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Osteochondral Allograft Transplantation Surgery for Osteochondral Lesions of the Talus in Athletes

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ABSTRACT

Osteochondral lesions of the talus (OLTs) continue to be a challenge for the treating surgeon, especially when lesions are refractory to marrow stimulation techniques. The purpose of this study is to evaluate the outcomes of lesions treated with osteochondral allograft transplantation. A review was performed of 30 athletes with 31 OLTs that were refractory to marrow stimulation or predicted to be refractory based on size and location of the lesion. Results were evaluated in terms of occupational outcomes and numeric pain scales. Lesions treated had a mean area of 1.37 (range 0.36 to 3.3) cm^2. Overall excellent outcomes were achieved in 11 (35%) ankles. Nineteen (61%) ankles achieved good or excellent occupational outcomes, and 12 (39%) ankles demonstrated poor occupational outcomes and the patients were unable to continue their previous active occupations. Patients were found to have a mean pain scale score of 3 (range 0 to 7) of 10 at a mean of 21 (range 10 to 24) months after operative management. Osteochondral allograft transplantation is an option for the treatment of selected athletes with large OLTs, as well as lesions that are refractory to marrow stimulation techniques. The results of this study may help active young patients and their surgeons to better understand outcomes and options in their shared decision-making process.

Osteochondral lesions of the talus (OLTs), as first described by Kappis (1) in 1922, are a common source of ankle pain, instability, osteoarthritis, and disability (1–7). There is debate as to the exact cause of these lesions, but trauma is thought to play a substantial role, with some studies demonstrating associated chondral injuries in >70% of ankle fractures and 6.5% to 38% of ankle sprains (8–10).

Initial treatment involves nonoperative management with a combination of immobilization, protected weightbearing, nonsteroidal antiinflammatory drugs, and/or physical therapy (6). Although the results of nonoperative treatment are widely varied, good to excellent outcomes have been reported in an average of 45% of studies (11–13). Surgical treatments are evolving and include mesenchymal stem cell stimulation (microfracture), osteochondral autograft/allograft, autologous chondrocyte implantation, particulated allograft implantation, and autogenous bone graft. Clinical outcomes of these treatment options are difficult to compare because of the current wide array of surgical interventions and the varying surgical indications. Many study outcomes have a low level of evidence or poor methodological quality (14). A recent review of the different treatment options demonstrated good to excellent outcomes in 85% to 88% of patients who were treated operatively regardless of the procedure (15).

The U.S. Armed Forces serves as a good model for studying these injuries due to the general high occupational demands and objective quantifiable physical requirements. A study evaluating the incidence of OLTs within the U.S. military found a rate of 16:100,000 in 2002 and annual increases to 56:100,000 in 2008 (16). Active duty personnel are tracked in the Medical Operational Data System (U.S. Department of Defense, Arlington, VA), which documents ability to return to active duty and limitations to duty based on injury through the electronic profile system, making this a model to track these outcomes.

The purpose of this study was to record outcomes of patients who have undergone fresh allograft osteochondral transfer for the treatment of OLT with specific attention to return to active duty and duty limitations as a result of the affected ankle. We also set out to characterize the lesions being treated with this modality and to report on postoperative pain and postoperative clinical outcomes.

Patients and Methods

This review was approved by the Madigan Army Medical Center Institutional Review Board. Electronic medical records and the surgical schedule were reviewed to identify all

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patients who underwent fresh allograft osteochondral transfer for OLTs from July 2010 through December 2013 (41 months). The initial review involved a search of Current Procedural Terminology (CPT) and International Classification of Diseases, 9th revision (ICD-9) codes. The following CPT codes were searched: 28445, 27899, 28100, 29891, 28103, 29892, and 28446. The following ICD-9 codes were searched: 732.7, 738.8, and 733.90. Once the possible charts were identified, a hand review was performed. All cases that specifically referenced an "osteochondral defect of the talus" or an "allograft transfer" were pulled, and the individual operative notes were then read and reviewed.

Only those patients who obtained a fresh allograft osteochondral transfer for the treatment of an OLT were included. In addition, patients were required to have undergone a history and physical examination and to have radiography and magnetic resonance imaging (MRI) results consistent with a symptomatic OLT (Fig. 1). Computed tomographic scans were obtained on some patients for surgical planning but were not routinely ordered during the study period. MRI results were analyzed by using the Centricity™ (GE Medical Systems, Waukesha, WI) picture archiving and communication system. Lesion dimensions were measured on coronal, transverse, and sagittal slices to determine the area and volume of chondral defects. The location of the defects was also characterized.

To be indicated for operative management, patients had to have activity-limiting symptomatic lesions for which a trial of nonoperative treatment was unsuccessful. Nonoperative treatment consisted of activity modification, therapist-guided physical therapy, and nonsteroidal antiinflammatory drugs. The first-line procedure at our institution for symptomatic OLTs is microfracture. For patients to be indicated for fresh allograft osteochondral transfer, patients had to had had microfracture surgery that was unsuccessful or to have features suggestive of a lesion that might not respond to microfracture. Features that were considered to be predictive of poor response to microfracture included lesions >1.5 cm^2, cystic lesions, and uncontained lesions located on the shoulder or extending through the side wall of the talus.

The Armed Forces Health Longitudinal Technology Application (U.S. Department of Defense, Arlington, VA) was used to determine patient age, date of last follow-up visit, laterality of surgery, and whether additional procedures were performed on the ipsilateral ankle. The Health Artifact and Image Management Solution (U.S. Department of Defense) database was used to retrieve operative reports that provided an intraoperative description of the lesions. The Medical Operational Data System (U.S. Department of Defense) was reviewed to determine each patient's ability to return to active duty. The system also described any limitations placed on return to duty with attention given to a patient's ability to run. In addition, the system could be used to determine if patients were medically separated from the military as a result of their ankle.

Patient results were classified as excellent, good, or poor. We defined an excellent outcome as one in which the patient was able to return to active duty with no restrictions. A good outcome was one in which a patient was able to remain on active duty with some restrictions on running. A poor outcome was defined as one in which additional procedures were required or the patient was medically separated from the military as a result of his or her ankle function. These data are considered objective occupational data because they are recorded in the military electronic medical record by a physician.

During the surgical procedure, ankle articular cartilage was exposed via a standard open anterior approach. An anterior plafondplasty was performed if needed so that the defect could be accessed perpendicularly. In patients with a posteromedial lesion that could not be fully accessed via an anterior approach, a medial tibial osteotomy was performed to allow adequate exposure (Fig. 2). Radiographic evaluation of preoperative MRI was used to size match donors to recipients. Allograft tali were obtained from healthy donors based on the criteria of the American Association of Tissue Banks. A cylindrical

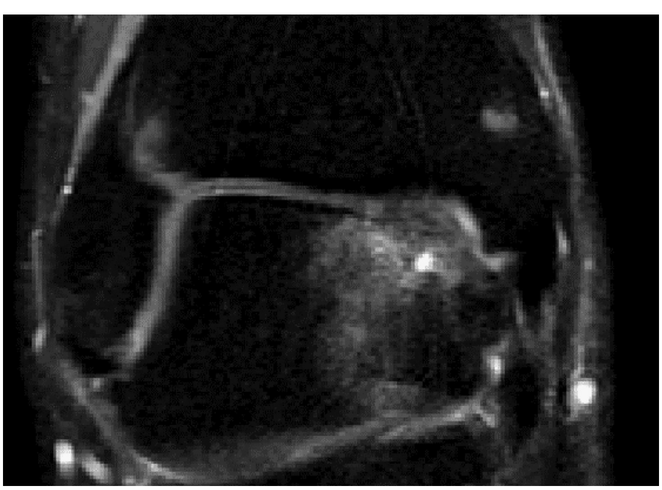

Fig. 1. Magnetic resonance scan of a large medial lesion that is uncontained with cystic changes.

Fig. 2. Anteroposterior fluoroscopic image of a medial malleolar osteotomy, which is required in this case to access the medial shoulder lesion. Two Kirschner wires are used as a glide path for the oscillating saw and osteotome when creating the osteotomy. A guide wire for a cylindrical reamer is then inserted into the central portion of the osteochondral defect to prepare the recipient bed for the allograft.

harvest system set was used to core out cartilage and subchondral bone surrounding the defect to provide a bed for the allograft bone plug.

An allograft osteochondral plug was then fashioned to fit into the recipient subchondral bone bed. This graft was soaked in platelet-rich plasma. AlloFuse® (AlloSource, Centennial, CO) demineralized bone matrix paste was also inserted into the recipient talus bed. The allograft osteochondral plug was gently pushed down until it was flush with the surface of the native talar dome. The joint was then irrigated with sterile saline, and passive range of motion was tested to ensure stability of the allograft plug and to ensure there was no crepitus or impingement. If a medial malleolar osteotomy was performed, predrilled screw holes were filled with 2 screws perpendicular to the osteotomy and 1 screw parallel to the distal tibial articular surface (Fig. 3). Incisions were closed in layers.

Patients were seen 2 weeks postoperatively to evaluate the surgical site and to remove sutures. Physical therapy was initiated, and patients were seen at regular

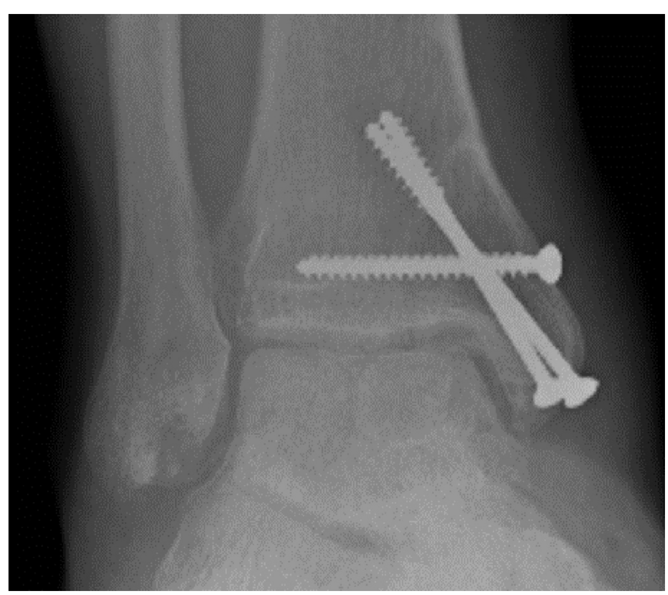

Fig. 3. Anteroposterior radiograph of the healed osteotomy and osteochondral allograft transfer. Two screws were placed perpendicular to the osteotomy to obtain compression, and a third screw was placed parallel to the joint surface to resist shear forces during early motion.

Table 1
Summary of patient demographics (N = 31 ankles in 30 patients)

Mean age (y)	33.77 (range 19 to 53)
Follow-up (mo)	21.35 (range 10 to 44)
Male (n)	28 (93%)
Laterality (no. of ankles right:left)	12:19
Mean area of lesion (cm^2)	1.37 (range 0.36 to 3.30)
Mean volume of lesion (cm^3)	0.78 (range 0.216 to 2.31)
Cysts present (no. of ankles)	17 (55%)
Uncontained lesion	20 (65%)
Location	6/14/1/8/1/1*
Daily pain scale score	3 (range 0 to 7)

"Uncontained" indicates a lesion that extends over the shoulder of the talus or through the side wall of the talus.

* Location as determined on the magnetic resonance scan: central-lateral/central-medial/posterolateral/posteromedial/anterolateral/anteromedial.

intervals (6 weeks, 3 months, 6 months, 1 year, and 2 years) postoperatively. After the procedure, patients were non-weightbearing in a controlled ankle motion walker boot for 8 weeks. The patents were encouraged to remove the controlled ankle motion boot for active range of motion exercises once the incision had healed.

The majority of this review is descriptive, although statistical analysis was performed to determine if the age of the patient or the physical nature of the lesions was associated with the occupational outcome. The cohort was divided into 2 groups. Those with a good or excellent outcome were placed in the first group, and those with a poor outcome were placed in the second group. Statistical significance was defined at the 5% ($p \leq .05$) level, and a paired t test was used to compare the groups. Statistical analysis was performed by the senior author (P.M.R.).

Results

There were 30 patients (31 tali) who met the inclusion criteria. Demographics are summarized in Table 1 and detailed in Table 2. The mean age was 33.6 (range 19 to 53) years, and the mean area of the lesion was 1.37 (range 0.36 to 3.30) cm^2. A total of 28 (93%) of the patients were male. The left talus was involved in 20 (65%) of the OLTs. The lesion was uncontained in 20 (65%) of the tali. Cysts were present in 17 (55%) of the ankles, and the lesion was medial in 20 (65%) of the ankles. A medial malleolar osteotomy was required in 12 (39%) of the ankles. Additional procedures were performed in 13 (42%) of the ankles and included a lateral ankle stabilization procedure in each case. The index procedure was performed initially in 25 (81%) of the procedures, with 6 (19%) of the ankles having had a previous microfracture. For 1 patient, both a previous microfracture and a previous autograph osteochondral transfer had failed. There were no patients with deep infections or postoperative complications apart from 1 patient who developed a superficial cellulitis that was treated with oral antibiotics.

Objective results in terms of return to duty were determined at a mean of 21 (range 10 to 44) months after the procedures. Excellent results were rated in 11 (35%) ankles. Good or excellent results were recorded in 19 (61%) ankles, and 12 (39%) ankles had results that were rated as poor based on the criteria described here earlier. The characteristics of the osteochondral lesions for these patients are outlined in Table 3. In comparing patients who had a good or excellent result with patients who had a poor result, we found no difference in terms of age ($p = .163$), volume of lesion ($p = .249$), area of lesion ($p = .347$), cystic changes ($p = .931$), containment of the lesion ($p = .8582$), or requirement for an osteotomy ($p = .234$) with the numbers given. Further data were collected on the 12 patients with a poor result. Seven (23%) of the patients in that group underwent a medical separation from the military primarily because of their ankle. Six (19%) of the patients with a poor result listed other medical complaints on their separation physical

Table 2
Details of patient demographics (N = 31 ankles in 30 patients)

Pt No.	Age (y)	Area (mm^2)	Cyst	Uncontained	PSH	Osteotomy	Other	Outcome
1	43	144	Y	Y				E
2	28	120		Y		Y		E
3	39	143	Y				LAS	E
4	39	180					LAS	E
5	53	112	Y	Y				E
6	19	180		Y				E
7	24	104	Y	Y				E
8	26	192	Y	Y		Y	LAS	E
9	31	80				Y	LAS	E
10	32	130	Y			Y	LAS	E
11	41	135		Y		Y	LAS	E
12	49	330	Y	Y			LAS	G
13	44	112		Y	LAS, microfracture			G
14	40	104	Y	Y		Y		G
15	35	112		Y			LAS	G
16	29	56	Y	Y		Y	LAS	G
17	36	128	Y			Y	LAS	G
18	34	98			LAS, microfracture	Y		G
19	33	153	Y					G
20	26	36			LAS			P
21	37	247	Y					P
22	28	104		Y			LAS	P
23	29	99	Y	Y	Primary repair		LAS	P
24	24	120	Y	Y			LAS	P
25	32	72						P
26	39	100	Y	Y		Y		P
27	22	180		Y	Microfracture, OATS			P
28	42	144		Y		Y		P
29	19	91		Y				P
30	48	220	Y	Y	Microfracture	Y		P
31	26	240	Y	Y		Y		P

Abbreviations: E, excellent or able to return to active duty without limitations; G, good or able to return to active duty but with some limitations on running; LAS, lateral ankle stabilization; microfracture, mesenchymal stem cell stimulation; OATS, osteoarticular autograft transfer system; Other, associated procedures performed during the same surgical encounter; P, poor or unable to return to active duty or requiring additional surgical procedures; PSH, past surgical history as it pertains to the evaluated ankle; Pt, patient (1 patient had bilateral ankles operated on); Uncontained, lesion extends over or through the shoulder of the talus; Y, yes.

Table 3
Outcomes (N = 31 ankles in 30 patients)

	Outcome Excellent (n = 11)	Good (n = 8)	Poor (n = 12)	*p* Value
Mean age (y)	34.1	36.3	30.9	.163
Size of lesion (cm^2)	1.39	1.34	1.39	.347
Uncontained (n)	7 (64%)	5 (63%)	9 (75%)	.8582
Cysts present (n)	6 (55%)	5 (63%)	6 (50%)	.931

Abbreviations: Good, able to remain on full active duty with some limitations on running; Excellent, able to return to full active duty with no limitations on running or physical activity; *p* value, determined testing null hypothesis between good/excellent results and poor results; Poor, required medical separation from the military all or in part because of the operative ankle or required additional surgical procedures; Uncontained, lesion extends over shoulder or through side wall of talus.

aside from their ankle, such as low back pain, sleep apnea, and posttraumatic stress disorder. No attempt was made to ask these patients to quantify the percentage that their ankle contributed to their separation. The average daily pain scale score at the final follow-up visit was 3 (range 0 to 7) of 10.

Discussion

OLT can be a challenging condition for active patients and their surgeons. A gold standard for treatment has not been determined (17). Marrow stimulation is first-line treatment for many surgeons because of its proven efficacy, low cost, and minimal morbidity (2,6,7,13,15,17–21). The success of marrow stimulation, however, appears to be size and location dependent. Multiple studies show decreasing effectiveness with lesions >1.5 cm^2 and in uncontained lesions (1,22–24).

The osteoarticular autograft transfer system (OATS) is an alternative method that allows coverage of larger areas by using healthy osteoarticular cartilage from the non-weightbearing surfaces of the knee (25–27). OATS has been used historically in patients with highly cystic lesions not amenable to marrow stimulation or in patients for whom marrow stimulation failed (24,28,29). Authors have reported good to excellent results in as many as 93% of patients, although most patients had to modify their level of activity in these studies (30–33). The main concern with autograft OATS is donor-site morbidity from the ipsilateral knee, which has been reported in 16.9% and may be underreported in the literature (34).

Autologous chondrocyte implantation has also been described for large OLTs involving staged harvest of healthy articular cartilage followed by culture and implantation into the lesion (35). Patient success rates have been reported as high as 90% (36). The need for multiple staged procedures and the expense of the harvest and culture of chondrocytes remain considerations for implementing this procedure.

Fresh talus osteochondral allograft transplantation has been described as an alternative for large tissue defects that provides coverage for the OLT without requiring a second procedure, as in autologous chondrocyte implantation, and does not have the donor site morbidity associated with autograft OATS (37–43). Results are limited to small, uncontrolled series of patients who had large OLTs treated with bulk allograft. Although the studies report improvement in pain, there was radiographic collapse or resorption in as many as 67% of patients. Conversion to arthrodesis has been reported in up to 13% of patients (37,43).

No previous study has evaluated the occupational outcomes of fresh autograft transfers using cylindrical osteochondral plugs for OLT. This is the first study to quantify return to work and return to activity after fresh allograft osteochondral transplantation. Nineteen (63.3%) of our patients were able to return to active duty after fresh autograft transfer. In addition, 10 (33.3%) of our patients were able to return to full military duty with no limitations on running. At a mean of 21 (range 10 to 44) months after the procedure, the mean pain scale score was 3 (range 0 to 7) of 10, which is consistent with previously reported postoperative pain in patients treated in a similar fashion with allograft transfer (37,40,43).

There are several limitations to this study. The sample size is small. This is a review without a comparative cohort. Our population was predominantly young males in the military, which limits the ability to apply these results to other populations. Although we attempted to identify every record during the study period, our use of ICD and CPT codes to identify potentially eligible patients may have been subject to coding biases. It is possible that some patients with a fair outcome may have been able to return to their previous level of activity but were restricted by the treating provider to protect them from further injury. Twelve of the 31 procedures required a medial malleolar osteotomy, and 11 of the patients had associated procedures at the time of transfer. Finally, the follow-up was limited in length for a condition that can be associated with the development of osteoarthritis.

In conclusion, OLTs that are large, uncontained, and refractory to microfracture can be difficult to treat effectively. The use of fresh allograft talus osteochondral plugs in an osteoarticular transfer procedure is a possible alternative procedure. A fresh allograft transfer allows for a single procedure without the risk of morbidity that could be associated with an autograft harvest. In our high-demand population of young active adults, this procedure was able to return 10 (33.3%) patients to their previous level of activity, and 19 (63%) of our patients were able to remain on active military status after the procedure. The results of this study may help active young patients and their surgeons to better understand outcomes and options in their shared decision-making process.

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