Fresh Osteochondral Allograft for the Treatment of Cartilage Defects of the Talus: A Retrospective Review

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Background: Osteochondral lesions of the talar dome can cause substantial functional impairment and present a difficult treatment dilemma. Interest has recently focused on fresh osteochondral allografts as a promising treatment alternative. The purpose of this study was to evaluate the clinical outcome of osteochondral lesions of the talus treated with a fresh osteochondral allograft.

Methods: We performed a transfer of fresh osteochondral allograft in forty-two patients with a symptomatic, refractory osteochondral lesion of the talus. Complete postoperative follow-up was achieved for thirty-eight patients with an average age of 44.2 years. Clinical evaluation was performed with use of the American Orthopaedic Foot & Ankle Society ankle-hindfoot score and a visual analog pain scale. All scores were obtained from either a retrospective chart review or a direct patient interview. All patients were also asked about their subjective satisfaction with the procedure. Magnetic resonance images were acquired for fifteen patients, to assess graft incorporation, subsidence, articular cartilage congruity, osteo-arthritis, and stability with use of the De Smet criteria.

Results: The average duration of follow-up after osteochondral allograft transplantation was 37.7 months. Graft failure occurred in four patients. With the inclusion of scores before revision for those with graft failure, the mean visual analog pain scale score improved from 8.2 to 3.3 points, and the mean American Orthopaedic Foot & Ankle Society ankle-hindfoot score improved from 52 to 79 points. Patient satisfaction with the outcome was rated as excellent, very good, or good by twenty-eight of the thirty-eight patients and as fair or poor by ten patients. Of the fifteen magnetic resonance imaging scans, most showed minimal graft subsidence, reasonable graft stability, and persistent articular congruence.

Conclusions: In our experience, transplantation of fresh osteochondral allograft is a viable and effective method for the treatment of osteochondral lesions of the talus as evidenced by improvements in pain and function.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Osteochondral lesions of the talus were described as early as 1922, by Kappis[1]. These lesions can frequently lead to pain, functional limitations, and disability[2-4], and management of symptomatic lesions remains a challenge. Patients typically complain of ankle pain, intermittent swelling, weakness, stiffness, and ankle instability. Traditionally, the diagnosis of osteochondral lesions of the talus has been made by plain radiography and physical examination, which may reveal swelling, a decreased range of motion, point tenderness, and decreased strength on the affected side[5-9]. More recently, magnetic resonance imaging (MRI) and diagnostic arthroscopy have proven to be superior in delineating lesion size, location, depth, and stability. Several staging systems have been developed on the basis of the first system that Berndt and Harty proposed in 1959[10].

Surgical treatment of osteochondral lesions of the talus has evolved in recent years. The initial treatment for most lesions consists of debridement of loose cartilage fragments and drilling of the lesion bed. Satisfactory results from this technique

have been reported to be as high as 80% to 86%[11-14]. The advantages of this technique include its broad familiarity to most orthopaedic surgeons, its relatively lower level of technical difficulty, and its reported high level of clinical success. However, the repair tissue formed is fibrocartilage[15-17], and this modality may not prevent the progression of degenerative joint disease[18,19]. Therefore, other cartilage repair and restoration techniques have been developed with the goal of restoring the articular surface of the ankle joint. Treatments with allograft or autograft osteochondral transplants or with autologous chondrocyte implantation have gained popularity recently. However, the lack of generally agreed-on surgical guidelines and a paucity of quality comparative studies have led to continued controversy regarding the utility of these techniques. The proposed advantages of an osteochondral allograft are its enhanced ability to replicate the anatomy after debridement of a large osteochondral defect and the avoidance of donor site morbidity associated with the use of autologous tissue[20-22].

The purpose of this study was to evaluate the clinical outcome of a large series of patients who had undergone an osteochondral allograft transfer of the talus for the treatment of an osteochondral lesion.

Materials and Methods

The clinical database of one surgeon (A.S.K.) was retrospectively reviewed to identify patients who had received an osteochondral allograft. Initially, all patients with an osteochondral lesion of the talus underwent a trial of nonoperative treatment consisting of an initial period of immobilization in a cast or controlled ankle motion brace followed by protected weight-bearing, pain medication, physical therapy for range of motion and strengthening, and orthotic shoe-wear modification. Patients with pain refractory to conservative management, substantial subjective activity limitation, and a decreased quality of life who remained symptomatic despite nonoperative treatment were deemed candidates for operative treatment. The specific indications for allograft treatment included lesions that failed prior operative intervention such as debridement and/or microfracture, lesions of ≥200 mm² and deemed unsuitable for other operative options, or lesions with a depth of >5 mm. With use of these criteria between 2004 and 2009, forty-two patients were treated with osteochondral allograft transfer for an osteochondral lesion of the talus. Of this group, thirty-eight patients had complete charts, operative reports, preoperative and postoperative scores on the visual analog scale (VAS) for pain, preoperative and postoperative American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot scores, and adequate follow-up.

The primary surgeon administered the visual analog scale and the AOFAS ankle-hindfoot rating score, both preoperatively and postoperatively. The VAS is a 10-point scale, with 0 representing no pain and 10 the worst pain imaginable. The AOFAS ankle-hindfoot score has been used previously in the foot and ankle literature for outcome assessment[5,20,23,24]. In addition, all participating patients were asked by the primary author (H.E.) to rate their own outcome subjectively as excellent, very good, good, fair, or poor. A poor response indicated worsening or no change in symptoms following surgery, and an excellent response indicated a postoperative improvement in symptoms matching the patient's best expectations. The primary surgeon was excluded from this assessment. Failure was defined as conversion to arthrodesis or total ankle arthroplasty.

Statistical analysis was performed by an independent statistician with the use of a standard paired t test to assess changes in preoperative and postoperative VAS scores and AOFAS ankle-hindfoot scores. A p value of <0.05 was considered to be significant.

Surgical Technique

Preoperatively, the recipient and donor were matched on the basis of size with use of radiographs and direct measurements of the allograft at the tissue bank.

All allografts were obtained from healthy donors meeting the criteria of the American Association of Tissue Banks. These allografts were recovered within twenty-four hours after donor death, processed, and maintained fresh at 4°C until the time of surgery.

Surgery was performed on an outpatient basis with the patient under regional anesthesia. The ankle joint was injected anteromedially with 20 mL of saline solution; an anteromedial arthroscopic portal was established; a 2.7-mm, 30° arthroscope was introduced with pressure irrigation; and then an anterolateral portal was established.

The talar articular surface was inspected, and the damaged surface debrided. Subsequently, the osteochondral lesion of the talus was probed and assessed for stability and for its anteroposterior as well as mediolateral location on the talar dome. The location of the lesion relative to the anterior tibial plafond determined whether an anteromedial or an anterolateral approach was used. Lesions in the anterior third of the talus were reached by a standard anterior approach, plafondplasty (removal of 3 to 4 mm of the anterior tibial plafond), and use of the osteochondral grafting instrumentation with the ankle in full plantar flexion. For more posterior lesions, a medial or lateral malleolar osteotomy was used. Medially, the osteotomy was performed through a straight medial incision. The anterior joint capsule and superficial deltoid fibers were incised, and the posterior tibial tendon was visualized and protected. Two parallel 1.6-mm guidewires were then inserted retrograde: the first was placed in the anterior colliculus and the second, 1 cm posterior to the first, avoiding the posterior colliculus. Both guidewires were advanced, measured, and predrilled. A 1-mm supramalleolar guidewire was then introduced at a 45° angle aiming toward the axilla of the malleolus. Next, the osteotomy was initiated with a small microsagittal saw and was completed with a thin osteotome. Then the malleolus was retracted distally. For lateral malleolar osteotomy, the fibula was exposed and the osteotomy was started anteriorly and distally at the level of the tibial plafond and directed posteriorly and proximally. In some cases, to achieve adequate exposure, the anterior capsule and anterior inferior tibiofibular ligament were incised. In the majority of lesions, which were medial, a 5-mm Schanz pin was placed through the talar neck and used as a joystick to apply a strong valgus force to the hindfoot and deliver the talar dome. This was crucial to allow for perpendicular preparation and reaming of the lesion.

After the initial debridement and exposure, graft-sizing instruments were introduced. An anterior cruciate ligament reamer guide pin of appropriate graft size (10 to 20 mm) was placed over the center of the osteochondral lesion of the talus, perpendicular to the tangent of the articular surface at the location of the lesion. The osteochondral lesion of the talus was then reamed to a depth at which bleeding subchondral bone could be confirmed, typically 10 to 12 mm. Following the establishment of the recipient site, an osteochondral graft was obtained from the fresh cadaver talus. All patients had only one osteochondral graft harvested, and the grafts were harvested from a similar anatomic location on the donor talus to appropriately match the contour and surface anatomy of the recipient bed.

The osteochondral graft was then placed in the prepared recipient bone bed with use of a press-fit technique to ensure maximal stability and congruence of the donor and recipient surfaces and obviate the need for internal fixation of the graft. The joint was then axially loaded and put through a range of motion to further mold the graft. All medial malleolar osteotomies were internally fixed with 4-mm, partially threaded, cancellous lag screws. Lateral malleolar osteotomies were reduced and stabilized with a 3.5-mm cortical lag screw and were buttressed with a five or six-hole semitubular plate. A compression dressing and a three-sided posterior molded plantar splint were applied, and all patients were discharged home on the day of surgery.

Postoperative care included protection in a non-weight-bearing splint for two weeks, at which time the sutures were removed. A short leg non-weight-bearing cast was then applied for an additional two weeks. At four weeks, a removable short leg splint was used and physical therapy for range of motion was begun, but the patient remained non-weight-bearing for a total of eight weeks, at which time weight-bearing was advanced, usually to full weight-bearing by twelve weeks.

Image Analysis

Postoperative MRI scans were acquired for fifteen patients. All scans were acquired during a two-month period, which ranged from six to sixty-six months (mean, 28.2 months) after surgery. All MRI scans were performed at one institution with use of an enclosed 1.5-T magnet. In each case, 3 to 5-mm-thick sagittal, coronal, and axial slices were acquired without contrast. A single fellowship-trained, musculoskeletal radiologist reviewed all of the MRI scans for signs of osteoarthritis, articular surface congruity, incorporation of the osteochondral allograft, and graft subsidence and stability. The radiologist was blinded to all patient information.

Source of Funding

Results

There were thirty-eight patients, twenty-two men and sixteen women, with an average age of 44.2 years (range, nineteen to seventy-four years). The average lesion size was approximately 1.5 cm^2. A traumatic etiology based on clinical history was established in thirty-three of the thirty-eight patients. Of the thirty-eight lesions, two were on the central aspect of the talus, twenty-eight were on the medial aspect, and eight were on the lateral aspect. Thirteen patients underwent a plafondplasty, twenty underwent a medial malleolar osteotomy, and five underwent a lateral malleolar osteotomy.

The patients had a mean of one prior operation (range, zero to four operations), and twenty-four patients had at least one prior ankle operation. Four patients had two, four patients had three, and one patient had four prior operations. These included arthroscopy in thirty-three ankles, open reduction and fixation of an ankle fracture in three, osteochondral autografting of the osteochondral lesion of the talus in two, and open reduction and internal fixation of a talar fracture in one ankle.

The average follow-up after osteochondral allograft transplantation was 37.7 months (range, six to seventy-two months). No patient had an infection requiring a return to the operating room, delayed wound-healing, or deep vein thrombosis. Secondary arthroscopic surgery was performed on seven patients at an average of 12.8 months (range, six to seventeen months) postoperatively. Four of the seven patients had lateral impingement syndrome secondary to an excess amount of lateral synovial tissue. All four grafts were found to be intact on arthroscopic probing. However, one graft contained a 5 to 6-mm area of denuded cartilage. The remaining three patients were found to have a loose graft on arthroscopic probing, and one graft also showed evidence of further cartilage degeneration. All three patients went on to graft failure. Overall, the graft failed in four of the original forty-two patients who underwent osteochondral allograft transplantation. This resulted in two total ankle replacements, one ankle arthrodesis, and one bipolar total ankle allograft.

For the thirty-eight patients, the preoperative VAS score averaged 8.2 points (range, 6 to 10 points). Postoperatively, the scores improved to an average of 3.3 points (range, 0 to 8 points), representing a mean improvement of 4.9 points (p < 0.001).

The preoperative AOFAS ankle-hindfoot scores averaged 52.3 points (range, 31 to 84 points). These scores improved postoperatively to an average of 78.8 points (range, 41 to 96 points), a mean difference of 26.5 (p < 0.001). When component scores were reviewed, there was often minimal change in the range of motion, stability, or alignment subsections, while the greatest changes were seen in the pain, activity, and walking distance subsections of the score. Patient satisfaction with the outcome was rated as excellent by eight patients (21%), very good by ten (26%), good by ten (26%), fair by six (16%), and poor by four (11%). If given the choice again, two of the thirty-eight patients involved in the study would choose to not undergo the procedure because of persistent pain following the procedure. Patient results are summarized in Table I.

Postoperative MRI scans were acquired for fifteen patients at an average of thirty-three months after surgery. Osteoarthritis was graded as none, as mild if there was preservation of the joint space with some anterior spurring, as moderate if there was evidence of cartilage loss and joint space narrowing, or as severe if there was a high degree of osteophyte formation, joint space narrowing, and subchondral cyst formation. Three scans showed moderate osteoarthritis, while one showed advanced arthritis with joint space collapse. The De Smet MRI stability criteria[25] (see Appendix) were used to assess graft stability at the osteochondral allograft-host interface. The MRI scans were evaluated for a line of high signal intensity at the interface, a round area of high signal intensity at the interface, a line of high signal intensity traversing the interface, or a focal defect in the articular surface. With use of the De Smet criteria[25], ten scans showed no signs of graft instability, while five showed at least one sign of graft instability. Ten showed signs of good or fair graft

TABLE I Summary of Demographic Data and Results for the Thirty-eight Patients	
Mean age (range) *(yr)*	44.2 (19 to 74)
Sex (M/F)	22/16
Side (R/L)	22/16
Location*	28/8/2
Mean size of lesion (range) *(cm²)*	1.5 (0.8 to 2.16)
Mean no. of previous operations (range)	1 (0-4)
Mean improvement on VAS score (range)† *(points)*	4.9 (0-8)
Mean improvement on AOFAS score (range)† *(points)*	26.5 (0-53)
No. of additional operations (no. of patients)	12 (8)
Graft failures	4

*The values are given as medial/lateral/central aspect of the talus. †The difference was significant (p < 0.001). VAS = visual analog scale, and AOFAS = American Orthopaedic Foot & Ankle Society.

TABLE II Summary of MRI Findings in Fifteen Patients				
Case	Osteoarthritis	Stability According to De Smet Criteria	Incorporation of Graft	Subsidence of Graft	Articular Cartilage
1	Moderate	Unstable	Fair	None	Good congruity
2	None	Stable	Good	None	Slight irregularity with cartilage intact
3	None	Stable	Fair	None	Slight irregularity with moderate loss of cartilage
4	Moderate	Stable	Fair	None	Good congruity
5	Mild	Stable	Good	None	Good congruity
6	Moderate	Unstable	Poor	None	Good congruity
7	Mild	Stable	Fair	None	Slight irregularity with cartilage intact
8	None	Stable	Fair	None	Good congruity
9	Mild	Stable	Fair	None	Slight irregularity with cartilage intact
10	None	Stable	Fair	None	Good congruity
11	Mild	Unstable	Poor	None	Good congruity
12	None	Stable	Poor	None	Good congruity
13	Mild	Stable	Good	None	Good congruity
14	Mild	Unstable	Poor	None	Good congruity
15	Advanced	Unstable	Poor	Total graft failure	Total graft failure

incorporation, with ingrowth of bone marrow on the T1-weighted images. Fourteen MRI scans had no evidence of graft subsidence, while one demonstrated complete graft collapse. Finally, ten scans demonstrated good articular congruity and consistent intermediate signal intensity contiguous with the host articular surface, while four showed slight articular irregularity and one showed complete discontinuity. The MRI findings are summarized in Table II.

Discussion

For symptomatic osteochondral lesions that do not respond to conservative treatment, arthroscopic debridement and curettage is widely recognized as the gold standard treatment for smaller lesions. Satisfactory results with this technique have been reported to be as high as 80% to 86%[11-14]. Unfortunately, arthroscopic debridement and curettage results in fibrocartilaginous tissue filling the defect[15-17], and it has shown suboptimal results for larger lesions, cystic lesions, and lesions requiring revision[11,26,27]. This has led to the development of surgical techniques aimed at restoring the superior biomechanical properties of hyaline cartilage, including autologous chondrocyte implantation, osteochondral autograft transfer, and fresh allograft transplantation.

Autologous chondrocyte implantation may be a good option for larger lesions that lack cystic features in patients with suitable bone stock[4,28]. Successful results for this procedure have been reported to be as high as 90%[29]. Limitations, however, include cost and the requirement for two separate surgical procedures. The literature has also not demonstrated a substantial advantage of autologous chondrocyte implantation and microfracture.

Osteochondral autograft transfer was initially proposed largely because of the success of autograft transfer for similar lesions of the knee[30-32]. Multiple studies using osteochondral autograft transfer have described success in up to 90% of patients[29,33,34]. However, the procedure involves the morbidity associated with disturbing an otherwise normal knee to obtain the graft[35,36]. Also the size and shape of the graft is limited by the amount of cartilage that can reasonably be harvested from a healthy knee. In addition, there is scant evidence to support the assumption that cartilage from the knee can withstand the tremendous forces sustained by the talar dome. These concerns led to the use of osteochondral allografts as first reported by Gross et al.[37] in 2001. In that report, at eleven years of follow-up, six of the nine patients had graft survival, with the remaining three undergoing ankle arthrodesis to treat graft failure. The advantages of this technique are that the surgery is a single procedure involving only one site, and it supplies mature potentially viable talar cartilage to reconstruct the articular surface (Figs. 1-A and 1-B).

As with all transplanted biologic material, there are risks of the spread of infection and an immune host response. In this study, the grafts were first screened for infection in accordance with the American Association of Tissue Banks standards. Currently, the relevance of any immune response to the fresh osteochondral allograft is unknown. Finally, concern has also

Fig. 1-A

Fig. 1-B

A postoperative T1-weighted coronal MRI scan of an ankle (Fig. 1-A), demonstrating excellent articular congruity, and a T2-weighted sagittal scan (Fig. 1-B) with no evidence of graft instability.

been raised regarding chondrocyte viability in the frozen osteochondral allograft. However, studies have demonstrated that chondrocytes in fresh osteochondral allografts can remain viable following harvest for up to fourteen days[38].

In recent years, several studies with similarly small sample sizes of patients managed with either bulk or plug allograft techniques have been published[20,37,39-42]. The reported success rates, based on graft survival and patient satisfaction, for fresh allograft treatment of osteochondral lesions have ranged between 73% and 100%[20,41,42]. In those studies, the average lesion size ranged from 2.7 to 3.8 cm^2 compared with an average lesion size in our study of 1.5 cm^2.Thus, most lesions in our study were focal, contained, unipolar osteochondral lesions as opposed to the more extensive lesions often associated with advanced osteoarthritis and cystic osteochondral defects. The clinical results of this study apply more directly to osteochondral lesions early in their formation before more extensive involvement of the talar articular cartilage has developed.

We found a significant improvement in the VAS pain score with an average improvement of nearly 5 points. Only one patient reported an improvement of <2 points in the VAS pain score postoperatively. We also found a significant improvement in AOFAS ankle-hindfoot scores, with a mean postoperative score of 79 points. These results are consistent with those of other recent studies investigating the use of osteochon-

dral allografts for the treatment of osteochondral lesions of the talus[20,41,42].

In our study of thirty-eight patients, four allografts failed, creating an overall failure rate of 10.5%. We found that a previous, failed osteochondral allograft did not negatively affect our ability to perform a repeat allografting, an ankle arthrodesis, or a total ankle replacement. In the literature, graft failure has been associated with a previous operation and the presence of subchondral cysts and large lesions[18,43]. All four of our patients with graft failure had a prior operation consisting of arthroscopy with microfracture (three patients) and arthroscopy with microfracture followed by a failed osteochondral autograft transfer (one patient). One patient also had preoperative evidence of a kissing lesion on the distal tibial articular surface, which may have predisposed to failure. We concluded that caution is advisable in patients with either combined findings of multiple prior operations and large lesions of the talar dome or findings of possible injury to both sides of the articular surface.

In our study, postoperative MRI scans were acquired to assess the ankle for osteoarthritis, graft incorporation, and stability. There are numerous reports in the literature of postoperative evaluation of osteochondritis dissecans by MRI[25,44-48]. Of the fifteen patients studied, five had signs of graft instability on postoperative MRI scans.

Although several studies[20,41,42] have recently evaluated osteochondral allograft transplantation for the treatment of talar lesions, they had a limited sample size of fifteen patients or fewer. This is likely secondary to the relatively rare occurrence of this condition. Therefore, we believe a unique strength of our study is the comparatively large sample size of thirty-eight patients.

We recognize the limitations of this study—in particular, its retrospective design, lack of comparative controls, four patients lost to follow-up, and relatively short duration of follow-up—for drawing any conclusion regarding osteoarthritis. In addition, although the primary surgeon was excluded from conducting the subjective satisfaction survey, all clinical examinations were done by the primary surgeon, thus producing the possibility of bias. Also, we acknowledge that only a limited number of postoperative MRI scans were acquired, and we do not suggest that MRI findings be used as evidence to support the effectiveness of the technique. Ideally, we believe the next step in evaluating osteochondral allograft transplantation would be a prospective randomized controlled trial comparing this surgical technique with other similar surgical techniques designed to restore the articular cartilage of the talar dome.

In conclusion, on the basis of our experience, we believe fresh osteochondral allograft transplantation is a viable and effective method for treating osteochondral lesions of the talus.

Appendix

eA A table presenting the De Smet MRI graft stability criteria is available with the online version of this article as a data supplement at jbjs.org. ∎

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