Intermediate Outcomes of Fresh Talar Osteochondral Allografts for Treatment of Large Osteochondral Lesions of the Talus

Roger Haene, FRCS(Tr&Orth), Erion Qamirani, MD, PhD, Robert A. Story, MBChB, FRACS(Ortho), Ellie Pinsker, BA&Sc, PhD candidate, and Timothy R. Daniels, MD, FRCS(C)

Investigation performed at St. Michael’s Hospital, Toronto, Ontario, Canada

Background: Large osteochondral defects of the talus present a treatment challenge. Fresh osteochondral allograft transplantation can be used for large lesions without the donor-site morbidity associated with other procedures such as autologous chondrocyte implantation or osteochondral autograft transfer. The goal of this study was to prospectively evaluate the intermediate outcomes of fresh osteochondral allografting for osteochondral lesions of the talus with use of validated outcome measures.

Methods: Sixteen patients (seventeen ankles) received a fresh osteochondral allograft, and all sixteen were available for follow-up. Data were prospectively collected with use of the Ankle Osteoarthritis Scale (AOS), Short Form-36 (SF-36), and American Academy of Orthopaedic Surgeons (AAOS) Foot and Ankle Module outcome measures. Postoperative American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot scale scores were also collected. All sixteen patients underwent radiographic and computed tomographic (CT) analyses preoperatively, and fifteen patients had these studies postoperatively.

Results: The average duration of follow-up was 4.1 years. The latest follow-up CT evaluation identified failure of graft incorporation in two of sixteen ankles. Osteolysis, subchondral cysts, and degenerative changes were found in five, eight, and seven ankles, respectively. Five ankles were considered failures, and two required a reoperation because of ongoing symptoms. The AOS Disability and the AAOS Foot and Ankle Core Scale scores significantly improved, but there was no significant change in the AOS Pain, AAOS Foot and Ankle Shoe Comfort Scale, or SF-36 scores. Overall, ten patients had a good or excellent result; however, persistent symptoms remained in six of these patients. Only four were symptom-free.

Conclusion: The use of a fresh osteochondral allograft is a reasonable option for the treatment of large talar osteochondral lesions. The high reoperation rate (two of seventeen) and failure rate (five of seventeen) must be taken into consideration when one is choosing this procedure for the management of these lesions.

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

Osteochondral lesions of the talus are a common cause of ankle pain and disability, with symptoms consisting of deep ankle pain on weight-bearing, prolonged swelling, and a diminished range of motion. In up to 92% of cases, these lesions are preceded by a traumatic event such as an ankle sprain or fracture. Lesions of the talar weight-bearing surface are more common in the posteromedial aspect of the talus followed by the anterolateral zone; centrally located lesions are uncommon.

While there is a consensus regarding nonoperative management of an asymptomatic osteochondral lesion of the talus, there are controversies regarding treatment of symptomatic lesions, particularly large osteochondral lesions of the talus (>1.5 cm in diameter). Current surgical recommendations for smaller symptomatic osteochondral lesions of the talus include fragment fixation, fragment excision, and curettage/drilling of the subchondral bone. Surgical management of larger osteochondral lesions of the talus is more controversial and includes...

Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. One or more of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete Disclosures of Potential Conflicts of Interest submitted by authors are always provided with the online version of the article.
options such as bone-grafting, autologous chondrocyte implantation, and autograft or allograft osteochondral transplantation. Osteochondral autograft transfer and fresh osteochondral allograft implantation have the advantages of providing viable chondrocytes, intact hyaline cartilage biologically attached to the bone, and stability via bone-to-bone healing rather than relying on the fragility of fibrocartilage generation. Osteochondral autografts for the treatment of osteochondral lesions of the talus are obtained from the distal part of the ipsilateral femur. Consequently, the use of this technique is limited by donor-site morbidity and the amount of graft available. Fresh osteochondral allografts can be used for large defects, and donor-site morbidity can be avoided. Although the use of allografts to treat knee osteochondral defects has been established, few investigators have evaluated fresh osteochondral allograft transplantation for talar lesions. The goal of this study was to prospectively analyze the intermediate-term results of fresh allograft transplantation for talar lesions with use of validated patient-centered outcome measures and radiographic evaluations.

Materials and Methods

Patients undergoing fresh allograft transplantation for a talar lesion between January 2003 and January 2007 were recruited for the study. Approval from the Hospital Research Ethics Board was obtained to follow this patient group prospectively. All patients were contacted and asked to return for clinical and radiographic review at a later time to assess postoperative morbidity. A nonenhanced computed tomographic (CT) scan and standing anteroposterior and lateral radiographs of the foot and ankle were obtained. No patient was lost to follow-up. The following outcome measures were collected preoperatively and annually postoperatively: the Ankle Osteoarthritis Scale (AOS) score, the American Academy of Orthopaedic Surgeons (AAOS) Foot and Ankle Module score, and the Short Form-36 (SF-36) score. Postoperative American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot scale scores were also collected.

The AOS is a visual-analog-scale-based, disease-specific, patient-reported instrument that has been validated for evaluation of patients with osteoarthritis. It consists of two subscales: pain and disability, with higher scores representing more overall pain or difficulty. The AAOS developed a patient-reported outcome assessment tool for individuals with foot-and-ankle-related diagnoses. It consists of a Foot and Ankle Core Scale and a Shoe Comfort Scale. The Shoe Comfort Scale assesses the ability of the individual to comfortably wear different types of footwear while the Foot and Ankle Core Scale includes questions pertaining to pain, function, stiffness, swelling, and giving-way. The AOFAS hindfoot score is a clinician-based and region-specific instrument. With a 100-point scoring system, the maximum of 100 points reflects the best clinical state. The SF-36 is a patient-reported measure of general mental and physical health and a well-established quality-of-life outcome measure. It is well supported by evidence of reliability and validity as well as responsiveness for a wide range of musculoskeletal disorders, and it demonstrates the effect that a musculoskeletal condition has on a patient’s overall health. Several types of outcome measures were included in the study because no one measure captures all of the important domains. The AOFAS score was obtained postoperatively for comparison as it has been used in other published clinical studies of talar allografts.

Fresh talar allografts were obtained from an American Association of Tissue Banks-accredited local bone bank and were matched for size by using standardized markers on radiographs. Donors were tested for infectious diseases, but no blood typing or human leukocyte antigen (HLA) matching was performed. Tissues were obtained within twenty-four hours after donor death and stored at 2°C until implantation, which occurred within seven days for all patients.

Surgical Technique

All patients underwent general anesthesia and were placed in the supine position with a tourniquet around the thigh. Antibiotic prophylaxis was provided, and the leg was prepared and draped in a standard fashion. Depending on the location of the lesion, the surgical approach was made through a medial malleolar osteotomy, combined fibular and Chapat tubercle osteotomies, or an anterolateral arthroscopy only. A step-cut medial malleolar osteotomy was performed as previously described. For the lateral malleolar osteotomy, a ten-hole one-third semitubular plate with screws as well as a lag screw over the planned osteotomy site were placed on the fibula and then removed. An oblique fibular osteotomy was then performed proximal to the anterior tibiofibular ligament. Next, the anterolateral aspect of the tibia (Chapat tubercle) was predrilled, and an oblique osteotome was made to reflect this tubercle together with the distal part of the fibula in a posterolateral direction after release of the anterior talofibular and calcaneofibular ligaments. In order to improve visualization and surgical access, a femoral distractor was used in all cases by placing 5.0-mm Schanz pins in the calcaneus and the proximal part of the tibia. The joint was distracted and, after it was evaluated for arthritic changes other than the known lesion, a decision was made to proceed with the allograft.

The lesion was prepared until healthy, bleeding bone was exposed (as evaluated by temporarily deflating the tourniquet). The lesion was then removed en bloc by completing a minimal resection osteotomy to preserve as much of the native talus as possible. Subchondral cysts were curedtted and filled with fresh cancellous calcaneal or talor allograft. The size of the lesion was measured, and a graft of the same size and shape was obtained from the same anatomical region of the donor talus. The graft and the bed of the lesion were meticulously contoured so that an anatomic fit could be obtained. Graft fixation was achieved with either Herbert screws or bioabsorbable pins (OrthoSorb Resorbable Pins, 40 × 1.3 mm; DePuy Orthopaedics, a Johnson & Johnson company), or a combination of the two. Implant placement was confirmed with intraoperative fluoroscopy. The joint was then irrigated, and the medial malleolar osteotomy site was stabilized with two partially threaded 4.0-mm screws and, on occasion, a neutralization plate. If a lateral approach was used, the Chapat tubercle osteotomy site was stabilized with two partially threaded 4.0-mm screws while the fibula was stabilized with a lag screw and a one-third tubular plate and screws. The released anterior talofibular and calcaneofoibular ligaments were also repaired.

Postoperatively, the ankle was immobilized for ten to fourteen days and then placed in a removable walking boot to allow early range-of-motion exercises. Weight-bearing was started six to twelve weeks after surgery, depending on graft integration as demonstrated on follow-up radiographs. Patients were followed and radiographs were obtained at six weeks, twelve weeks, six months, and then annually.

Statistical Analysis

Tests of normality revealed that variables were normally distributed; consequently, the two-sided paired t test was used to compare the preoperative and postoperative scores for the AOS, AAOS, and SF-36 outcome measures. For all tests, a p value of <0.05 was considered significant. With seventeen patients, the study has 0.84 power to detect an effect size of 0.76 between matched pairs with a type-1 error probability of 0.05. With use of a standard deviation of 26, a difference in the mean preoperative and postoperative AOS scores of at least 20 could be detected with 0.84 power. This is based on AOS standards established in prior studies.

Source of Funding

No external funding from granting agencies or industry was utilized in this study.

Results

Seventeen ankles in sixteen patients (eight male and eight female) underwent fresh osteochondral allografting. The average follow-up period was 4.1 years (range, two to seven
years), and the mean age (and standard deviation) at the time of the operation was 35.8 ± 11.3 years (range, fifteen to fifty-three years). The mean patient height was 173 cm (range, 145 to 191 cm), the mean body mass was 195.8 lb (88.8 kg) (range, 140 to 230 lb [63.5 to 104.3 kg]), and the mean body mass index was 30 kg/m² (range, 21 to 35 kg/m²). Of these seventeen patients, the mean number of allografts per patient was 2.9 (range, one to five allografts).

Fig. 1-A Intraoperative photograph of a left ankle following a medial malleolar osteotomy. The talar defect has been excised, and the talar bed has been prepared for the allograft. Fig. 1-B The talar allograft has been placed into the defect and is ready to be stabilized with headless screws.

Fig. 2-A Anteroposterior radiograph of a talar allograft six months postoperatively. Fig. 2-B Anteroposterior radiograph of the same talar allograft three years postoperatively. Note that the allograft has undergone resorption. This patient was eventually treated with an ankle fusion.
ankles, sixteen had previously undergone single or multiple procedures including arthroscopic debridement (fourteen ankles), arthroscopy and bone-grafting of the lesion (four ankles), and osteochondral autograft transfer from the knee (one ankle). A medial malleolar osteotomy was performed in fourteen ankles; combined fibular and Chaput osteotomies, in two ankles; and an arthroscopy only, in one ankle. Preexisting degeneration was found elsewhere in two ankles. The osteochondral lesion was found posteromedially in eleven ankles, medially in three ankles, posterolaterally in two ankles, and anterolaterally in one ankle.

Preoperative CT scans demonstrated that all lesions were uncontained and involved either the medial or lateral talar gutter. All of the talar lesions had at least one dimension greater than 15 mm, except for the talar lesion treated previously with an osteochondral autograft from the knee, which had a diameter of between 10 and 15 mm. All talar lesions had a height ranging from 8 to 13 mm, with the exception of one 20-mm-high lesion. The mean allograft length was 21.9 mm (range, 10 to 38 mm), the mean width was 13.4 mm (range, 8 to 22 mm), the mean height was 10.7 mm (range, 8 to 20 mm), and the mean volume based on these parameters was 3408 mm³ (range, 1000 to 10,868 mm³). The means for the length and height approximated the median value, with a broad spread on either side of the mean. Supplementary bone graft was required in two ankles. Fourteen ankles required a Herbert screw to ensure graft stability, and three other ankles were stabilized with bioabsorbable pins (OrthoSorb Resorbable Pins, 40 × 1.3 mm).

All osteotomy sites healed, and there was one malunion of a medial malleolar osteotomy site with slight proximal migration that did not require additional treatment. A follow-up CT scan was performed at an average of 4.1 years (range, two to six years) on sixteen of the seventeen ankles. Failure of graft incorporation (Figs. 2-A and 2-B) was identified in two of these sixteen ankles, and the mean graft position relative to the native talus was 0.5 mm of subsidence (range, 6 mm of subsidence to 2 mm proud). On the latest radiographs and CT scans, osteolysis and subchondral cysts of >2 mm in diameter were found in five and eight of the grafts, respectively. Degenerative changes outside of the graft area consisting of subchondral cyst formation and joint space narrowing were found in seven of the ankles.

The average AOS Disability and AAOS Foot and Ankle Core Scale scores significantly improved from 53.4 preoperatively to 36.9 postoperatively (p = 0.03) and from 52.3 to 69.9 (p = 0.02), respectively. The AOS Pain and SF-36 Physical Component Summary (PCS) scores both showed some improvement; however, there were no significant changes. These scores improved from 45.3 to 36.5 (p = 0.14) and from 34.9 to 40.5 (p = 0.09), respectively. Similarly, there was no significant change in the AAOS Foot and Ankle Shoe Comfort Scale score, which decreased from 66.8 to 59.6 (p = 0.27), or the SF-36 Mental Component Summary (MCS) score, which decreased from 49.1 to 47.8 (p = 0.79). The AOFAS hindfoot scores, which were collected only postoperatively, averaged 79.3. On the basis of procedure success and residual symptoms, the patients were then stratified into the following four descriptive clinical groups (Fig. 3-A).

Failures: Five of the seventeen ankles were considered a failure. Specifically, two allografts failed to incorporate postoperatively, one patient withdrew from the study with ongoing symptoms (the outcome scores were obtained, but the patient did not return for a CT scan or radiographic review), and two ankles either had undergone or were awaiting arthrodesis as a salvage procedure.

Poor: Two of the seventeen ankles underwent an arthroscopic debridement to reduce ongoing symptoms.

Good: Six of the seventeen ankles had mild-to-moderate ongoing symptoms at the time of the latest follow-up.

Excellent: Four of the seventeen ankles were functioning well at the time of the latest follow-up (at a mean of 3.6 years).

Discussion

Despite modern diagnostic modalities and revised staging systems, the surgical management of large osteochondral lesions of the talus is controversial. No randomized clinical trials of the various treatment options have been performed, to our knowledge, and the success rate of operative management has been documented primarily on the basis of retrospective case series with limited outcome data. Treatment options for osteochondral lesions of the talus consist of nonoperative management, internal fixation of the fragment, fragment excision alone, excision with curettage, excision with curettage and drilling, cancellous bone-grafting, osteochondral autograft transfer, autologous chondrocyte implantation, and fresh allograft osteochondral transplantation.

The treatment of large lesions (>1.5 cm) remains a clinical challenge because of the poor intrinsic potential of cartilage for regeneration and the weak biomechanical properties of fibrocartilage created by procedures that stimulate the bed of the
defect. Surgical options that aim to restore hyaline cartilage in these large defects include autologous chondrocyte implantation, osteochondral autograft transfer, and fresh osteochondral allograft transplantation. Osteochondral autograft transfer and autologous chondrocyte implantation are associated with donor-site morbidity, and there is a limit to the size of the graft that can be harvested with osteochondral autograft transfer. The advantages of a fresh osteochondral allograft technique include a decrease in patient morbidity and the ability to resurface a large lesion with an anatomically similar graft. The disadvantages include possible disease transmission, immune reaction, and slower remodeling. The role of histocompatibility antigen, or HLA, matching is not clear, and HLA testing is not currently recommended or performed for osteochondral transplantation. Resolution has not been an obvious clinical problem in transplants involving the knee or ankle.

Cartilage viability is an important factor for successful clinical outcomes after transplantation of osteochondral allografts. It has been shown that cryopreservation of osteochondral allografts results in a substantial decline in chondrocyte viability, with only 20% to 30% chondrocyte survival. In addition, Williams et al. demonstrated that fresh human osteochondral allograft tissue stored for more than fourteen days undergoes substantial decreases in chondrocyte viability, viable cell density, and metabolic activity with preservation of glycosaminoglycan content and biomechanical properties. Current recommendations are that an osteochondral allograft should not undergo cryopreservation and should be transplanted within fourteen days after retrieval. In our clinical series, all allografts were stored at 2°C and used within the first seven days after retrieval.

Fresh osteochondral allograft transplantation is a well-established technique for the treatment of cartilage defects of the knee; however, only a handful of studies have evaluated this method for the management of talar lesions. Gross et al. evaluated nine patients with an osteochondral lesion of the talus who were treated with fresh osteochondral allograft transplantation. Six grafts remained in situ, with a mean duration of survival of eleven years; arthrodesis was required in the other three cases as a result of resorption and fragmentation of the graft. This study was limited by the lack of validated outcome scores. In a retrospective case series of eighteen patients who had undergone fresh allograft transplantation (stored for up to twenty-eight days), Hahn et al. evaluated thirteen patients who were available for follow-up. They reported a significant improvement in AOFAS hindfoot and Foot Function Index (FFI) scores at a mean of forty-eight months postoperatively, and all thirteen patients reported satisfactory results. However, it should be noted that five of these patients needed additional surgery. Görtz et al. used the Olerud-Molander Ankle Score to retrospectively evaluate twelve patients at a mean of thirty-eight months after they received a fresh allograft to treat an osteochondral lesion of the talus. They reported good-to-excellent results in five patients. In another retrospective study, Janis et al. used the Foot and Ankle Outcome Score (FAOS) to evaluate fifteen patients who had received a fresh allograft for an osteochondral lesion of the talus. At a mean of 1.6 years postoperatively, they reported a substantial improvement in the FAOS and no graft failures. Raikin prospectively followed fifteen patients with a large talar osteochondral lesion for an average of fifty-four months after fresh allograft transplantation. There were two failures requiring ankle arthrodesis, and five patients had an excellent outcome as determined by the nonvalidated AOFAS hindfoot score.

In general, these studies showed results similar to those in our study, but the primary differences between those studies and ours is their retrospective design and a lack of validated outcome measures. To illustrate the inefficiencies of using a nonvalidated outcome measure, we also collected postoperative AOFAS hindfoot scores in our series. The AOFAS score is the most commonly used hindfoot outcome score although it has not been validated. In our series, the AOFAS hindfoot score alone would have suggested that 71% of the ankles (twelve of seventeen) had a good-to-excellent outcome (scores of >70) while providing limited insight into their overall functional outcomes (i.e., pain, disability, footwear, comfort, and mental state) (Fig. 3-B).

In this current clinical series, it was possible to stratify the patients’ clinical status in greater detail on the basis of the quality of the prospective data (Fig. 3-A). Only four of the seventeen ankles were symptom-free (excellent), and five of the seventeen were considered failures; eight of the seventeen had ongoing symptoms, with two requiring arthroscopic debridement because of discomfort. Among the scores used in all of the studies to date, the AOS is the only validated one for ankle osteoarthritis and posttraumatic ankle arthritis, and this prospective clinical review did not demonstrate significant improvement in the AOS Pain scale score following surgery. Less appropriate scores used in previous studies would have characterized a great number of our patients as having a good-to-excellent result (Fig. 3-B), which, to a casual reader, would have suggested that fresh osteochondral allografting is a reliable procedure with a moderately high success rate. Our findings, by contrast, suggest a more cautious conclusion.

A limitation of this study was that it was not randomized in order to include other operative treatment strategies for large talar lesions. Also, the group of patients was too small for us to perform a comparative statistical analysis of patient, surgical, and CT parameters against the collected outcome scores and thus look for predictive factors. Nonetheless, this study demonstrated that fresh osteochondral allograft transplantation for a large osteochondral lesion of the talus can substantially improve the functional status of the patient as determined by validated outcome measures. However, the high rates of secondary arthroscopic debridement (two of seventeen ankles) and clinical failure (five of seventeen ankles) suggest that the current indications for this procedure should be carefully evaluated and the patient should be properly educated before it is considered as a surgical option.
References