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Case Report

Costal cartilage grafting in the treatment of concurrent osteochondral lesion of the talus in a trimalleolar fracture

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ABSTRACT

A 49-year-old female sustained a trimalleolar fracture concurrent with 10 years history of symptomatic osteochondral lesions of the talus. We performed a costal cartilage grafting for osteochondral lesions of the talus through the inherent medial malleolar fracture gap, followed by internal fixation of the fracture. During the follow-up, the fracture healed within the expected time, accompanied by favorable functional outcomes and pre-injury pain relief. At 3 years postoperatively, the graft merged with the bone bed of the talus, and progressive endochondral ossification was observed at the graft-bone interface. The case provides us a chance to verify whether the costal cartilage grafting is reliable for the treatment of osteochondral lesions of the talus.

Introduction

Osteochondral lesions of the talus (OLT) are focal damages to the talar dome cartilage and subchondral bone caused by single or repetitive injuries. The lesions usually present with chronic pain and dysfunction, which gradually lead to ankle osteoarthritis [1]. Surgical treatments for symptomatic OLT mainly focus on improving function and preventing the development of osteoarthritis [2]. A series of techniques have been described based on lesion size. Microfracture is the most common procedure used for lesions $<1.5 \text{ cm}^2$. For larger defects, osteochondral autograft transplantation (Mosaicplasty) is usually associated with higher success rates, yet there are concerns about the donor site injuries such as persistent knee pain [3,4].

Costal cartilage seems to be a promising option for cartilage replacement with less donor-site morbidity. It has great restoration potential due to its native structure since it contains a continuous transformation from osteochondral tissue to hyaline cartilage. Costal cartilage grafting is widely used in plastic and cosmetic surgery [5]. Theoretically, it's an all-purpose solution when facing osteochondral lesions, but outcomes vary tremendously between different recipient sites. In the orthopedic field, costal cartilage grafting is mainly used on non-weight-bearing joints, and the outcomes are positive [6]. Recently we applied the technique to repairing large osteochondral lesions of the femoral head with satisfied outcomes [7]. To date, however, whether costal cartilage grafting is likewise suitable for ankle joints remains unclear.

We introduce a trimalleolar fracture case with painful OLT receiving costal cartilage grafting followed by internal fixation. The medial malleolar fracture provided a natural approach for cartilage replacement without additional osteotomy. The case allowed us to evaluate the repair capability of costal cartilage in the ankle joint.

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Case report

A 49-year-old female presented to our hospital complaining of persistent left ankle pain after an ankle sprain 2 days ago. Radiographic images revealed a displaced trimalleolar fracture (Fig. 1), which is a supination-external rotation stage 4 fracture based on the Lauge-Hansen classification [8]. There were serious blisters around the ankle, and no neurovascular compromise was found. In addition, an osteochondral lesion was noted at the medial corner of the talar dome (Fig. 1A). Osteophytes were found at the distal tibia and superior aspect of the talar neck (Fig. 1B). Computed tomography (CT) scan showed a grade 4 OLT with full-thickness cartilage defects based on Outerbridge classification (Fig. 1C, D) [9]. After further inquiries, the patient reported a 10-year progressive left ankle pain without apparent trauma history. Though the conservative treatments for OLT were ineffective, she refused surgical intervention for several years. Several score systems were used to evaluate the OLT condition before surgery. The pre-injury visual analogue scale (VAS) pain score was 4, and the American Orthopaedic Foot and Ankle Society (AOFAS) ankle hindfoot scale was 82. Quality of life short form 12 (SF-12) outcomes were 35.3 on physical component summary (PCS-12) and 67.3 on mental component summary (MCS-12).

The patient was fully informed of her situation. The prognosis of simply repairing the trimalleolar fracture was poor because osteochondral defects may still cause pain. Though it is not common to repair OLT and trimalleolar fracture in one surgery, the potential benefit of doing so is worthwhile since it gave the patient a chance to avoid late-stage ankle arthroplasty or arthrodesis, with merely a mild cost of one small piece of costal cartilage. With the patient's consent, we repaired the OLT with costal cartilage through the inherent medial malleolus fracture, then performed internal fixation for trimalleolar fracture. A 10 cm standard longitudinal curved incision was made anterior to the medial malleolus. The anteromedial capsule was released, and the medial malleolus fragment was reflected distally to visualize the lesion at the medial dome of the talus. As the fracture site is distal to the normally scheduled osteotomy, ankle eversion facilitated the exposure of the dome. A 2×2 cm² round-shaped cartilage defect was observed (Fig. 2A), and thorough osteochondral debridement was performed at the cyst-like defect area, followed by subchondral slotting (Fig. 2B). We used an aluminum foil to replicate the debrided defect by pressing it into the slot and obtained its outline. Then we carefully harvested a 3 cm long graft from the right 7th rib (can be harvested from the 6th–9th rib, depending on the lesion size), making sure the osteochondral rib was avoided and only the cartilage was used. After carefully shaping based on the foil outline, we press-fitted the cartilage into the bone slot of the talus and fixed the graft with an absorbable screw (4.5 mm Inion OTPS™). The articular surface was further trimmed to fit the tibial plafond and verified by dynamic tests (Fig. 2C). Last, the trimalleolar fracture was fixed with cannulated screws (4 mm Zhejiang Guangci MEDICAL Device Co. Guci™), and a distal fibula locking compression plate (3.5 mm Zhejiang Guangci MEDICAL Device Guci™).

There was no wound complication or donor site complication. The patient was instructed to fully bear weight 6 weeks after surgery when the fracture showed evident healing. The pre-injury pain gradually improved. At the 2-year follow-up, she reported being able to walk and squat easily, along with a full range of ankle dorsiflexion motion without pain. At the 3-year follow-up, the VAS pain score

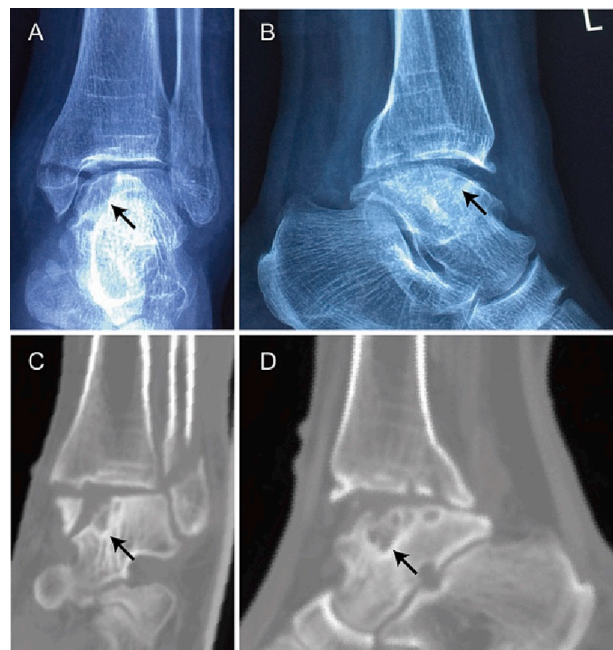


Fig. 1. Preoperative images showed concurrent OLT and trimalleolar fracture. OLT was noted at the medial corner of the talar dome (A, B, arrow). Osteophytes were noted at the distal tibia and superior aspect of the talar neck (B). CT showed a grade 4 OLT with full-thickness cartilage defects (C, D, arrow).

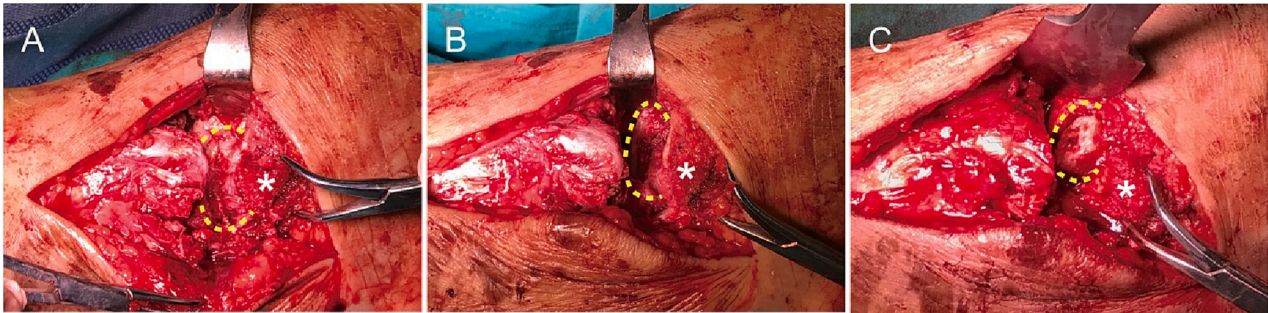


Fig. 2. Intraoperative views. A 2×2 cm² round-shaped cartilage defect (A, dotted line) was observed at the medial dome of the talus with medial malleolus fragment traction (A, B, C, asterisk). Osteochondral debridement and subchondral slotting were performed (B, dotted line). The costal cartilage graft was shaped and press-fitted into the slot (C, dotted line).

was 0, and the AOFAS ankle hindfoot scale improved to 97. Quality of life SF-12 outcomes were 56.6 on physical and 60.8 on mental. The joint space remained normal, and no sign of ankle osteoarthritis progression was observed (Fig. 3). CT scans showed that the graft formed a relatively smooth articular surface with the surrounding bone at the 2-year follow-up (Fig. 3C). At 3 years, the graft started to merge with the talus (Fig. 3F). At a recent 4-year follow-up, magnetic resonance imaging (MRI) showed the graft has healed with the surrounding talus (Fig. 4).

Discussion

This report presents a rare case of concurrent OLT and trimalleolar fracture. Considering her chronic ankle pain history, the treatment should not merely fix the trimalleolar fracture, but also manage the cartilage lesions to improve the outcome. The cartilage lesion was $2 \times 2 \text{ cm}^2$ involving the medial aspect of the talus dome, so cartilage replacement would be a reasonable strategy. The medial malleolar fracture provided a natural approach for this procedure without additional osteotomy. Though osteochondral autografting (Mosaicplasty) is a popular surgical technique, the main concern lies in the iatrogenic injuries caused to the donor site [10–12]. Andrade et al. [4] reported a non-negligible 16.9% incidence rate of donor site morbidity in patients receiving knee-to-ankle mosaicplasty. Valderrabano [12] suggested that knee-to-ankle mosaicplasty should be considered carefully considering that half of the patients (6/12) have persistent knee pain at 6-year follow-up, and radiological evidence of recurrent lesions was found in all cases. In contrast, the most serious donor site complication of costal cartilage harvesting is pneumothorax, which does not happen in our report. A systematic review shows that incidence is quite low at nearly 0.1% [13]. Other complications include pleural tear, infection, seroma, and persistent/severe pain, but the incidences are all below 0.6%.

In this case, we performed costal cartilage grafting for OLT to avoid the potential knee donor site morbidity of mosaicplasty, followed by internal fixation of the trimalleolar fracture. The results show that the procedure of cartilage grafting did not affect surgery and the healing of malleolus fractures. The pre-injury ankle pain completely disappeared after surgery, and the clinical measurements of function improved to near-normal. The outcomes of surgical treatments of chondral lesions conventionally depend on the

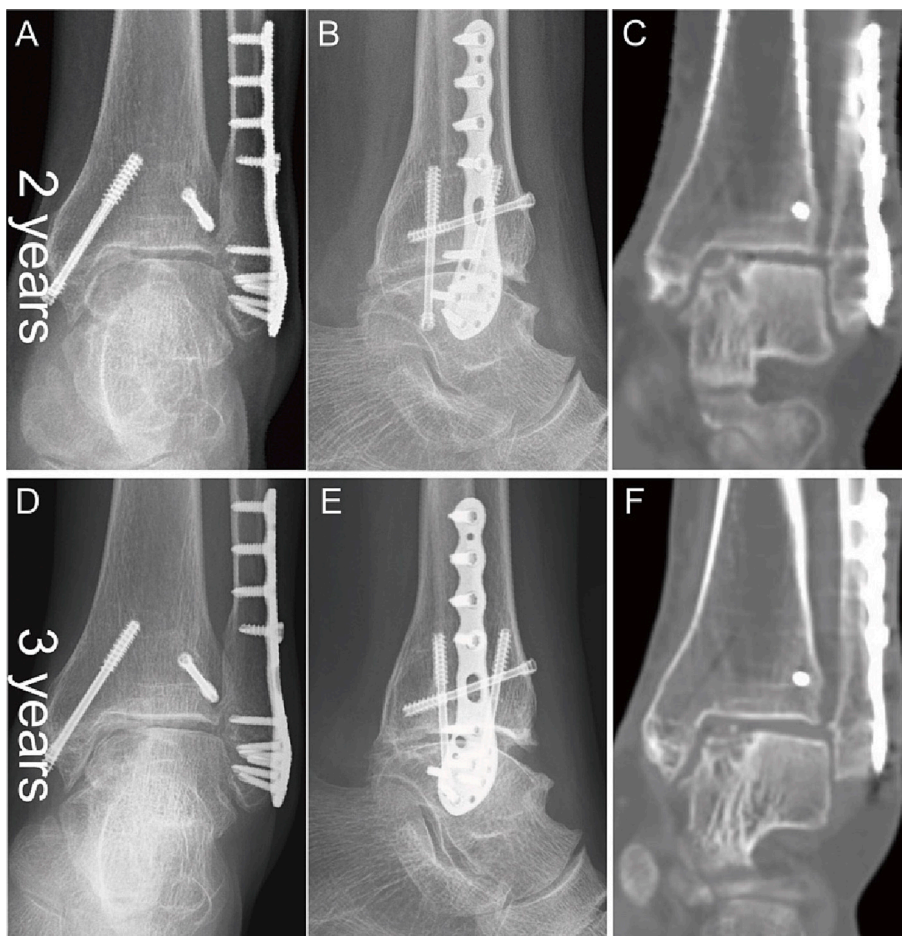


Fig. 3. Postoperative imaging showed no evidence of progression of ankle osteoarthritis (A-C, 2-year postoperative; D-F, 3-year postoperative). CT scans showed the graft was merged with the talus, and circumferential ossification was formed at the graft-bone interface (C, F).

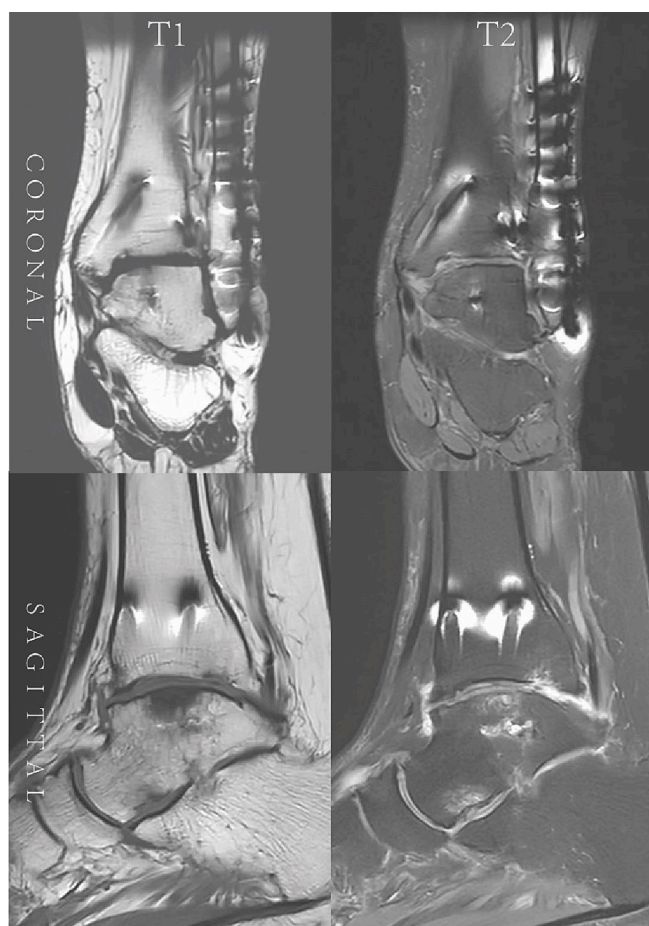


Fig. 4. A recent 4-year MRI showed satisfying healing between graft and surrounding talus.

restoration of the osteochondral structure integrity. Costal cartilage graft containing abundant hyaline cartilage may replace the chondral defects with an intact structure, which we recently reported in osteochondral lesions of the Femoral Head [7]. In this case, the restoration of OLT by costal cartilage grafting eliminates the pre-injury pain and prevents the development of osteoarthritis. A specific advantage is that the transplanted cartilage shows progressive endochondral ossification from the subchondral area to the midstance but not at the articular surface. The endochondral ossification ability makes the graft integrate into the bone bed of the talus, while the graft near the articular surface still maintains the hyaline cartilage nature. Various degrees of endochondral ossification may attribute to the local blood supply. Sufficient blood supply at the graft-bone interface leads to ossification, and in contrast, graft towards the articular surface does not show ossification [14].

Conclusion

The case provides us a chance to evaluate costal cartilage grafting potential in the treatment of OLT without additional medial malleolar osteotomy. The results suggest that costal cartilage grafting effectively relieves the ankle pain of OLT and prevents the development of osteoarthritis. Further studies should be performed to optimize the clinical application of the surgery.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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