CASE REPORT

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Autologous Cartilage Transfer from Carpal Bones for the Treatment of Osteochondral Defect in Distal Tibial Pilon Fracture: A Rare Case Report

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ABSTRACT

High-energy tibial pilon fractures frequently lead to complex intra-articular injuries, metaphyseal bone loss, and articular surface defects, posing significant challenges in surgical reconstruction. Osteochondral defects, in particular, may progress to osteoarthritis (OA) if not properly addressed. We present a rare case of a 25-year-old male who sustained multiple fractures, including a complex intra-articular distal tibial fracture with osteochondral and metaphyseal bone loss. Due to concurrent wrist trauma requiring arthrodesis, autologous cartilage from resected proximal carpal bones was harvested and used to reconstruct the tibial articular defect. The metaphyseal defect was filled with autologous iliac crest bone graft, and internal fixation was achieved via anteromedial and lateral plating. The patient was followed for 2 years. No post-operative complications, such as infection or wound problems, were observed. Functional evaluation using the Foot and Ankle Outcome Score revealed significant improvements in all subscales, with no range of motion limitations in the ankle. Autologous cartilage transfer from carpal bones may offer a viable alternative for treating distal tibial osteochondral defects, especially in cases where simultaneous wrist arthrodesis is indicated. This approach provides a novel solution for joint surface reconstruction and may prevent long-term complications such as post-traumatic OA.

Keywords: Bone defect, Cartilage transfer, Fracture, Pilon, Plafond

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INTRODUCTION

The surgical treatment of tibial plafond fractures was first described by Rüedi and Allgöwer.[1] These injuries are typically associated with high-energy mechanisms such as axial loading or shearing forces. They can result in multiple metaphyseal fragments, bone loss, displaced intra-articular comminution or defects, and severe soft-tissue injuries. The fibula is also commonly fractured in high-energy trauma. Approximately 10–28% of these fractures are open injuries.[2]

Most surgeons recommend anatomical reconstruction of the joint surface, restoration of tibial alignment, and stabilization of the fracture to facilitate bone healing.[3] Osteochondral defects caused by intra-articular comminution may lead to progressive degeneration of the articular cartilage and eventually osteoarthritis due to the inability to achieve a sufficiently smooth joint surface.[4,5] In pilon fractures, complete articular injuries with multiple intra-articular fragments and metaphyseal comminution account for 54–76% of all cases.[6,7]

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Over the past two decades, the treatment strategy for pilon fractures has shifted toward a two-stage surgical approach, allowing for soft-tissue recovery before definitive fixation.[7,8] Despite advancements, infection rates during reconstructive attempts reported in the literature range from 5% to 19%.[7-9] Even in the absence of infection, patients – particularly those with type C3 injuries – struggle with stiffness (35%), persistent swelling (29%), and post-traumatic arthritis (39%).[6,9]

Challenges in managing these injuries include filling metaphyseal bone defects and supporting a fragmented joint surface during reconstruction. Options available to orthopedic surgeons include plate fixation with augmentation using cancellous autografts, structural allografts, demineralized bone matrix, and calcium-based cements.[10-12] However, in cases where the joint surface is too fragmented or defective to be reconstructed, primary arthrodesis or secondary arthrodesis after post-traumatic arthritis is recommended.[13]

In this case report, we present the use of an autologous cartilage graft harvested from the wrist to treat a distal tibial osteochondral lesion (OCL), demonstrating its feasibility in appropriately selected cases.

CASE PRESENTATION

Written informed consent was obtained from the patient for the scientific use of their data presented in this study. A 25-year-old male patient presented with multiple injuries sustained from a high-energy fall 1 month prior. His injuries included a left wrist fracture-dislocation, left femoral intertrochanteric fracture, left ankle fracture-dislocation, right medial malleolar fracture, fractures of the proximal bases of the right second and third metatarsals, sacral fracture, and pubic diastasis.

Initial emergency treatment at an outside facility involved external fixation for the left ankle fracture-dislocation, proximal femoral nailing for the left femoral fracture and screw fixation for the right medial malleolus. Following stabilization of his general condition, the patient was referred to our institution for further management.

Orthopedic evaluation and radiological imaging revealed additional fractures of the left distal radius, scaphoid, and lunate. Therefore, proximal row carpectomy and wrist arthrodesis were scheduled. For the left ankle fracture-dislocation, a staged procedure was planned, including removal of the external fixator, medial and lateral plating, autologous iliac crest bone grafting for the metaphyseal defect, and cartilage grafting using autologous cartilage harvested from the resected proximal carpal bones.

Under general anesthesia, with the patient in the supine position and a thigh tourniquet applied, an anteromedial approach was used to reduce the fracture. An osteochondral defect measuring approximately 2×0.5 cm was identified on the articular surface (Fig. 1). An appropriately sized cartilage graft, harvested from the proximal carpal bones, was shaped and secured to the defect site using a single Kirschner wire (Fig. 2). Autologous cancellous bone graft was obtained from the right iliac crest and placed into the metaphyseal defect. Internal fixation was completed with an anteromedial plate, followed by anatomical plating of the lateral malleolus through a lateral approach (Fig. 3). The wounds were appropriately closed and dressed. A short leg splint was applied. Post-operative radiographs of the wrist and ankle were obtained (Figs. 4-7).

The patient was followed for a total of 2 years. Scheduled follow-ups occurred at 2 weeks, 1 month, 3 months, 6 months, 1 year, and 2 years. The left lower extremity was kept non-weight-bearing for 6 weeks. Ankle rehabilitation exercises were initiated 1 week postoperatively following splint removal. Partial weight-bearing began at 6 weeks and was gradually increased. Rehabilitation of the left wrist and hip also began in the early post-operative period. Sutures were removed at 2 weeks, and low-molecular-weight heparin was administered for 4 weeks postoperatively.

No wound complications or infections were noted during follow-up. The patient showed significant improvement in pain, as indicated by the Visual Analog Scale. At the final evaluation,

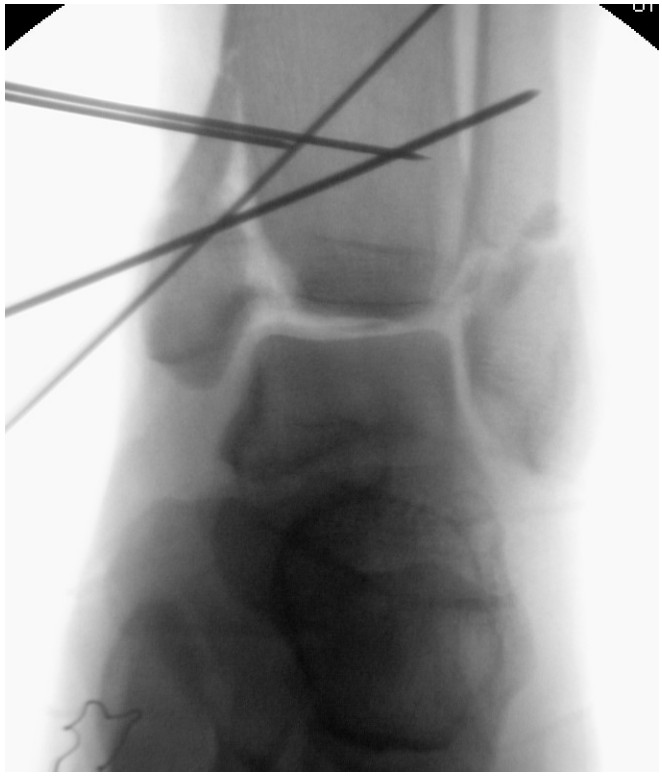

Figure 1. Fluoroscopic view after reduction shows the chondral and metaphyseal bone defect.

Figure 2. Fracture fixation after graft placement using K-wires and a Weber clamp.

Foot and Ankle Outcome Score (FAOS) subscales were as follows: Pain 87.1, Symptoms 85.1, Quality of Life 88.9, Sports and Recreation 78.5, and General Health 79.9. No range of motion limitation of the ankle was observed.

DISCUSSION

The surgical management of metaphyseal bone loss and osteochondral defects resulting from high-energy distal tibial plafond fractures remains a significant challenge. In most cases, the defects occur in the metaphyseal region of the fracture. Compared to metaphyseal bone loss, chondral defects are encountered less frequently. According to Lauge-Hansen classification, chondral damage is more commonly seen in supination-adduction type injuries, particularly due to impaction in the anteromedial tibia, where OCLs occur more frequently.

In a systematic review by Martijn et al.,[14] the incidence of OCLs detected immediately after trauma was reported to be 45.1%, with 16.6% of these involving the tibial plafond. Da Cunha et al.[15] found that patients with chondral lesions had significantly worse scores in all subdomains of the FAOS – including pain, symptoms, daily activities, sports and recreation, and quality of life – compared to patients without chondral lesions. Furthermore, patients with full-thickness lesions had significantly lower post-operative quality of life scores compared to those without full-thickness damage.

Figure 3. Fluoroscopic image showing fracture fixation and chondral graft stabilization with a K-wire.

While metaphyseal defects are generally treated with autografts from the iliac crest or structural allografts, chondral defects – such as in our case – may benefit from cartilage grafting techniques. Due to the complexity and fragmentation of articular cartilage, suitable donor sites for autografts are limited. In our patient, wrist arthrodesis was already planned, which allowed us to harvest autologous cartilage from the resected carpal bones. This represents a rare and unique approach to treating a distal tibial osteochondral defect.

The retrospective nature of this study, and the rarity of simultaneous wrist arthrodesis and ankle chondral defect in the same patient, are limitations to be acknowledged. However, autologous cartilage grafting using carpal bones should be considered a viable alternative in select cases.

Figure 4. Post-operative anteroposterior X-ray of the ankle.

Figure 5. Post-operative lateral X-ray of the ankle.

Figure 6. Post-operative anteroposterior X-ray of the wrist following wrist arthrodesis.

CONCLUSION

The treatment of distal tibial OCLs is surgically challenging, particularly when accompanied by metaphyseal bone loss and comminuted articular surface damage. In this case report, the successful use of autologous cartilage graft harvested from proximal carpal bones was demonstrated in the rare context of simultaneous wrist arthrodesis and ankle osteochondral defect. In appropriately selected cases, autologous cartilage obtained from different anatomical regions may offer an effective and alternative option for joint surface reconstruction. Long-term follow-up results were functionally satisfactory, and this method is presented as a novel approach with potential to contribute to the current literature.

DECLARATIONS

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient for the scientific use of their data presented in this study.

Figure 7. Post-operative lateral X-ray of the wrist following wrist arthrodesis.

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

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