23
SYMPOSIUM

Management of Osteochondral Lesions of the Talus

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Abstract

Management strategies for symptomatic osteochondral lesions of the talus are primarily surgical. Treatment options for symptomatic osteochondral lesions of the talus most commonly include bone marrow stimulation techniques, osteochondral autograft transplantation, osteochondral allograft transplantation, autologous chondrocyte implantation, matrix-induced autologous chondrocyte implantation, and particulated juvenile articular cartilage. The selection of the most appropriate treatment option should be based on the specifics of a talar lesion, in particular, lesion size.

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Osteochondral lesions of the talus (OLTs) are a common cause of chronic ankle pain and disability. Most OLTs are associated with prior trauma and may cause substantial long-term functional limitations.[1-3] The management of OLTs is complicated by the limited healing capacity and poor regenerative potential of articular cartilage.[4] Nonsurgical treatment has been reported to be only moderately successful at mitigating symptoms and returning patients to their prior level of activity.[5,6] Tol et al[7] reported that patients who underwent surgical treatment of OLTs had substantially better outcomes compared with patients who underwent nonsurgical treatment of OLTs.

Nonsurgical Treatment

Often, nonsurgical management of OLTs is initially undertaken because many OLTs are discovered incidentally on imaging and are of an indeterminate age. Nonsurgical treatment may include cast or boot immobilization, activity modification, anti-inflammatory medications, and, possibly, corticosteroid injections. The success of nonsurgical treatment is limited. A large systematic review reported good to excellent overall outcomes in 45% of patients with OLTs who were treated nonsurgically.[7] In a study of 34 patients with OLTs who underwent nonsurgical treatment, Shearer et al[8] reported good or excellent outcomes in 54% of the patients at a mean follow-up of 38 months. Adjuvant nonsurgical treatment options include injections of hyaluronic acid formulations and platelet-rich plasma. Hyaluronic acid and platelet-rich plasma injections have been reported to improve pain and functional scores at 6-month follow-up; however, their long-term effectiveness is limited.[9,10]

Surgical Treatment

Surgical treatment is indicated for patients with symptomatic, focal OLTs

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in whom a trial of nonsurgical treatment fails. First-line surgical treatment options include reparative bone marrow stimulation (BMS) techniques, such as curettage, drilling, and microfracture. BMS techniques are typically performed arthroscopically and result in good to excellent outcomes in 72% to 85% of patients in whom they are performed.[7] Before arthroscopic BMS techniques were developed, BMS techniques typically were performed in an open manner with the use of tibial or fibular osteotomy. Open BMS techniques allowed for direct visualization of the lesion and potentially easier instrumentation but were complicated by a relatively high rate of degenerative ankle arthritis.[11] Care should be taken to evaluate patients with OLTs for ankle instability because cartilage treatment strategies are predicated on a stable joint. BMS techniques are unlikely to succeed in patients in whom ankle instability is present; therefore, ankle instability should be addressed either before or concurrent with the management of OLTs.

BMS Techniques

BMS techniques, which initially were developed to manage chondral injuries in the knee, have been successfully adopted to manage OLTs. Currently, microfracture is the most common initial BMS procedure used to manage OLTs because of its relative ease of use, ability to be performed arthroscopically, low cost, low morbidity, and quick recovery. BMS techniques rely on the penetration of subchondral bone, which allows stem cells to migrate from the marrow cavity into the prepared lesion site. Typically, stem cell proliferation results in fibrocartilaginous healing, which is biomechanically inferior compared with hyaline cartilage.[12] Tol et al[7] reported good to excellent outcomes in 85% of patients with OLTs who underwent OLT excision and BMS. Excellent results, however, are not always retained over time. In a study of 50 patients with OLTs who underwent arthroscopic BMS, Ferkel et al[13] reported that the outcomes of 35% of the patients deteriorated 5 years postoperatively. Several studies have reported good outcomes in patients who undergo revision BMS procedures. In a study of 38 patients with OLTs who underwent arthroscopic curettage and drilling, Schuman et al[14] reported good to excellent results in 86% of the 22 patients in whom the procedure was a primary surgical treatment and 75% of the 16 patients in whom the procedure was a revision surgical treatment. In a study of 12 patients who underwent revision arthroscopy and débridement, Savva et al[15] reported improved mean American Orthopaedic Foot and Ankle Society ankle-hindfoot scores, with 11 patients reporting satisfaction with their clinical outcomes at a mean follow-up of 5.9 years.

Patient factors, including age, sex, body mass index, and duration of symptoms, have not consistently been reported to correlate with BMS outcomes;[13,16-18] however, lesion-specific factors appear to have a substantial influence on BMS outcomes. Patients with focal OLTs who undergo BMS have better outcomes compared with patients with degenerative, uncontained OLTs who undergo BMS.[16] Large OLTs (>1.29 to 1.50 cm^2), delaminating OLTs, or cystic OLTs may not respond well to microfracture, and patients with these types of lesions have less reliable outcomes.[13,17-22] Chuckpaiwong et al[19] reported a strong correlation between the size of an OLT and BMS outcomes, reporting excellent results in patients with OLTs smaller than 1.5 cm^2 who underwent BMS and inferior results in patients with larger OLTs who underwent BMS. Similar results were reported by Choi et al[18] and Cuttica et al,[17] with both studies reporting that OLTs larger than 1.5 cm^2 were associated with worse outcomes, and that the size of an OLT was the most important predictor of poor results. Some surgeons consider 100 mm^2 to 150 mm^2 as the consensus threshold limit for BMS procedures.

Other Treatment Options

A myriad of treatment options, including osteochondral autograft transplantation (OAT), osteochondral allograft transplantation, autologous chondrocyte implantation (ACI), matrix-induced ACI (MACI) with collagen or hyaluronic scaffolds, particulated juvenile articular cartilage implantation, and bone marrow aspirate concentrate (BMAC), have emerged in an attempt to improve the outcomes of patients with OLTs. The goal of these techniques is the replacement or regeneration of hyaline cartilage on the articular surface of the talus to provide the most durable and anatomically equivalent tissue possible.

Osteochondral Autograft Transplantation

OAT can be used as a primary or revision procedure after failed microfracture to manage OLTs larger than 1 cm^2. In OAT, the OLT is removed and replaced with one or more osteochondral plugs, which allow for bone-to-bone healing and hyaline articular cartilage replacement. Classically, autograft was harvested from a patient's knee; however, newer OAT techniques

allow autograft harvest from the ipsilateral anterior talus.[23] Osteotomies are often required for OAT because perpendicular access to the OLT is necessary for optimal placement.

Several studies have reported positive results in patients who undergo OAT.[23-25] These positive results include good to excellent outcomes in 74% to 100% of patients who underwent OAT and histologic verification of the presence of hyaline cartilage at the site of an OLT.[6,17,23-25] In a study of 36 patients with OLTs (mean size, 1 cm^2) who underwent OAT mosaicplasty, Hangody et al[26] reported good to excellent outcomes in 94% of the patients at a mean follow-up of 4.7 years. In a larger study of 831 patients who underwent OAT mosaicplasty, Hangody and Füles[25] reported an overall donor site morbidity of 3% in patients in whom the osteochondral autograft was harvested from the superomedial or superolateral edges of the ipsilateral femoral condyle. In a recent systematic review of a subgroup of 212 patients with OLTs who underwent OAT, Zengerink et al[6] reported good to excellent outcomes in 87% of the patients; however, donor site morbidity was observed in 12% of the patients. Donor site morbidity in patients with OLTs who undergo OAT is an ongoing concern, which has led to increased interest in fresh osteochondral allograft transplantation. In addition to the concern for donor site morbidity, a recent prospective, randomized study reported no difference in the 2-year outcomes of patients with OLTs who underwent either microfracture, OAT, or simple chondroplasty.[20] These findings call into question the theoretical benefits of OAT compared with simpler, less expensive treatment options, such as microfracture or simple chondroplasty.

Osteochondral Allograft Transplantation

Fresh osteochondral allograft transplantation is a single-stage procedure that eliminates the potential for donor site morbidity because the graft is acquired from a fresh cadaver specimen. A preoperative CT scan should be obtained for patients in whom an osteochondral allograft is being considered to calculate the dimensions of the OLT for tissue bank analysis, which can take several months before a size-matched allograft becomes available. Typically, allograft acquisition requires 2 weeks to clear tissue cultures. After 3 weeks, an allograft may begin to show signs of deterioration.

Multiple recent studies have reported favorable results in patients with OLTs who undergo fresh talar osteochondral allograft transplantation, which can be performed in patients who have large, cystic shoulder OLTs that are not amenable to other treatment options.[27-31] In a retrospective study of eight patients with shoulder OLTs who underwent fresh osteochondral allograft transplantation, Adams et al[27] reported that all the patients had improved pain and functional scores at a mean follow-up of 48 months; however, radiographic lucencies at the graft site were observed in five of the eight patients (63%), and four of the eight patients (50%) required an additional surgical procedure. In a prospective study of 19 patients with substantial OLTs who underwent fresh osteochondral allograft transplantation, Berlet et al[28] reported improved pain and function scores in 12 patients at a mean follow-up of 3.3 years; however, radiographic lucencies at the graft site were observed in three patients, edema was observed at the graft site in four patients, an osteochondral allograft failed to incorporate in one patient, and one patient underwent osteochondral allograft revision. In a study of 38 patients with OLTs who underwent fresh osteochondral allograft transplantation, El-Rashidy et al[29] reported good, very good, or excellent outcomes in 74% of the patients at mean follow-up of 37.7 months. The authors reported that allograft failure occurred in four of the patients (11%). In a prospective study of 15 patients with large cystic OLTs (>3,000 mm^3) who underwent fresh osteochondral allograft transplantation, Raikin et al[31] reported an 87% survival rate and good to excellent outcomes in 73% of the patients at a minimum follow-up of 2 years.

Disadvantages of fresh osteochondral allograft transplantation include the time interval for allograft availability, the potential for disease transmission, and the possible immunogenicity of an allograft, which can lead to rejection. Patients in whom fresh osteochondral allograft transplantation fails often require ankle arthrodesis.

Autologous Chondrocyte Implantation

ACI is a two-stage surgical procedure that attempts to fill an OLT with a patient's own transplanted chondrocytes. The first stage of ACI involves the harvest of chondrocytes from the edge of a patient's OLT or knee. These chondrocytes then undergo culture expansion in a laboratory for several weeks. In the second stage of ACI, the cultured chondrocytes are transplanted into the patient's OLT after the lesion has been débrided. A periosteal patch from the proximal tibia is sutured over the transplanted chondrocytes for containment. OLT margin cartilage has been used as a culture specimen to minimize donor site morbidity.[32] The indications for

ACI include well-contained, unipolar OLTs larger than 1 cm^2. Complications of ACI, including graft failure, delamination, and graft hypertrophy, are relatively low (3.8%).[33]

Multiple retrospective studies have reported good to excellent outcomes in patients who undergo ACI in the ankle joint.[34-37] In a study of 11 patients with OLTs who underwent ACI, Nam et al[38] reported good to excellent outcomes in 9 patients at a mean follow-up of 38 months. Complete OLT coverage was observed in 10 of the patients who underwent second-look arthroscopy; however; the authors reported a 20% rate of graft hypertrophy. Giannini et al[35] reported a histologic appearance of hyaline-like cartilage in eight patients who underwent second-look arthroscopy after ACI.

Matrix-Induced ACI

MACI, which is a second-generation ACI technique, is currently used in Europe for the management of OLTs. MACI eliminates the need for a periosteal patch by using a tissue-engineered bioabsorbable collagen membrane with implanted cultured autologous chondrocytes that is fixed to the site of an OLT with fibrin glue.[39] MACI does not require extensive joint exposure or osteotomy, which decreases surgical time and morbidity.[40,41] MACI also diminishes the risk of cell loss from an OLT, uneven cellular distribution, and periosteal hypertrophy.[42] Good to excellent outcomes have been reported in 70% to 92% of patients with OLTs who underwent mini-open or all-arthroscopic ACI or MACI as a primary or revision procedure.[37,38,43,44] In a study of 10 patients with full-thickness OLTs who underwent MACI, Giza et al[45] reported improved pain and functional scores in 9 of the 10 patients at 1 year and 2 years postoperatively. Currently, MACI is not approved by the FDA for use in the United States.

Particulated Juvenile Articular Cartilage

Particulated juvenile articular cartilage is designed to form a hyaline-like cartilage mass within a prepared OLT.[46,47] Particulated juvenile articular cartilage has the ability to cover large OLTs without the requirements for preimplantation autologous chondrocyte harvest or a periosteal patch. Because a particulated juvenile articular cartilage graft is composed of juvenile cartilage cells, it has an increased cellular density compared with an adult articular cartilage graft and the potential for increased glycosaminoglycan production and type II collagen development, which are key to healthy articular cartilage.[48] Particulated juvenile articular cartilage implantation is a single-stage procedure that, typically, does not require osteotomy. Disadvantages of particulated juvenile articular cartilage include the possible immunogenicity of the particulated juvenile articular cartilage, disease transmission, and cost.

Current evidence for the use of particulated juvenile articular cartilage in patients with OLTs is based primarily on studies on its use for the management of patellar, femoral condyle, and trochlear osteochondral lesions of the knee. Patients with OLTs who underwent particulated juvenile articular cartilage implantation demonstrated improved pain and function 2 years postoperatively.[49,50] In a recent multicenter study of 23 patients with OLTs (24 ankles) who underwent particulated juvenile articular cartilage implantation, Coetzee et al[47] reported overall good to excellent results in 78% of the patients at a mean follow-up of 16.2 months. Good to excellent outcomes were reported in 92% of patients who had OLTs that were 10 to 15 mm in size.

Bone Marrow Aspirate Concentrate

Biologic adjuncts, such as BMAC, are an increasingly common treatment strategy for patients who have soft-tissue, cartilage, and bony injuries. BMAC is obtained via aspiration of the bone marrow content, after which the cellular components are separated based on a centrifuge gradient that allows for the collection of both hematopoietic and mesenchymal stem cells. Pluripotent mesenchymal stem cells can be differentiated into both chondral and osseous progenitor cells, whereas hematopoietic cells as well as collected platelets and growth factors can help signal and propagate the cellular regenerative process. Wilke et al[51] reported that the introduction of BMAC into the full-thickness cartilage lesions of 12 horses improved cartilage repair, with several of the cartilage lesions having a propensity for type II hyaline-like cartilage. Improved cellular density, improved cellular orientation, and greater type II collagen content have been reported with the use of BMAC as an adjunct to microfracture and OAT in animal studies.[52,53]

Improved graft ingrowth, enhanced chondrocyte proliferation, and limited potential for articular fluid ingress around the graft plugs, which may lead to early failure, have been reported with the use of BMAC in human studies. In a study of 72 patients with large OLTs who underwent OAT with adjunct BMAC, Kennedy and Murawski[54] reported substantially improved mean Foot and Ankle Outcome Scores and

Medical Outcomes Study 12-Item Short Form scores at a minimum follow-up of 1 year; however, three patients had donor site knee pain postoperatively, and in one patient a perigraft cyst developed that required decompression at 28 months postoperatively. In a prospective study of 48 patients with OLTs who underwent microfracture with adjunct BMAC via a hyaluronic acid scaffold, Giannini et al[55] reported improved pain and functional scores as well as histologic verification of variable degrees of tissue remodeling at a minimum follow-up of 24 months.

Video 23.1: Ankle and Cartilage Treatment in the Athlete. Eric Giza, MD (3 min)

Table 1
Treatment Algorithm for Osteochondral Lesions of the Talus Based on Size

OLT Size	Treatment
Small (<5 × 5 mm) with minimal cystic changes)	Microfracture, drilling, or curettage
Medium (5 × 5 mm to 10 × 10 mm) or smaller with cystic changes	Microfracture, drilling, or curettage
	MACI (not currently available for use in the United States), particulated juvenile articular cartilage, or bone marrow aspirate
Moderate (10 × 10 mm to 20 × 20 mm)	MACI (not currently available for use in the United States), particulated juvenile articular cartilage, or bone marrow aspirate
	ACI, OAT, or osteochondral allograft transplantation
Large (>20 × 20 mm)	OAT or osteochondral allograft transplantation
	Bulk allograft

ACI = autologous chondrocyte implantation, MACI = matrix-induced autologous chondrocyte implantation, OAT = osteochondral autograft transplantation, OLT = osteochondral lesion of the talus.

Treatment Options

Good results have been reported in most patients with OLTs who undergo BMS; however, certain subsets of patients with OLTs who undergo BMS have poorer outcomes. Although several studies have reported that the size of an OLT is the primary factor in suboptimal microfracture outcomes, the size of an OLT that is most appropriate for each treatment option remains controversial.[22,56] The authors of this chapter used the best available evidence in the literature to create a treatment algorithm for OLTs based on lesion size (**Table 1**).

Summary

OLTs are a common source of ankle pain and functional disability. The management of OLTs with BMS techniques is reasonably effective in most patients; however, certain OLT characteristics, including size larger than 1.5 cm^2 and cystic changes, remain barriers to improved outcomes. Surgeons should consider a treatment algorithm that is based on the best available evidence to aid in the selection of the most appropriate treatment option for patients with OLTs.

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