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Case Reports and Series

Reconstruction of a Large Osteochondral Lesion of the Distal Tibia with an Iliac Crest Graft and Autologous Matrix-induced Chondrogenesis (AMIC): A Case Report

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ABSTRACT

Isolated osteochondral lesions (OCL) of the distal tibia are rare and lack clear treatment guidelines. With the case we present here, we suggest a novel surgical approach and report the successful use of autologous matrix-induced chondrogenesis–aided reconstruction for OCL of the distal tibia. A 29-year-old male patient complained about persisting pain of the left ankle joint and a restricted activity level 12 months after an ankle sprain. Imaging revealed edema of the subchondral bone and thinning of the cartilage above the osseous defect at the lateral distal tibia. The OCL was debrided followed by microfracturing of the underlying sclerotic bone. A cancellous bone plug was harvested from the iliac crest and impacted into the defect. A collagen matrix was then fixed on the defect. After 12 months, the patient was free of pain and returned to full activity. Conventional radiographs at 1 year showed successful osseous integration of the plug and a nearly anatomic shape of the tibial joint line. Delayed gadolinium-enhanced MRI of cartilage scans at 36 months showed an intact cartilage layer over the defect and glycosaminoglycan content, indicating hyaline-like cartilage repair. This case demonstrates autologous matrix-induced chondrogenesis–aided reconstruction of large osteochondral lesions of distal tibia to be a promising treatment method. Our aim was to describe the case of a patient with a large isolated osteochondral lesion of the distal tibia treated by a novel operative technique using cancellous bone from the iliac crest and a collagen I/III matrix.

Joint-preserving treatment of osteochondral lesions (OCL) in younger patients remains a challenge for the orthopaedic surgeon. Several treatment strategies for talar OCL have been described in recent years. However, for the less common OCL of the distal tibia, no clear treatment guidelines have been established. Mologne and Ferkel reported good results after arthroscopic treatment of OCL of the distal tibia (1). Experience from treatment of talar OCL shows that large lesions require an adequate reconstruction of the osseous defect. The aim is to acquire a nearly anatomical shape of the joint surface to provide a cancellous surface for further cartilage-stimulating procedures (2).

Autologous matrix-induced chondrogenesis (AMIC)–aided reconstruction of chondral lesions of the knee joint shows promising midterm results (3,4). Previously, we adapted this method for treatment of talar OCL by combining the collagen matrix with an autologous bone graft (5).

With this case, we report the first successful use of this new technique for the treatment of an OCL of the distal tibia.

Case Report

A 29-year-old male patient presented at our outpatient clinic complaining of persisting pain, recurrent swelling, and restriction of motion of the left ankle joint. History revealed a severe ankle sprain 12 months prior. Sport activities were reduced because of pain. Walking on uneven surfaces was reported to be difficult. The patient, who was a physical education teacher, was performing sports frequently on a high level before injury, including running, swimming, volleyball, skiing, and snowboarding, an average of 10 hours a week. The corresponding retrospectively assessed value of the Tegner activity scale score before onset of symptoms was 6 (6).

Clinical examination showed swelling of the left ankle and pressure pain at the anterolateral ankle joint line. A medial ankle joint instability was detectable. Range of motion (ROM) of the painful ankle joint was restricted with dorsal extension of 10° and plantarflexion of 30° (totaling 40°; contralateral ankle joint 60°). Standing alignment of the left lower leg demonstrated a hindfoot valgus and forefoot abduction consistent with a flexible flatfoot deformity (grade 2 tibialis

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posterior insufficiency according to Johnson and Strom) (7). Pain measured by the visual analogue scale (0 points, no pain; 10 points, maximal pain; during normal walking) was 4 (8,9). The American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale (score composed of pain, function, and alignment; minimum score, 0 points; maximum score, 100 points) was poor with 61 points (10).

Initial conventional radiographs and computed tomography scans showed an inhomogeneity of the anterolateral tibial joint subchondral bone plate and an increased translucency of the subchondral bone (Fig. 1*A* and *B*). Lateral radiographs showed a ventral osteophyte formation, which explained the reduced dorsal extension in the presence of joint instability. The lesion's size was measured in multiplanar reformats of computed tomography scans, totaling 1520 mm^3. Magnetic resonance imaging (MRI) showed an edema of the subchondral bone and thinning of the cartilage above the osseous defect (Fig. 1*C* and *D*).

The talus appeared normal on all imaging modalities. Because of the young age and previous high sports activity level of the patient, we decided for a surgical reconstruction of the OCL.

The patient was informed that data concerning the case would be submitted for publication and written consent was obtained.

Operative Course

The surgery was performed with the patient in the supine position. A tourniquet was applied. An initial diagnostic arthroscopy revealed an obvious medial instability with an elongated medial ligament complex. No lateral instability could be detected. An International Cartilage Repair Society grade 4 OCL on the anterolateral tibial joint surface was detected (11).

An anterolateral incision was then used to expose the ankle joint. A synovectomy was performed. Defective cartilage and the fibrous/necrotic bone underneath were debrided (Fig. 2). Cancellous bone was grafted from the left iliac crest and impacted into the defect. A collagen type I/III matrix (Chondro-Gide; Geistlich Pharma AG, Wolhusen, Switzerland) was cut to match the defect size. The matrix was fixed in place with fibrin glue (Tissucol; Baxter, Deerfield, IL, USA). The stability of the matrix was checked by moving the ankle joint through the whole ROM several times. The skin approach was extended to perform a lateral calcaneus-lengthening osteotomy for hindfoot valgus correction according to the technique described by Hintermann et al (12). The medial ligament complex was reconstructed directly anatomically as described by Brostrom and Karlsson et al (13,14).

Postoperative Care

Postoperative care consisted of immobilization with a functional orthosis (Aircast Walker; Aircast-DJO-Ormed, Vista, CA) with maximum ROM of 30° and partial weightbearing for 6 weeks (maximum 15 kg), followed by progression to full weightbearing under intense physical therapy focusing on strengthening the ankle joint and stabilizing the lower leg muscles and ROM.

Follow-up

The patient returned to his full-time job and low-impact sport activities 2 months after surgery. At 1 year follow-up, he was able to participate in all sport activities, including playing volleyball and running, at the same level before initial symptoms had occurred (Tegner score 6). No feeling of instability was reported, which correlated with a stable medial ligament complex on clinical examination. The foot showed a well-corrected hindfoot alignment of 5° valgus. The ROM of the ankle joint increased to 20° dorsiflexion and a plantarflexion of 40°, with a total ROM of 60° (preoperatively 40°, contralateral ankle 60°). The postoperative American Orthopaedic Foot and

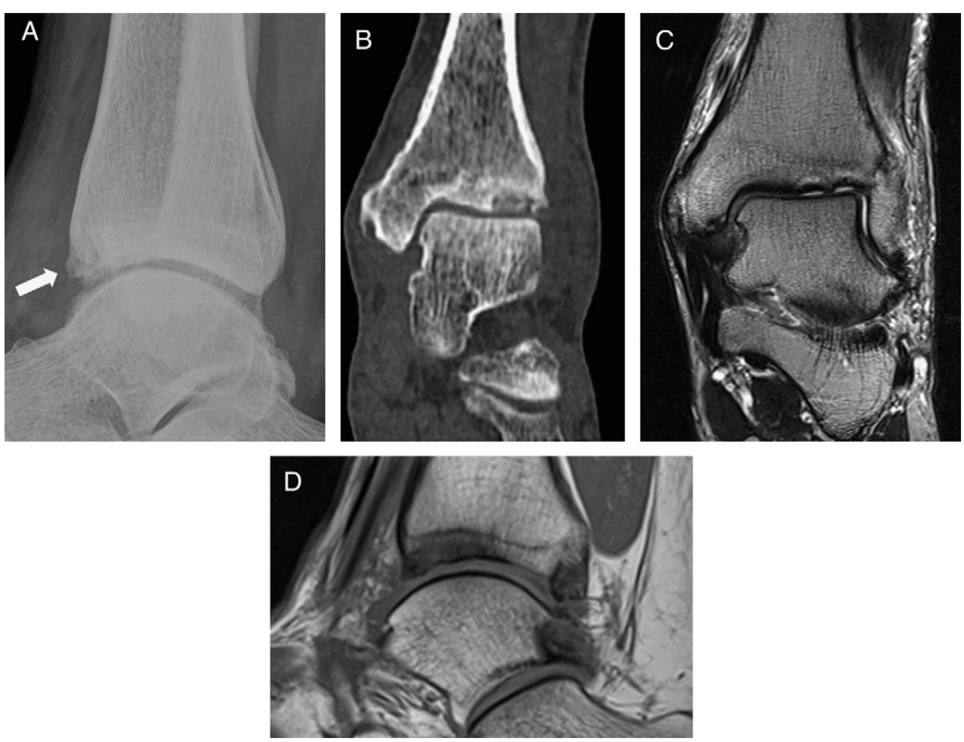

Fig. 1. Preoperative management. The lateral radiograph of the ankle shows increased translucency of the anterior distal tibia (*arrow*) (*A*). Computed tomography scan shows the defect located anteriolateral on the distal tibia totaling 1520 mm^3 (*B*). Magnetic resonance image shows edema of the subchondral bone and thinning of cartilage above the osseous defect in coronary (T2 turbo-spin-echo [tse]) (*C*) and sagittal (T1 tse) planes (*D*).

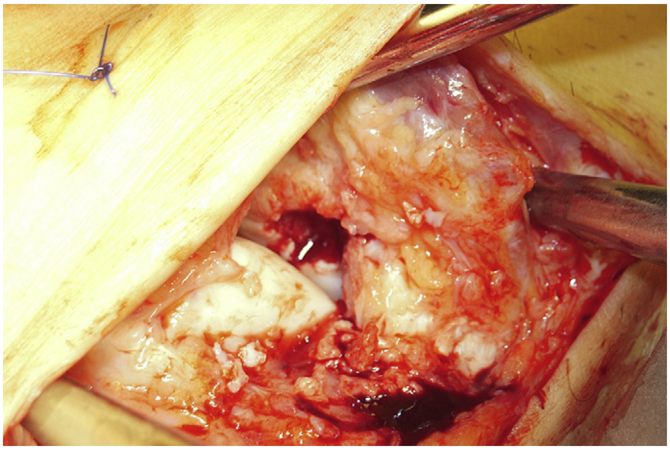

Fig. 2. Surgical course. The osteochondral lesion at the anterolateral tibial joint surface after debridement.

Ankle Society hindfoot score was 87 at 3 months and 100 after 6 months, remaining stable at 12 and 36 months after surgery (compared with 69 points preoperatively). After 6 months, the visual analogue scale score was 0 points. The patient remained pain free after 36 months. Conventional radiographs taken 1 year post-operatively showed a well-consolidated calcaneal osteotomy and a well-integrated osseous bone plug in the distal tibia with a normal joint line. MRI scans were performed at 36 months' follow-up. The quality of the repair tissue was evaluated by using the Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) score (15,16) and by measuring the glycosaminoglycan (GAG)-content with the delayed gadolinium-enhanced MRI of cartilage (dGEMRIC)-protocol (17–20). For observation and documentation of the MOCART score, a version modified by Welsch et al with points given for each of the 9 variables was used, with a maximum of 100 possible points indicating a healthy homogenous cartilage (21). The patient's MOCART score was 75 points, indicating well-integrated repair tissue with a complete coverage of the defect and only slight inhomogeneous areas (Fig. 3*A*).

Quantitative evaluation of the repair tissue was performed in precontrast and postcontrast T1 maps (T1-weighted gradient-echo-sequences) using OsiriX DICOM-Viewer Software (Geneva, Switzerland) to measure the T1 times (Fig. 3*B*). Analogous to Domayer et al, the relative relaxation rate (rΔR1) was calculated from the relaxation rates (ΔR1) of the repair tissue (RT) and reference cartilage (RC) (22). The T1 time of the RT was1608 ms in the native scan, decreasing to 427 ms after contrast agent application, and 1403 ms before and 547ms in RC, respectively. The T1 time of the RT was 1608 ms in the native scan, decreasing to 427 ms after contrast agent application, respectively, and 1403 ms before and 547 ms in RC. $\Delta R1_{RT}$ was 1.72×10^{-3} and $\Delta R1_{RC}$ 1.12×10^{-3} with a consecutive rΔR1 of 1.54.

Discussion

This case report describes an excellent mid-term result 3 years after reconstruction of a large OCL of the distal tibia using a cancellous bone graft in combination with a collagen matrix. The patient was relieved of all symptoms and returned to full daily and recreational activities. An excellent morphological result with an intact cartilage layer covering the complete lesion has been demonstrated on post-operative MRI. Relaxation times in dGEMRIC suggest a nearly normal GAG-content compared with surrounding healthy hyaline cartilage. An rΔR1 value of 1.0 can be interpreted as healthy hyaline cartilage, therefore a value of 1.54, as seen in this case, would indicate hyaline-like cartilage repair tissue (22).

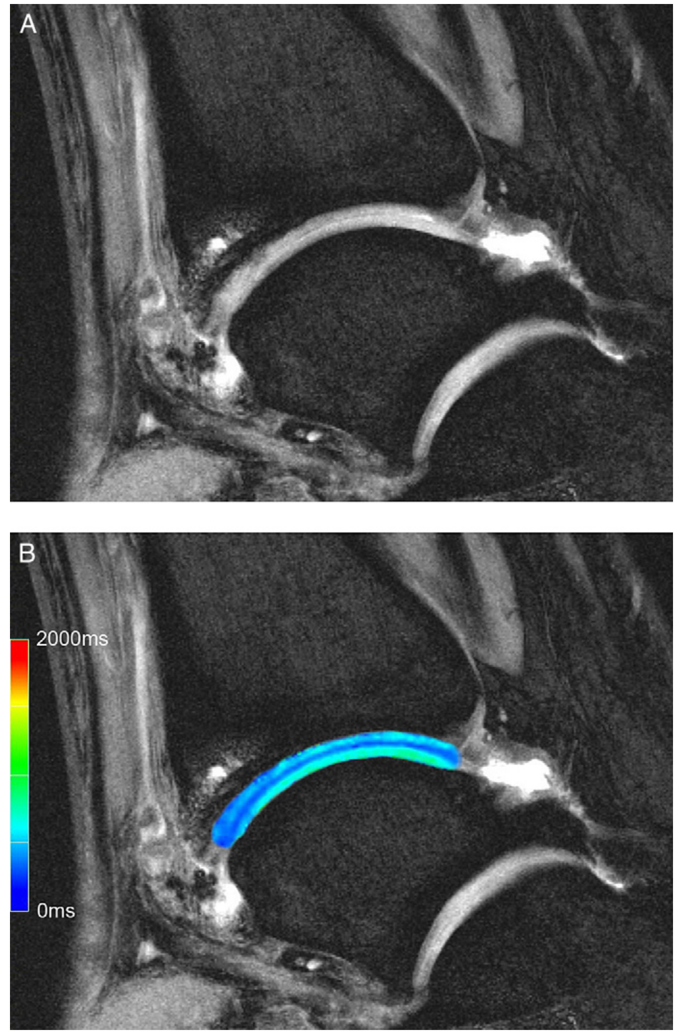

Fig. 3. Follow-up at 36 months. Sagittal magnetic resonance image demonstrates intact cartilage covering of the anterior defect (*A*). Quantitative analysis of the repair zone (dGEMRIC) shows nearly normal glycosaminoglycan content of the repair tissue compared with healthy surrounding cartilage (*B*, color scale indicates T1 relaxation times).

Good clinical results for surgical treatment of distal tibia OCL have been previously described by Mologne et al (1). In a case series of 17 patients, an excision, a curettage, and an abrasion arthroplasty of the lesion were performed. Additionally, in 5 cases the procedure was supplemented by transmalleolar drilling, in 2 cases by micro-fracturing, and in 2 cases by iliac bone grafting. The results were described as excellent in 7 cases, as good in 7 cases, as fair in 1 case, and as poor in 2 cases.

Ueblacker et al described the successful retrograde transplantation of osteochondral cylinders from the femoral trochlea into a distal tibia OCL in 2 cases with good clinical and radiological outcome (23). However, this technique requires sacrificing of healthy cartilage from an unimpaired donor joint. Donor site morbidity after osteochondral transfer from the knee to the ankle joint has been reported to be a major problem (24,25).

Successful allografting for distal tibia OCL has been reported in a single case by Chapman and Mann (26). However, this surgical technique is currently not available in Europe because of forensic issues.

For autologous chondrocyte transplantation (ACT), one case with a good outcome after 8-year follow-up has been reported (27). This technique requires initial harvesting of cartilage from the knee joint for cell culturing with later implantation of the engineered scaffold. A major disadvantage of the ACT is the high costs combined with the effort of cell culturing, which was described as a total of $13,600 ($8,600 for the procedure plus $5,000 for *in vitro* cell expansion) compared with $3,700 for microfracturing (28). The costs of AMIC-aided treatment are comparable with microfracturing, in addition to the costs for the collagen matrix.

To the knowledge of the authors, this is the first case describing this novel technique for operative treatment of large OCL of the distal tibia. Wiewiorski et al reported an excellent outcome after reconstruction of a large OCL of the talus (5). The initial results of the AMIC-aided procedure for chondral lesions of the knee joint are promising (3,4). However, there are significant differences in the anatomy, quality of cartilage, and the subchondral bone-cartilage interface between the knee and the ankle joint, therefore direct comparison of clinical outcome is difficult (29,30).

In conclusion, the AMIC-aided procedure was successfully used for surgical treatment of an OCL of the distal tibia. An excellent clinical and radiological result has been presented after a follow-up of 36 months. The presented technique is an economically efficient, single-step procedure and allows for early return to full daily and recreational activities. Further research is needed to compare this novel operative technique with conventionally used cartilage repair techniques.

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