Structural Allograft Transplantation for Osteochondral Lesions of the Talus

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Introduction

We describe the technique for structural fresh allograft transplantation to treat large talar shoulder lesions.

Osteochondral lesions of the talus are defects of the articular cartilage of the talus and the underlying subchondral bone¹⁻³. They are well recognized as a source of pain and disability and can pose a formidable treatment challenge to the orthopaedic surgeon due to the poor intrinsic ability of cartilage to heal as well as the tenuous vascular supply to the talus. Traditional treatments, such as bone marrow stimulation and osteochondral grafting, have been described as viable options for smaller lesions⁴⁻⁷. However, a subset of osteochondral lesions of the talus involves the talar shoulder. These are typically large lesions involving a substantial amount of the weight-bearing portion of the talar dome on either the medial or the lateral articular surface. Their size, two-dimensional articular cartilage geometry, three-dimensional osseous geometry, and loss of the medial or lateral articular buttress may preclude treatment with traditional techniques. For these large, sometimes cystic, talar shoulder lesions, we employ fresh structural allograft transplantation. In the past decade, structural allograft transplantation has become increasingly popular, with several authors reporting positive midterm results⁸⁻¹³.

The following are the critical steps of this procedure:

- Step 1: Patient selection and education
- Step 2: Preoperative planning and approval
- Step 3: Surgical approach and osteotomy
- Step 4: Prepare recipient site
- Step 5: Harvest graft from donor talus
- Step 6: Implant and secure graft into recipient site

- Step 7: Reduce osteotomy site and close
- Step 8: Postoperative care

Step 1: Patient Selection and Education

The patient and surgeon must be prepared for a waiting time of unknown length and have a flexible schedule for when the graft is ready for implantation.

- Our indications for this procedure include large osteochondral lesions involving the talar shoulder (Fig. 1) that cannot be adequately treated with other joint-sparing procedures or osteochondral lesions of the talus for which previous treatment, such as arthroscopic bone marrow stimulation, has been unsuccessful. We do not have a specific minimum lesion size requirement, and we employ this technique on both cystic and noncystic lesions.
- Prior to proceeding with transplantation of a fresh osteochondral allograft, both the patient and the surgeon must be prepared for a waiting time of unknown length and have a flexible schedule for when the graft is ready for implantation. In our series, the mean time from the clinic visit at which the decision was made to treat the patient with osteochondral allograft transplantation to the time of surgery was 104 days (range, forty to 174 days).
- The patient must also understand that there are negligible but real risks of disease transmission through the graft and host rejection of the graft. There is no guarantee that this procedure will provide pain relief, and ankle arthrodesis or arthroplasty could be needed in the future.

Step 2: Preoperative Planning and Approval

Inspect the graft for the correct approximate size, operative side, and quality of the cartilage surface prior to proceeding with surgery.

- When a patient is deemed a potential candidate for this procedure, obtain the appropriate radiographs. The methods for determining the appropriate size of the donor talus vary and depend on the specific tissue bank being used. They can be as simple as placing a U.S. quarter coin next to the talus when making either ipsilateral or contralateral ankle radiographs. Alternatively, some suppliers provide specific radiographic markers or require more sophisticated imaging techniques such as a computed tomography (CT) scan.
- We obtain allografts only from a nationally recognized supplier that complies with the procurement and processing guidelines of the U.S. Food and Drug Administration and is accredited by the American Association of Tissue Banks^{14,15}.
- Although this treatment modality is becoming more popular, not all third-party payers in the United States guarantee payment. We do not seek an allograft talus until the patient has secured authorization for insurance coverage. Often, this requires an open dialogue between the treating surgeon and the insurance company.
- Once donor tissue is identified, the graft is processed for approximately fourteen to twenty-one days, depending on the supplier. The surgeon is notified after the graft has passed the appropriate disease and infection screening steps. The surgeon notifies the patient, and every attempt must be made to proceed with surgery as soon as possible after the graft arrives at the surgical facility.
- The most important step in preoperative planning is to inspect the graft for the correct approximate size, operative side, and quality of the cartilage surface prior to proceeding with surgery. Depending on the timing of graft arrival, this step may be carried out as late as when the patient is in the preoperative holding area, but it should not be performed after the patient has arrived in the operating room.

Step 3: Surgical Approach and Osteotomy

Make sure that the proposed osteotomy site exits into the tibial plafond and not at the axilla as this allows for easier access to the lesion.

- With the patient supine, use a contralateral hip bump if performing a medial malleolar osteotomy or an ipsilateral hip bump or beanbag positioning device for a lateral malleolar osteotomy. A stack of sheets can be placed

under the leg to be operated on, to help surgical exposure of the medial malleolus (Fig. 2). Place an unsterile thigh tourniquet.

- As most of these lesions are located medially, we will only discuss the medial approach. Make a longitudinal curvilinear medial incision centered over the medial malleolus. Protect the saphenous vein and nerve. Through an anterior ankle arthrotomy, define the anterior margin of the medial malleolus and visualize the joint cartilage to ensure that there is not widespread articular cartilage damage (Fig. 3-A). Next, open the posterior tibial tendon sheath-flexor retinaculum. Leave a cuff of tissue on the tibia for later closure. Insert a Hohmann retractor between the tibia and the posterior tibial tendon for protection.
- Predrill the medial malleolus for two small-fragment screws. Next, place a Kirschner wire obliquely (roughly perpendicular to the predrilled holes) through the medial malleolus to define the trajectory of the planned osteotomy (Fig. 3-B). Place the wire proximal to the intended osteotomy site to serve as a guide, but out of the way of the saw. It is important that the proposed osteotomy site exit into the tibial plafond and not at the axilla as this allows for easier access to the lesion. Confirm the Kirschner wire position with intraoperative fluoroscopy.
- Score the tibial periosteum perpendicular to the sagittal longitudinal axis of the tibia (Fig. 3-B). Periosteal stripping is not necessary. Use a microsagittal saw and irrigate with cool saline solution to make the osteotomy. Confirm the correct trajectory, using intraoperative fluoroscopy, shortly after initiating the cut (Fig. 3-C). Continue the osteotomy to the subchondral bone, and then complete the osteotomy with a chisel. Make liberal use of fluoroscopy to ensure that the talar articular cartilage is not damaged.
- Release the inferior aspect of the posterior tibial tendon sheath and reflect the medial malleolus distally. A skin-hook retractor works well in this situation. A Kirschner wire distractor can help to visualize the joint. Carefully inspect the joint again for widespread articular cartilage damage (Fig. 3-D).

Step 4: Prepare Recipient Site

Measure the dimensions of the talar defect and its location from anterior to posterior along the talar shoulder at least twice.

- Carefully define the extent of the osteochondral lesion. Excise the diseased portion of the talus using reciprocating (Fig. 4-A) and microsagittal (Fig. 4-B) saws and cool saline solution irrigation. Typically, the microsagittal saw is used to make the cuts in the sagittal and axial planes and the reciprocating saw is used for the coronal plane cuts. Debride any cystic lesions with a curet. Uneven edges can be smoothed with a rasp.
- Measure the dimensions of the talar defect (Fig. 4-C) and its location from anterior to posterior along the talar shoulder. Measure at least twice to obtain accurate measurements. Using a sterile marking pen, record the dimensions on a towel or preferably on a sterile piece of paper or cardboard. Ask a co-surgeon or surgical assistant to check the measurements.

Step 5: Harvest Graft from Donor Talus

Err on the side of creating too large a graft that later can be trimmed instead of a graft that is initially too small.

- Carefully clamp the allograft talus with bone-holding forceps. Alternatively, an allograft holding device can be used (Fig. 5-A). Next, locate the same position of the lesion on the allograft talus and mark the dimensions of the lesion on the allograft (Fig. 5-B), using calipers and a ruler. Measure twice before cutting to ensure accurate measurements. Be sure to err on the side of creating too large a graft that later can be trimmed instead of a graft that is initially too small. Also, make sure to account for the kerf of the saw blade. An assistant should hold the clamped talus in an orientation that is most comfortable for the surgeon making the cuts.
- Extract the graft from the allograft talus (Fig. 5-C) and wash it with copious amounts of sterile saline solution to reduce the immunogenic load.

Step 6: Implant and Secure Graft into Recipient Site

Secure the graft with one or two 1.5 or 2.0-mm-diameter solid screws.

- The graft will almost certainly need to be tailored to fit into the recipient talus. Because the recipient talus is more stable, we find it is easier to remove cancellous bone from the talus rather than the graft. This can often be achieved with a small burr (Fig. 6-A), rasp, or

the reciprocating saw. It is unlikely that a perfect match will be obtained for the four cancellous bone surfaces. However, make every attempt to match the graft's articular surface to the native talus without any step-off. It is important to realize that a good clinical match might not have as good a radiographic appearance, as it is unlikely that the thicknesses of the donor and recipient cartilage will be the same. This can lead to a graft-host mismatch of the dome and shoulder of the talus as seen fluoroscopically.

- The graft should have some interference fit (Fig. 6-B). We routinely secure the graft with one or two 1.5 or 2.0-mm-diameter solid screws. Place the screws in lag fashion and countersink the heads below the articular surface. Typically, we place either one screw from dorsal to plantar and a second from medial to lateral (assuming a medial osteochondral lesion of the talus) or two dorsal-to-plantar screws (Fig. 6-C). Confirm screw placement using fluoroscopy. The screw heads may seem prominent under fluoroscopic visualization, as the talar surface is a dome and the articular cartilage is thicker than the low-profile screw head.

Step 7: Reduce Osteotomy Site and Close

Ensure that there is no intra-articular step-off.

- Copiously irrigate the joint. Reduce the medial malleolus. Confirm the reduction through the anterior arthrotomy and posteriorly under the posterior tibial tendon. Place two screws in the predrilled holes. A three or four-holed antiglide plate can also be placed. Confirm the reduction using fluoroscopy. Ensure that there is no intra-articular step-off. There will be a slight gap at the osteotomy site due to the thickness of the saw blade.
- Close the deep structures—i.e., the posterior tibial tendon sheath, the flexor retinaculum, and the anterior arthrotomy. Perform a subcutaneous and tensionless skin closure.
- Apply a well-padded, posterior plaster-of-Paris slab and a sugar-tong splint with the ankle in the neutral position.

Step 8: Postoperative Care

After transitioning to a boot-brace, the patient should remove it to perform ankle range-of-motion exercises four to five times per day.

Observe the patient overnight for pain control. The patient should remain non-weight-bearing in the splint for ten to fourteen days. Then, he or she can be transitioned into a removable boot-brace or short-leg cast. Depending on the stability of the osteotomy site, the patient should remain non-weight-bearing or touch-down weight-bearing for ten to twelve weeks. During the time the boot-brace is worn, the patient should remove it to perform ankle range-of-motion exercises four to five times per day. Radiographs are routinely made at six weeks, three months, six months, and yearly after surgery (Fig. 7).

Results

In our series, there were eight patients with a mean age of thirty-one years (range, seventeen to forty-four years)⁸. There were three male and five female patients followed for a mean of forty-eight months (range, twenty-five to ninety-one months). Pain (as measured on a 10-point scale) decreased significantly, from a mean of 6 points (range, 5 to 8 points) preoperatively to a mean of 1 point (range, 0 to 2 points) at the time of final follow-up. Likewise, there was a significant improvement in the Lower Extremity Functional Scale score¹⁶ at the time of final follow-up.

The mean postoperative American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot score was 84 points (range, 71 to 91 points), and the mean Short Musculoskeletal Function Assessment scores were similar to reported normative scores for the overall “uninjured” population¹⁷.

Final follow-up radiographs demonstrated no lucencies, graft subsidence, joint space narrowing, or degenerative changes in three of the eight patients. Four patients with a medial graft had partial radiolucency along the lateral graft border at the interface of the allograft and host bone (Fig. 7). These patients were functioning well with nearly total resolution of preoperative symptoms, and no further treatment was needed. One patient had persistent pain and a “clicking” sensation and had radiolucency surrounding the entire graft. A CT scan suggested possible nonunion of the allograft and prominent screws. Ankle arthroscopy revealed partial delamination of the graft at the graft-host interface, prominent screws, and scar tissue along the medial gutter. One dorsal screw was removed, and the stable graft was left in place. This patient underwent a second arthroscopic debridement of the medial gutter approximately four years after graft placement. There was fraying of the cartilage edges of the graft but no progression of the delamination. This patient consistently had the worst outcome measure scores. At the time of writing, the patient did not wish to have any further treatment.

Three other patients required additional surgery. One underwent removal of painful medial malleolar implants from a united medial malleolar osteotomy site. Another underwent revision open reduction and internal fixation of an ununited medial malleolar osteotomy site. The third patient, who had a medial allograft, had varus malalignment of the ankle and underwent supramalleolar and calcaneal osteotomies to protect the graft.

What to Watch For

Indications

- Our indications for this procedure include large osteochondral lesions involving the talar shoulder that are not treatable with other joint-sparing procedures or osteochondral lesions of the talus that were previously treated unsuccessfully with other techniques, such as bone marrow stimulation. We do not have a specific minimum lesion size requirement, and we employ this technique for both cystic and noncystic lesions.

Contraindications

- Widespread cartilage degeneration. This technique should be reserved for isolated osteochondral lesions. Widespread joint disease is better treated with total ankle allograft transplantation, total ankle replacement, or ankle arthrodesis.

Pitfalls & Challenges

- Inappropriate patient selection. This procedure requires a patient who can tolerate the physical and mental stress of a surgical waiting period of unknown duration. Additionally, the patient must have a flexible schedule to proceed with surgery on short notice. If the patient is not amenable to this approach, time and money can be wasted.
- Failure to inspect the graft before surgery. It is the surgeon's responsibility to inspect the graft for the correct side and quality of cartilage. In the past, we received a graft with cartilage that was not acceptable for implantation.
- Cutting too small a graft. It is necessary to repeatedly measure the size of the lesion and the graft dimensions. It is easy to correct a graft that is too large. However, a graft that is too small is more difficult to successfully stabilize. Recovery options include “bone shims” or taking a second graft from an additional area on the graft talus that will closely match the recipient site.

- Inadequate fixation of the medial malleolar osteotomy site. A medial malleolar nonunion can be devastating to the patient's recovery. If the small-fragment screws do not achieve adequate purchase, or if the patient is large, consider adding an antiglide plate to achieve secure fixation of the malleolar osteotomy site.

Clinical Comments

One criticism of block allograft techniques, such as this one, compared with other cartilage resurfacing

techniques, such as transplantation of particulated juvenile cartilage allograft¹⁸, is that a medial or lateral malleolar osteotomy is needed. In our series⁸, one patient had a painful medial malleolar nonunion and one had painful medial malleolar implants; both required additional surgery. This leads to the following questions: What additional measures are being used to prevent nonunion of medial malleolar osteotomies? Are anatomic medial malleolar plates being used?

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References

1. Berndt AL, Harty M. Transchondral fractures (osteochondritis dissecans) of the talus. *J Bone Joint Surg Am.* 1959;41:988-1020.
2. Giannini S, Vannini F. Operative treatment of osteochondral lesions of the talar dome: current concepts review. *Foot Ankle Int.* 2004;25:168-75.
3. Pappas AM. Osteochondritis dissecans. *Clin Orthop Relat Res.* 1981;158:59-69.
4. Al-Shaikh RA, Chou LB, Mann JA, Dreeben SM, Prieskom D. Autologous osteochondral grafting for talar cartilage defects. *Foot Ankle Int.* 2002;23:381-9.
5. Hangody L, Füles P. Autologous osteochondral mosaicplasty for the treatment of full-thickness defects of weight-bearing joints: ten years of experimental and clinical experience. *J Bone Joint Surg Am.* 2003;85-A Suppl:25-32.
6. Chuckpaiwong B, Berkson EM, Theodore GH. Microfracture for osteochondral lesions of the ankle: outcome analysis and outcome predictors of 105 cases. *Arthroscopy.* 2008;24:106-12. Epub 2007 Nov 19.
7. Choi WJ, Park KK, Kim BS, Lee JW. Osteochondral lesion of the talus: is there a critical defect size for poor outcome? *Am J Sports Med.* 2009;37:1974-80. Epub 2009 Aug 4.
8. Adams SB Jr, Viens NA, Easley ME, Stinnett SS, Nunley JA 2nd. Midterm results of osteochondral lesions of the talar shoulder treated with fresh osteochondral allograft transplantation. *J Bone Joint Surg Am.* 2011;93:648-54.
9. Görtz S, De Young AJ, Bugbee WD. Fresh osteochondral allografting for osteochondral lesions of the talus. *Foot Ankle Int.* 2010;31:283-90.
10. Gross AE, Agnidis Z, Hutchison CR. Osteochondral defects of the talus treated with fresh osteochondral allograft transplantation. *Foot Ankle Int.* 2001;22:385-91.
11. Hahn DB, Aanstoos ME, Wilkins RM. Osteochondral lesions of the talus treated with fresh talar allografts. *Foot Ankle Int.* 2010;31:277-82.
12. Meehan R, McFarlin S, Bugbee W, Brage M. Fresh ankle osteochondral allograft transplantation for tibiotalar joint arthritis. *Foot Ankle Int.* 2005;26:793-802.
13. Raikin SM. Fresh osteochondral allografts for large-volume cystic osteochondral defects of the talus. *J Bone Joint Surg Am.* 2009;91:2818-26.
14. Jacobs NJ. Establishing a surgical bone bank. In: Fawcett K, Barr AR, editors. *Tissue banking.* Arlington, VA: American Association of Blood Banks; 1987. p 67-96.

15. Vangsness CT Jr, Garcia IA, Mills CR, Kainer MA, Roberts MR, Moore TM. Allograft transplantation in the knee: tissue regulation, procurement, processing, and sterilization. *Am J Sports Med.* 2003;31:474-81.
16. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. *Phys Ther.* 1999;79:371-83.
17. Barei DP, Agel J, Swiontkowski MF. Current utilization, interpretation, and recommendations: the musculoskeletal function assessments (MFA/SMFA). *J Orthop Trauma.* 2007;21:738-42.
18. Adams SB Jr, Yao JQ, Schon LC. Particulated juvenile articular cartilage allograft transplantation for osteochondral lesions of the talus. *Tech Foot Ankle Surg.* 2011;10:92-8.

Figures

Fig. 1

Mortise radiograph of the ankle demonstrating a large medial talar dome cystic lesion without evidence of widespread degenerative changes (**Fig. 1-A**). Coronal (**Fig. 1-B**), sagittal (**Fig. 1-C**), and axial (**Fig. 1-D**) CT images demonstrating the extent of the lesion.

Fig. 2

Typical patient positioning. There is a contralateral hip bump and an ipsilateral stack of sheets to assist in the surgical exposure of the medial malleolus.

Fig. 3-A

Medial incision with an anterior ankle arthrotomy used to inspect the cartilage.

Fig. 3-B

The posterior tibial tendon sheath has been incised longitudinally at the level of the proposed osteotomy. The posterior tibial tendon is protected behind the Hohmann retractor. A Kirschner wire is placed obliquely through the medial malleolus to define the trajectory of the osteotomy, but it is just proximal to the osteotomy. The periosteum is scored at the proposed osteotomy site, and an oscillating saw is used to make the osteotomy.

Fig. 3-C

Intraoperative fluoroscopy demonstrating the Kirschner wire and the initial cut of the saw blade to confirm the correct trajectory for the osteotomy cut.

Fig. 3-D

An intraoperative photograph of a different patient with a lateral osteochondral lesion of the talus. A fibular osteotomy has been performed, and a Kirschner wire distractor has been placed. The osteochondral lesion of the talus (arrows) can be seen in the foreground of the joint. Additional cartilage damage can be seen along the anterior aspect of the talus. In this case, the allograft transplant was performed for the lateral osteochondral lesion of the talus and the area of anterior cartilage damage was treated with microfracture.

Fig. 4-A

A reciprocating saw is used to make the coronal plane cuts.

Fig. 4-B

A microsagittal saw is used to make the axial and sagittal plane cuts.

Fig. 4-C

Calipers are used to measure the dimensions of the defect.

Fig. 5-A

An allograft has been pinned into an allograft-holding device. Calipers are being used to mark the dimensions of the lesion on the graft.

Fig. 5-B

This photograph shows the written measurements being transposed to the allograft talus.

Fig. 5-C

The reciprocating and oscillating saws are used to remove the graft from the allograft talus.

Fig. 6-A

A burr is used to remove any prominent areas of cancellous bone that might prevent an interference fit of the graft.

Fig. 6-B

The graft is placed into the defect.

Fig. 6-C

Two small-fragment screws are used to secure the graft.

Fig. 7

A six-week postoperative radiograph depicting the graft and medial malleolar osteotomy.

Fig. 1

Fig. 2

Fig. 3-A

Fig. 3-B

Fig. 3-C

Fig. 3-D

Fig. 4-A

Fig. 4-B

Fig. 4-C

Fig. 5-A

Fig. 5-B

Fig. 5-C

Fig. 6-A

Fig. 6-B

Fig. 6-C

Fig. 7