograde cancellous bone grafting is an effective treatment for large cystic osteochondral lesions of the tibial plafond, leading to significant improvements in clinical outcomes, as reflected by AOFAS scores. Despite a recurrence rate of 36.3%, which is likely due to the persistent communication between the cyst cavity and the joint space, patients experienced notable functional recovery. This suggests that clinical improvement can still be achieved even when radiological evidence indicates cyst persistence or recurrence. The results highlight the need for advanced surgical techniques to fully close this communication and reduce recurrence rates. Future studies should focus on comparing various surgical approaches, including minimally invasive techniques, to optimize long-term outcomes for these challenging lesions.

DECLARATIONS

Ethics Committee Approval: The Antalya Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 13.06.2024, number: 9/17).

Author Contributions: Idea/Concept – MBE, HS, HC, FD, OFE; Design – MBE, HS, HC, FD, OFE; Control/Supervision – OFE; Data Collection and/or Processing – HS, HC, OFE; Analysis and/or Interpretation – HC, HS, MBE, MY; Literature review – MBE, FD, OFE; Writing – MBE, FD, OFE; Critical Review – OFE, HC, HS; References and fundings – MBE, FD, OFE

Data Avaliability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors had no conflict of interest to declare.

Informed Consent: Informed consent were obtained from the participants.

Use of AI for Writing Assistance: In the writing of this manuscript, no Large Language Model (LLM) was used in the study design, writing, literature review, or statistical analyses.

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ABBREVIATIONS

AOFAS - American Orthopaedic Foot and Ankle Society

CT - Computerized Tomography

MMO - Medial Malleolar Osteotomy

MRI - Magnetic Resonance Imaging

OLT - Osteochondral lesions of the talus

OLTP - Osteochondral lesions of the tibial plafond

PDW - Proton Density Weighted

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