Does Fresh Osteochondral Allograft Transplantation of Talar Osteochondral Defects Improve Function?

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Abstract

Background Fresh osteochondral allograft transplantation can be used to replace talar osteochondral defects (OCDs) with single bulk osteochondral graft. While limited studies report improvement of function, improvement in quality of life and radiographic durability is unknown.

Questions/purpose We therefore determined if this technique improved function, increased quality of life, and provided durable graft stability radiographically and by MRI.

Patients and Methods We prospectively followed 19 patients (19 OCDs). We excluded seven patients (four with insufficient followup, two who were lost to followup, and one with graft failure), leaving 12 patients with a minimum followup of 2 years (average, 3.3 years; range, 2.0–4.6 years). Functional and quality of life outcomes

were quantified using the American Orthopaedic Foot and Ankle Society (AOFAS) score and the SF-12 Health Survey. Graft incorporation and stability were assessed through radiographs and MRI.

Results Mean total AOFAS scores (61 ± 9 to 79 ± 6), pain subscores (17 ± 8 versus 26 ± 5), and function subscores (34 ± 3 versus 42 ± 4) improved from preoperatively to last followup. We observed no improvements of the physical and mental health components of the SF-12 Health Survey from preoperatively to last followup. At last followup, three of the 12 grafts had radiolucencies, four had edema, one failed to incorporate, and none had subsidence. One of the 19 patients in the overall series underwent graft revision.

Conclusions Patients with talar OCDs can expect functional improvement after this technique. The majority will have stable grafts at least short term. Larger studies with longer followup are needed to determine if this procedure substantially improves quality of life, if graft radiolucencies and edema have any long-term implications, and whether the grafts are durable.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. Study enrollment and all followups were conducted at Orthopedic Foot and Ankle Center, Westerville, OH, USA. All operative procedures were performed at Grant Medical Center, Columbus, OH, USA.

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Introduction

OCDs of the talus are relatively common and often develop after a traumatic injury [14, 17, 20, 35, 40, 41, 44]. Talar OCDs typically occur in young patients between 20 and 35 years of age and affect males twice as often as females [14, 20, 35, 44]. Given the poor intrinsic healing properties of cartilage [27, 36, 43], the size and location of the lesion [12, 35, 41, 43], and the potential for

progression to osteoarthritis [41], selecting the most appropriate management of talar OCDs remains controversial and substantially enhancing patient function is a challenge.

Traditional treatment modalities include debridement with abrasion arthroplasty, subchondral drilling, microfracture, autogenous osteochondral grafts, and autologous chondrocyte implantation [17, 44]. Each of these options, however, has specific disadvantages. Subchondral drilling, abrasion arthroplasty, and microfracture replace the defect with fibrocartilage, which deteriorates with time [3, 17]. Although autogenous osteochondral grafting and mosaicplasty techniques replace underlying subchondral bone and are associated with functional improvement [4, 12, 17, 19, 25, 39], donor site availability is limited for larger defects [17]. Additionally, the use of two or more cylindrical plugs for larger defects may result in fibrocartilage development in the area between the plugs and also may not adequately fill irregularly shaped OCDs [17]. Because autologous chondrocyte implantation is not limited by the size of the donor site, it has been used to treat large talar OCDs [17]. Unfortunately, it does not replace the subchondral defect, requires two procedures, and is difficult to perform [17].

Fresh osteochondral allograft transplantation addresses many of the disadvantages associated with other surgical treatment options and offers several advantages [8, 17]. First, it fills the defect with a mature hyaline cartilage structure while addressing underlying bone deficiency [8, 30]. Because osteochondral allografts may be created to match any size defect and eliminate the need for a donor site, this technique is particularly advantageous for large or deep OCDs and in revisions [17, 20, 26]. The use of a single graft versus multiple plugs also reduces potential fibrocartilage ingrowth [17]. Reported disadvantages associated with osteochondral allografts include immunogenicity and limited chondrocyte viability [9, 17, 26].

Numerous authors report using fresh osteochondral allografts in the knee [5, 8, 11, 13, 16, 21, 22, 30, 47]. Studies examining fresh osteochondral allograft transplantation for treating talar OCDs are limited to case series of one to 15 patients [18, 20, 24, 27, 32, 37, 38, 45]. Although these studies describe improvement in function, some involved retrospective designs [20, 32, 37, 45], small patient populations [20, 32, 37, 45], multiple conditions such as OCDs, traumatic arthritis, and osteoarthritis [32, 45], and limited imaging findings [18, 24, 32, 37, 45]. None of these studies incorporated a standardized quality of life assessment or reported followup MRI evaluations.

We therefore determined if this technique improved function, increased quality of life, and provided durable graft stability radiographically and by MRI.

Patients and Methods

Between April 2004 and November 2007, we prospectively followed 19 patients (19 lesions) who underwent fresh allograft transplantation for OCD lesions of the talus. We considered enrollment for patients at least 18 years of age with talar OCDs and for whom nonoperative methods and arthroscopic excision with microfracture and débridement failed. Indications for surgery were: (1) failure of at least one prior surgical treatment; (2) functional ankle ROM; (3) closed growth plates; (4) absence of cartilage changes on the tibial side; and (5) lesion size greater than 0.5 cm in at least one dimension as measured by MRI. Contraindications for surgery included degenerative joint disease of the tibiotalar joint, reflex sympathetic dystrophy, uncorrectable malalignment, and ligamentous instability. We excluded patients younger than 18 years or those with active infection or malignancy, whereas those with less than 2 years of followup were excluded from this preliminary analysis. Four of the 19 enrolled patients had less than 2 years of followup (two were lost to followup; one experienced early graft failure). The remaining 12 patients comprised the study cohort. There were six women and six men with a mean age of 39.9 years (SD, 13.5; median, 41.6 years; range, 21.6–65.2 years). Three patients reported tobacco use. One patient had diabetes. The mean followup was 3.3 years (range, 2.0–4.6 years). We obtained Institutional Review Board approval before initiating the study and all patients provided informed consent before study enrollment.

Nine OCDs were located in the left talus and three were in the right; 10 involved the medial talus and two the lateral. We used preoperative radiographs and MRI (0.5-T magnet with extremity coil) to classify OCDs according to grading criteria described by Berndt and Harty [6] and Anderson et al. [2], respectively (Table 1). Preoperative MRI also was used to measure lesion size. The mean preoperative OCD area was 1.5 cm² (SD, 1.1; median, 1.2 cm²; range, 0.2–3.0 cm²). We implanted a block allograft in six patients with uncontained lesions, whereas a plug allograft was used in six with contained OCDs.

Before surgery, we estimated talar sizes using a lateral radiograph of the ankle corrected for magnification based on the requirements of the tissue procurement organization [35]. Donor talar graft size was within 2 mm of the host talus. Fresh talar allografts were acquired from the Joint Restoration Foundation (Centennial, CO, USA). All donor allografts used in this series were processed and preserved fresh until implantation, which occurred between 14 and 21 days postharvest. Before implantation, we soaked grafts in autologous platelet-rich plasma to augment the chondral body of the graft with high concentrations of growth factors to improve integration of the allograft and reduce immunogenic reactions [1, 15, 29].

All procedures were performed by one of three senior authors (GCB, CFH, TMP) using a standardized surgical technique. The surgical approach was dependent on defect location. For lateral talar defects, we used an anterolateral approach and a fibular osteotomy was performed to ensure full observation of the defect. For medial talar defects, we performed a medial malleolar osteotomy to provide full observation of the medial aspect of the talus (Fig. 1). After adequate observation of the defect, we thoroughly débrided the area until a stable articular rim was achieved, if possible. The location of the lesion and dimensions of the excavated osteochondral bone were used to match the donor allograft. During surgery, lesions were matched by measurements from reproducible landmarks, such as the

articular cartilage margin with the talar neck anteriorly, and were confirmed with a measurement from the posterior articular cartilage margin. The articular contour was matched with the talus by having a similar shape and size as the host.

For contained lesions, we used a press-fit technique using the Allograft OATS® Instrumentation System (Arthrex, Inc, Naples, FL, USA). The largest plug size necessary to adequately fill the defect was used. Graft impaction was achieved through a series of small taps using an oversized tamp until the graft was flush with the surrounding articular surface. No additional fixation was necessary for these lesions.

We used bulk allograft transplantation for uncontained lesions with no medial or lateral wall or for large structural lesions. A skin marker was used to outline the lesion (Fig. 2). The lesions were converted to a block shape with right angles to the articular surface to allow easier implantation of the talar allograft (Fig. 3). We then used an oscillating saw to isolate the desired allograft, which was inserted in the patient's matching defect site (Fig. 4). Additional contouring of the graft was necessary in some patients to provide the best alignment. After proper graft alignment was achieved, we secured the graft using bio-resorbable poly-L-lactic acid osteochondral darts with a double-reversed barb design (Arthrex, Inc) (Fig. 5). All osteotomies were reduced and fixated using appropriate hardware (Fig. 6). To verify anatomic reduction of the talus and fibula, we observed the final construct under fluoroscopy in the AP and lateral planes.

Postoperative rehabilitation was similar for all patients. We prescribed nonweightbearing ambulation in a short leg cast for 4 weeks. At 4 weeks, a below-knee fracture boot

Table 1. Distribution of osteochondral defect classifications based on radiographic [6] and MRI classification [2] schemes

Patient number	Radiographic OCD classification	MRI OCD classification
1	Stage II	Stage IV
2	Stage II	Stage IIA
3	Stage II	Stage IV
4	Stage III	Stage III
5	Stage III	Stage V
6	Stage III	Stage III
7	Stage II	Stage IV
8	Stage I	Stage III
9	Stage II	Stage IV
10	Stage III	Stage IV
11	Stage I	Stage III
12	Stage II	Stage IIA

Fig. 1 A chevron medial malleolar osteotomy is performed to provide full observation of a medial talar osteochondral defect with medial talar shoulder involvement.

Fig. 2 A skin marker is used to outline margins of nonviable osteochondral tissue in preparation of the planned bulk resection.

was applied and active, assisted ROM of the ankle was permitted. Patients were instructed to begin full weight-bearing ambulation as tolerated at 6 weeks postoperatively. A 6-week course of physical therapy (two times per week) focusing on joint mobilizations, strength, and balance was initiated at 8 weeks.

We evaluated patients preoperatively and postoperatively at 3, 8, and 12 months and yearly thereafter. The AOFAS Ankle-Hindfoot Scale, which measures pain, function, and alignment, and the patient-administered SF-12 Health Survey were used to evaluate functional and quality of life outcomes, respectively [28, 46]. Three

Fig. 3 After bulk resection, the nonviable osteochondral defect is converted to a block shape with right angles to the talus.

Fig. 5 The fresh osteochondral allograft is secured to host bone using two bioresorbable poly-L-lactic acid osteochondral darts.

Fig. 4A–C The donor graft is harvested by first tracing the lesion shape onto the donor graft. Next, a block shape is outlined, ensuring that it fully encompasses the lesion. (A) The donor graft is harvested using a sagittal saw. (B) The harvested graft before insertion and (C) the implanted allograft in the recipient's defect are shown.

patients unable to return for followup were contacted by mail and asked to complete a questionnaire containing a question about pain, the SF-12 Health Survey, and questions regarding postoperative complications and additional procedures for their ankle at an outside facility. Nine patients were examined by one of the three senior authors (GCB, CFH, TMP) at least 2 years after undergoing fresh osteochondral allograft transplantation and three patients returned completed questionnaires.

We obtained standing AP, lateral, and mortise ankle radiographs at all evaluation intervals. MRI (0.5-T magnet

Fig. 6 Reduction of the predrilled chevron medial malleolar osteotomy is fixated with guidewire for cannulated 4.0-mm screws.

Fig. 7 A four-zone illustration was used to assess graft subsidence and radiolucencies.

with extremity coil) was performed at yearly followup intervals. Three authors (GCB, CFH, TMP) blindly reviewed postoperative imaging to evaluate graft stability. Because a standardized radiographic assessment has not been established previously, two senior authors (GCB, CFH) created a four-zone radiographic illustration to assess graft subsidence and radiolucencies (Fig. 7). MRI was used to evaluate stability of OCD allografts according to the guidelines proposed by Choi et al., including the degree of defect filling by the allograft, absence of displacement, and peripheral integration of repair cartilage and osseous components [10]. Owing to limitations of our MRI technology, we were unable to adequately evaluate the cartilage surface contour [10]. We also assessed the presence of edema on MRI because postoperative marrow edema has been associated with an increased risk of graft failure [10, 45]. Two patients who completed questionnaires did not return to undergo radiographs and MRI of their ankles. Another two patients opted not to have MRI of their ankles. All four of these patients had 1-year followups with radiographic and MRI evaluations.

We used descriptive statistics, including mean, median, SD, frequency, and percentage, to describe demographic, clinical, and diagnostic imaging data. The AOFAS Ankle-Hindfoot Scale overall scores and the pain, alignment, and function subscores were compared preoperatively and postoperatively. The physical and mental component summary scores from the SF-12 also were compared between preoperative and postoperative intervals. We used the paired t-test to compare normally distributed continuous variables, whereas the Wilcoxon signed rank test was

used to compare nonnormally distributed continuous variables or ordinal variables. Missing data were not estimated or carried forward in any statistical analyses. We performed statistical analyses using SigmaStat® Software, Version 2.0 (SPSS, Inc, Chicago, IL, USA).

Results

The overall AOFAS score and AOFAS pain and function subcomponent scores at last followup were improved over preoperatively (Table 2). The most recent followup AOFAS score, on average, increased 18 points from the preoperative score, whereas the pain and function subcomponents improved by 9 and 8 points, respectively.

We observed no difference in alignment between the preoperative and most recent followups (Table 2).

The most recent SF-12 physical and mental health component scores tended to be improved –13 and 8 points compared with preoperatively, respectively (Table 3). Despite improvements in these SF-12 scores, the powers of the statistical tests were less than 80%. A post hoc power analysis for these quality of life scores revealed that for greater than 80% power to detect differences, assuming an alpha level of 0.05 and an effect size equal to the current difference in the outcome measure, a cohort comprising between 14 (physical health component) and 18 (mental health component) patients would be necessary. No graft-related complications were reported among the 12 patients. At the most recent followup, we identified no complications

Table 2. Comparison of AOFAS Ankle-Hindfoot Scale scores [28].

AOFAS Ankle-Hindfoot Scale component	Preoperative evaluation	Most recent followup evaluation	p Value
Total AOFAS score	N = 12	N = 9	
Mean $\pm$ SD*	61 $\pm$ 9	79 $\pm$ 6	p = 0.001 ^Ω
Median	63	79	
Range (minimum–maximum)	40–69	69–87	
AOFAS pain subscore	N = 12	N = 12	
Mean $\pm$ SD*	17 $\pm$ 8	26 $\pm$ 5	p = 0.008 ^Ω
Median	20	30	
Range (minimum–maximum)	0–20 (severe–moderate pain)	20–30 (moderate–mild pain)	
AOFAS function subscore ^Ψ	N = 12	N = 9	
Mean $\pm$ SD*	34 $\pm$ 3	42 $\pm$ 4	p = 0.001 ^Ω
Median	34	41	
Range (minimum–maximum)	30–39	37–47	
AOFAS alignment subscore	N = 12	N = 9	
Mean $\pm$ SD*	10 $\pm$ 0	10 $\pm$ 0	p = 1.000
Median	10	10	
Range (minimum–maximum)	10–10 (good–good)	10–10 (good–good)	

* SD = standard deviation; ^Ψfunction = activity limitations + maximum walking distance + walking surfaces + gait abnormality + sagittal motion + hindfoot restriction + ankle-hindfoot stability; ^Ωthe powers of the statistical tests were greater than 90%.

Table 3. Comparison of SF-12 physical and mental health components [46]

SF-12 component	Preoperative evaluation	Most recent followup evaluation	p Value
Physical health component	N = 12	N = 11	
Mean $\pm$ SD*	28 $\pm$ 10	41 $\pm$ 12	p = 0.022 ^Ω
Median	29	41	
Range (minimum–maximum)	10–40	25–56	
Mental health component	N = 12	N = 11	
Mean $\pm$ SD*	47 $\pm$ 7	55 $\pm$ 13	p = 0.040 ^Ω
Median	47	59	
Range (minimum–maximum)	38–58	18–65	

* SD = standard deviation; ^Ω the powers of the physical and mental health component statistical tests were 62.3% and 48.0%, respectively.

in the four patients who did not meet the minimum 2-year followup criterion for inclusion. Of the two patients who were lost to followup, one did not have any complications at the 3-month followup and the other did not return for followup.

On the most recent MRI, we observed graft incorporation in seven of the eight patients, although edema around the graft was detected in four of the eight patients. We identified no instance of graft subsidence on MRI ($n = 8$) or radiographically ($n = 10$). Radiolucencies occurred in zone 1 for two patients and were visible in all 4 zones in another patient. MRI at 1-year followup was available for the four patients who did not have 2-year MRI and revealed full graft incorporation, no graft subsidence, and no presence of edema around the graft in all patients. Likewise, for the two patients with 1-year radiographs only, graft subsidence was absent and no radiolucencies in any zone were present.

Among the 12 patients with a minimum 2-year followup, all grafts remained intact and no revision procedures had been performed by the most recent followup. One of the 19 patients enrolled in the study, however, required revision of the initial allograft 2.7 years after graft collapse. Before revision, ankle arthroscopy with extensive debridement and curettage of the synovial cyst was performed to allow the patient to participate in her final collegiate ice hockey season. Accounting for this failure, 12 of 13 grafts survived.

Discussion

Fresh osteochondral allograft transplantation is a viable alternative to other treatment options and may be better for larger talar OCD lesions or revisions [20, 26]. Osteochondral allograft transplantation replaces the defect with a single intact hyaline cartilage structure, reducing risk of fibrocartilage development and eliminating donor site morbidity [17]. We therefore determined if this technique improved function, increased quality of life, and provided durable graft stability radiographically and by MRI.

We recognize limitations to this study. First, as with other allograft studies [18, 20, 24, 27, 30, 32, 37, 38, 45], we used a prospective cohort design with no control group. A prospective control group was not feasible, as we believe that other treatment options, including total ankle arthroplasty or arthrodesis, would greatly limit function and mobility. Consequently, we did not want to withhold this treatment from young, active patients for whom previous treatment failed. Second, owing to the uncommon nature of this condition, we had a limited sample size. Third, the mean length of followup for this study was

3.3 years, which is shorter than in some previous studies [18, 20, 24, 38, 45] evaluating fresh osteochondral allograft transplantation for the management of talar OCDs.

Our function scores were comparable to those of similar studies (Table 4) [18, 20, 24, 27, 32, 38, 45]. Three others used the AOFAS score to assess functional outcomes [24, 32, 38]. Improvements of 15 and 18 points between preoperative and postoperative scores were similar between the study by Meehan et al. [32] and our study, but were lower than the 36- and 45-point improvements reported by Hahn et al. [24] and Raikin [38]. Although some allograft studies evaluated patient satisfaction, they included subjective questions [18, 20, 24, 38].

We identified no studies that used a standardized assessment tool, such as the SF-12 Health Survey, to evaluate quality of life before and after osteochondral allograft transplantation in the ankle. Despite showing small increases in the physical and mental health components, a post hoc power analysis revealed that these findings were underpowered to detect any differences. However, the scores are comparable to SF-12 results in a previous study that used fresh osteochondral allograft transplantation for knee OCDs [30].

MRI was used to address previously reported limitations of radiography, including low sensitivity, an inability to quantify lesion extent, and inability to evaluate articular cartilage integrity [2, 31, 33, 36, 42]. The disparity in detection capabilities between radiography and MRI in the current series (Fig. 8) further supports these claims, as preoperative MRI showed more advanced stages of the disease process in several cases (Table 1). Prior studies have assessed graft stability solely on radiographs [18, 20, 24, 27, 32, 37, 38], but no standardized methods of assessing talar osteochondral allografts have been developed. The most commonly reported radiographic findings include generalizations regarding graft resorption, graft fragmentation, joint space narrowing, and degenerative changes [18, 20, 24, 27, 32, 37, 38]. We created a four-zone radiographic illustration to establish a uniform method of evaluating graft stability. Although a previous study assessed radiolucency, zonal analysis was not provided [27]. Previous studies evaluating other various treatment modalities of talar or knee OCDs have shown that MRI is sensitive in detecting focal graft collapse and assessing osseointegration [4, 7, 23, 34, 47], thus we recommend MRI at annual followups to confirm radiographic findings and to assess edema around the graft. In our series, two-year MRI revealed no incidence of graft subsidence, graft incorporation in seven of the eight patients, and edema around four of eight grafts. The clinical importance of radiolucencies, lack of incorporation, and presence of edema is unknown at this time and further studies are necessary to determine long-term implications. Prospective

Table 4. Comparison of clinical outcomes and quality of life scores

Study	Study design	OCD allograft procedure	Number of patients with unipolar OCDs	Mean followup (years)	Clinical outcome evaluation assessments	
					AOFAS Ankle-Hindfoot scale	Other clinical outcome assessments
Gross et al. [20]	Retrospective case series	Revision	9	12.0 (r, 4.0–20.0)	NA	Patient survey by Pell Ability to walk distances > 1 hour = 5 patients No pain symptoms = 5 patients Able to wear fashionable shoes = 3 patients No ADL limitations = 5 patients Employed full time = 6 patients
Tontz et al. [45]	Retrospective case series*	Primary	1	4.0 (r, 4.0–4.0)	NA	NA
Meehan et al. [32]	Retrospective cases series*	Primary	1	2.5 (r, 2.5–2.5)	85 (r, 85–85)	NA
Raikin [38]	Prospective case series	Revision	15	4.5 (r, 2.2–7.3)	83 (r, 54–97)	Visual analog pain scale = 3.3 (r, 1.0–8.0)
Gortz et al. [18]	Prospective case series	Revision	11 (12 OCDs)	3.2 (r, 2.0–8.9)	NA	Olerud-Molander ankle score = 71 (r, 15–100)
Hahn et al. [24]	Prospective case series	Revision (10 cases) Primary (2 cases) Secondary attributable to avascular necrosis (1 case)	13	4 (r, 1.7–6.5)	81 (r, 61–95)	Foot function index = 2.01
Janis et al. [27]	Retrospective case series	Primary	15	1.6 (r, 0.80–2.1)	NA	Foot and ankle outcome score Pain component score = 66.0 (r, 7.1–99.2) Other symptoms component score = 64.8 (r, 8.3–97.2) ADL component score = 71.2 (r, 10.3–94.1) Sport & recreation function component score = 50.7 (r, 0.0–80.0) Quality of life component score = 42.1 (r, 0.0–81.3)
Current study	Prospective case series	Revision	12	3.3 (r, 2.0–4.6)	79 (r, 69–87)	NA

* Study population includes multiple diagnoses, including posttraumatic arthritis, degenerative joint disease of the ankle, and tibial OCD lesions. For comparison purposes, only the data of the cases involving unipolar talar OCDs were used.

Fig. 8A–B The preoperative radiograph and MRI scan of a 44-year-old woman show the disparity between radiographic and MRI lesion classifications. (A) The radiograph shows a localized area of subchondral trabecular compression, corresponding to a Stage I OCD, as described by Berndt and Harty [6], whereas the (B) MR image of the same lesion reveals the presence of synovial fluid around a large, nondisplaced fragment, corresponding to a Stage III OCD, as described by Anderson et al. [2].

Table 5. Comparison of graft survival.

Study	Graft survival	Reason for revision of the OCD allograft
Gross et al. [20]	6 of 9	Fragmentation and resorption greater than 50%, with secondary osteoarthritic changes
Tontz et al. [45]	0 of 1	Collapse
Meehan et al. [32]	1 of 1	NA
Raikin [38]	13 of 15	Collapse, with arthritis development (two grafts)
Gortz et al. [18]	10 of 12	Fragmentation and collapse (one graft); Development of large subchondral cysts (one graft)
Hahn et al. [24]	13 of 13	NA
Janis et al. [27]	15 of 15	NA
Current study	12 of 13	Fragmentation and collapse

studies comparing the accuracy of radiography and MRI in the evaluation of fresh osteochondral allografts also are warranted.

Graft survival after fresh osteochondral transplantation has varied, with reported rates ranging from 0.0% to 100.0% (Table 5) [18, 20, 24, 27, 32, 38, 45]. Revision bipolar tibiotalar allografting was required at an undetermined followup interval in the only talar OCD case reported by Tontz et al. [45]. Three other studies that used allograft OCD transplantation as a primary procedure reported no incidences of graft failure at mean followups ranging from 1.6 to 4.0 years [24, 27, 32]. Graft survival in the current series occurred in 12 of 13 patients at a mean followup of 3.3 years. This survival incidence is comparable to those reported in three previous studies assessing allograft OCD transplantation as a revision procedure, in which six of nine, 10 of 12, and 13 of 15 grafts remained in situ at followup intervals ranging from 3.2 to 12 years (Tables 4 and 5) [18, 20, 38]. We

continue to follow our patients to determine long-term survival of these grafts.

Our observations corroborate those of previous studies showing that fresh osteochondral transplantation produces functional improvement in patients with large talar OCDs for whom previous treatment had failed [18, 20, 24, 27, 32, 38]. However, these studies lacked standardized quality of life assessments and involved limited radiographic evaluations [18, 20, 24, 27, 32, 38]. Despite increased postoperative SF-12 scores, our study was underpowered to claim statistically significant or clinically relevant improvements. We observed radiolucencies, lack of graft incorporation, and edema on postoperative radiographs and MRI. At a minimum followup of 2 years, graft survival occurred in 12 of 13 patients, but long-term survival of these allografts is unknown. Additional larger and longer-term studies are warranted to appropriately evaluate quality of life after fresh osteochondral allograft transplantation and to determine the implications of our radiographic and MRI findings.

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