CHAPTER **34**

CALCANEAL AUTOGRAFTS: INDICATIONS, TECHNIQUE, AND COMPLICATIONS

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INTRODUCTION

When it comes to using bone grafts, everyone knows that autografts are superior to other types of bone and bone substitutes. In foot and ankle surgery, autografts are not always necessary. Bone voids are often filled with allogenic cortical or cancellous bone, demineralized bone matrix, or other commonly-accepted substitutes. In certain patients, bone healing may be a concern and autograft is preferred to augment healing. This includes patients with co-morbidities such as diabetes mellitus, smoking, and increased age.

Autografts can be harvested from many sites in the body including the anterior and posterior iliac crest, proximal tibia, distal tibia, and the calcaneus. The iIliac crest is a great source for large cortical, corticocancellous, and cancellous bone. As podiatric surgeons, it is out of our scope of practice to obtain this type of graft. This means coordinating the surgery with an orthopedic surgeon who can harvest the graft. Patients also tend to have a great deal of pain in this donor site, which can affect their mobility during the postoperative period. Therefore, the iliac crest should be reserved for cases where the quantity of bone will not be sufficient from other sources.

The proximal tibia is another option for autogenous bone, either from the tibial tuberosity (cancellous bone) or the proximal anterior medial tibia (cortical, cortico-cancellous). Harvesting this bone may be performed by the podiatric surgeon in certain geographic areas or may require an orthopedic surgeon. Patient must be non-weight bearing for at least six weeks following harvesting graft from this site. The distal tibia is a great place to obtain cancellous bone or a cortical strut. This site has no effect on weight bearing, but there is limited quantity of bone that can be harvested. The fibula is another good place to harvest autogenous bone. The middle third of the fibula can be safely used. Some people advocate leaving the medial cortex intact for regeneration, while others leave only the periosteum intact. This is a great source of cortical bone, but the dissection in this area is difficult due to the peroneal muscles and the common peroneal nerve.

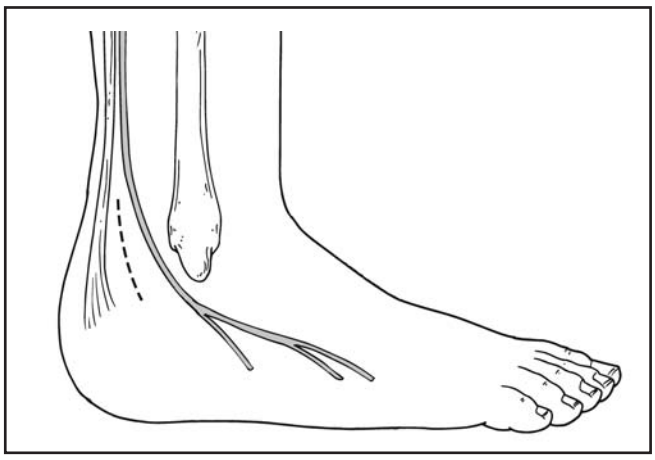


Figure 1. Course of the sural nerve relative to incision placement.

The calcaneus is a great source of autogenous bone and is the focus of this paper. Cortical, cancellous or a combination of both can be easily obtained. The technique can be easily learned and performed by the podiatric surgeon. There is a good quantity of bone that can be harvested from this site to use in many applications of foot and ankle surgery. Although this requires a period of non-weight bearing for at least six weeks, healing is very predictable.

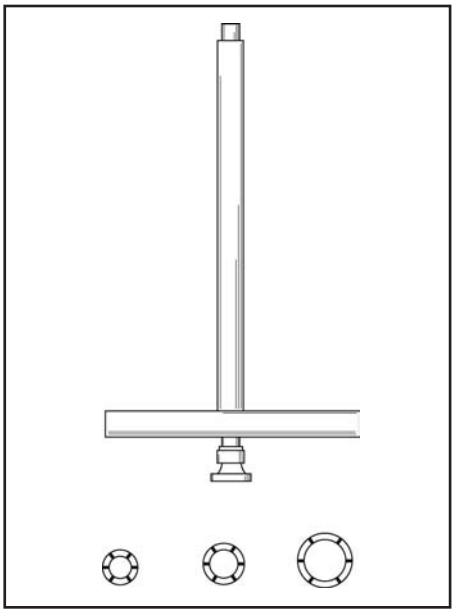
ANATOMY

Whether you are harvesting a trephine graft from the central body of the calcaneus or taking a cortical graft from the posterior superior aspect of the calcaneus, care should be taken to avoid the sural nerve. The sural nerve lies in the subcutaneous tissue approximately 1 cm posterior to the fibula. Incisions should lie posterior to this structure so it can be safely retracted anteriorly (Figure 1). Blunt dissection should still be used through the subcutaneous tissue to avoid damage to the nerve or its branches. Knowing where the Achilles tendon, plantar calcaneus, anterior process of the calcaneus and the distal fibula are will help to visualize the area to aim for in harvesting the graft (Figure 2).

TREPHINE GRAFT

Trephine grafts from the calcaneus are a great source of autogenous cancellous bone. These are commonly used to facilitate fusion sites elsewhere in the foot and ankle.

Figure 2. Identifying the Achilles tendon, anterior beak of the calcaneus, the plantar calcaneus and the distal fibula can help with incision planning.



Figures 3 A and B. Trephine and "teeth" patterns of various trephine sizes.

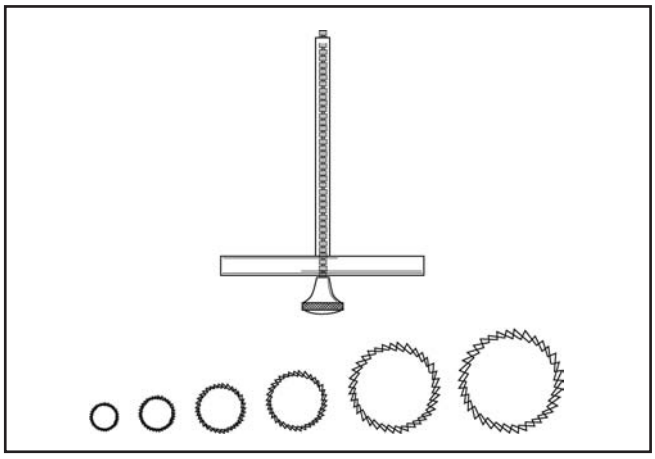


Figure 3 C and D. PI Plug cutter and the "teeth" patterns of the various sizes.

Figure 4. A small vertical or oblique incision is used for trephine grafting.

Although termed "trephine" graft, Podiatry Institute plug cutters are a better tool to harvest grafts with. They have more teeth and are finer than the corresponding trephine, which makes them less aggressive to the calcaneus (Figure 3). Various quantities of bone can obtained from this technique depending on the diameter of the plug cutter. This bone can also be combined with demineralized bone matrix (DBM), allogenic cancellous bone chips, bone putty, and other non-autogenous sources of bone to increase the quantity.

A small oblique or vertical incision is made over the lateral wall of the calcaneus, posterior to the sural nerve and peroneal tendons (Figure 4). Fluoroscopy is used to properly identify the proper positioning on the lateral wall of the calcaneus to assure the graft will be taken far enough posterior from the posterior facet of the subtalar joint and anterior to the insertion of the Achilles tendon on the posterior tuber. Care is taken to assure the instrument is perpendicular to the lateral wall of the calcaneus. A Kirschner wire (K-wire) may be used as a guide for the plug cutter if necessary. The plug cutter is placed against the lateral wall of the calcaneus and penetrates through the cortex manually. The plug cutter may be advanced to the medial wall, but should not penetrate the medial wall, thereby protecting the neurovascular structures. It is also not recommended to use power trephines as these are associated with a high rate of thermal necrosis.

The bone is then loosened from the surrounding bone

Figure 5. A vertical or oblique incision is used to access the lateral superior wall of the calcaneus for corticocancellous graft harvesting.

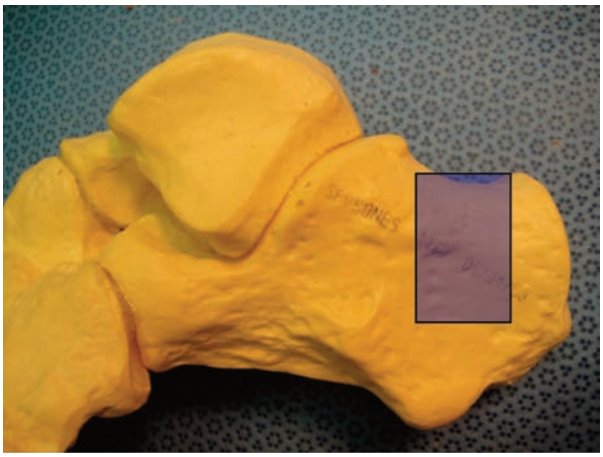


Figure 6. The area that a corticocancellous graft can be harvested from. (Please note that this entire area is too large for one graft. It is meant only to show a "safe zone").

with the plug cutter so it remains in the instrument upon removal. A common mistake is pulling the plug cutter out before the bone is free, resulting in an empty instrument. A clockwise and counter-clockwise circumduction motion of the hand in an exaggerated fashion will help to facilitate removal of the bone. The bone is then ready for use in the recipient site. The donor site in the calcaneus does not necessarily need to be back filled with allogenic bone product, but this is usually left to the discretion of the surgeon.

CORTICOCANCELLOUS GRAFT

The calcaneus is a great site for corticocancellous autograft used in other foot and ankle recipient sites. Common uses are repair of nonunions, brachymetatarsia, and fusion sites where length is necessary. A linear or curvilinear incision is made over the superior lateral aspect of the calcaneus (Figure 5), taking care to avoid the sural nerve and peroneal tendons. The area of bone between the posterior tuber and the posterior facet of the subtalar joint allows for a significant amount of donor bone (Figure 6).

Blunt dissection is performed from the subcutaneous tissue down to the level of the periosteum of the calcaneus. The periosteum is reflected from the donor site. This will decrease the chance of soft tissue invagination at the recipient site and ensure increased bone to bone contact.

The borders of the graft are then identified on the calcaneus. I recommend when first doing this procedure, that you use K-wire guides. Several 0.062" K-wires are placed at the anterior-inferior and posterior-inferior borders of the graft as guides for cutting the graft (Figure 7). These guides can then be checked under fluoroscopy to assure proper placement. The wire should be perpendicular to the lateral wall of the calcaneus in both the frontal and sagittal planes. Care should be taken to make sure the wires are not convergent or divergent as this will affect the shape of the graft.

A sagittal saw is then used to cut the anterior, posterior, and inferior borders of the graft, respectively. A line can be drawn on the saw to ensure the proper depth is obtained. For example, if the graft should be 1 cm in height, then this length is marked on the saw blade (Figure 8). This will also help to protect the medial cortex and the neurovascular structures on the medial side of the calcaneus. The dorsal cortex is the final cut made, and is the finesse of the procedure. This should be performed with hand instrumentation, specifically a 10 mm curved osteotome. The osteotome point is placed on the dorsal-superior-medial side of the graft, usually 1 cm or so from the lateral border. Once the cortex is penetrated the hand is raised until it is almost parallel to the long axis of the leg. Otherwise the graft may be "skived" and your end result is a cortical shell with little to no cancellous bone.

If the graft does not come out easily, use a straight 10 mm osteotome to pry the anterior, posterior and inferior borders by hand. Once the graft is removed it can be fashioned into the exact shape and size needed for the recipient site (Figure 9). It is the surgeon's choice whether or not to back fill the donor site with allogenic graft. Cancellous chips or other materials may be placed in this area. A radiolucent area is usually seen in the calcaneal donor site for a few months, but then should show complete ossification of the area (Figure 10).

It is recommended that the recipient graft site be prepared first so you know the exact amount of bone needed from the calcaneus. The length of bone can be obtained from anterior to posterior or from superior to inferior, depending on the specific amount of bone needed and the

Figure 7. K-wires are used as axis guides for the upcoming saw cuts on the anterior and posterior inferior borders.

Figure 8. A line is marked on the saw blade to measure proper depth from lateral to medial.

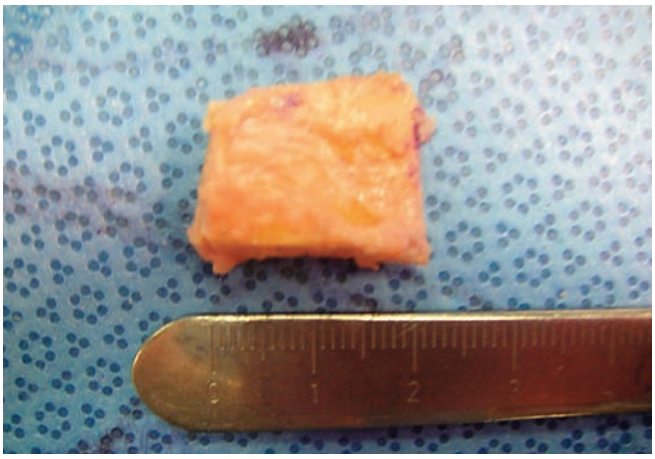


Figure 9. Graft removed.

Figure 10. S/P 3 months from harvesting corticancellous bone.

shape of the calcaneus. Most grafts can be easily up to 2 cm in length. If more is needed, it is recommended considering another site for donor bone, such as the iliac crest. Taking too much bone from the calcaneus increases the chance of stress risers and subsequent fracture through the graft site. It is very important that an appropriate period of non-weight bearing be followed to allow time for the bone to heal. Six to eight weeks is generally sufficient when larger cortical or trephine grafts are harvested. Smaller trephine grafts do well with shorter periods of offloading.

CASE PRESENTATIONS

Case 1

A first metatarsophalangeal joint is shown after failed attempts at a shortening osteotomy and subsequent hemi-implant for hallux limitus (Figure 11A.). A salvage first metatarsophalangeal arthrodesis with interpositional calcaneal graft to prevent excessive shortening is shown (Figure 11B).

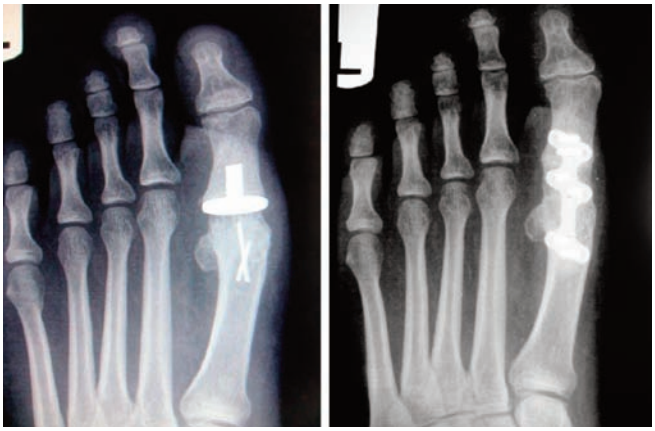


Figure 11 A and B. Pre and postoperative radiographs from 1st MTPJ arthrodesis with interpositional bone grafting.

Case 2

A nonunion of a Lapidus arthrodesis is shown (Figure 12A). The fusion site was revised, and again, calcaneal graft was utilized to prevent excessive shortening (Figures 12B, 12C).

Figure 12 A. Non-union Lapidus.

Figure 12 B and C. S/P Nonunion revision with interpositional bone graft.

Complications (Case 3)

Although rare, complications can occur with harvesting calcaneal grafts. These include hematoma, infection, sural nerve (and its branches) entrapment, fracture of the calcaneus, and lytic lesion formation in the calcaneus. This patient presented to my office with severe heel pain. Radiographs showed absence of healing in the previous trephine site that was performed 3 years prior by another surgeon (Figure 13).

The graft was used for a talonavicular fusion. Radiographs had a slight abnormal appearance surrounding the trephine site. A magnetic resonance image revealed an intraosseous lipoma encompassing the majority of the posterior aspect of the calcaneus with corresponding pathologic fracture (Figure 14).

The patient showed no improvement after six weeks of non-weight bearing, at which time she was taken to surgery for evacuation of the lipoma and packing of calcaneus with allogenic cancellous chips (Figure 15). She is now ambulating pain-free.

In conclusion, autografts are superior to allografts and should be used whenever possible, especially when dealing with patients with co-morbidities or revisional surgery. Harvesting of calcaneal autografts is a relatively simple procedure that can be used in many applications in foot and ankle surgery.

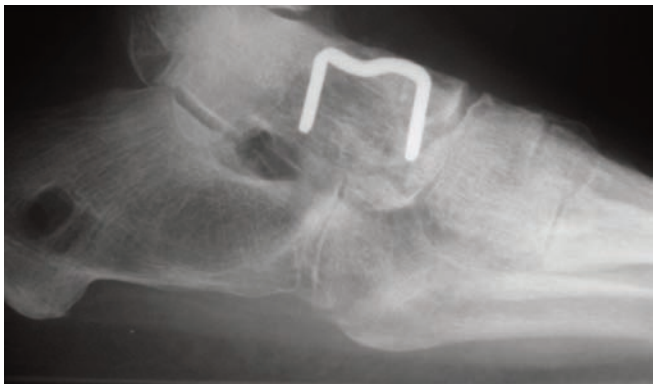


Figure 13. Lateral radiograph showing previous trephine site with large radiolucent area in the calcaneus.

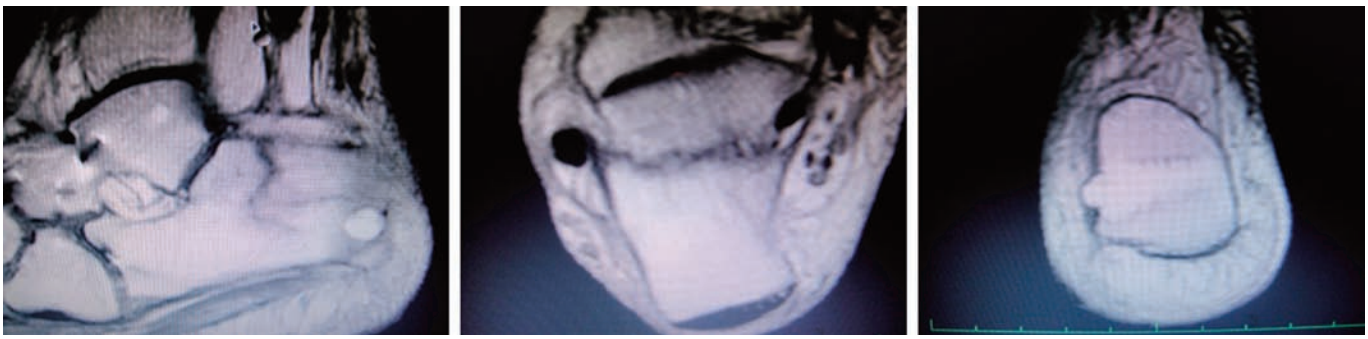


Figure 14 A, B, C. MRI showing lobulated intraosseous lipoma, previous trephine site and pathologic fracture through the superior aspect of calcaneus.

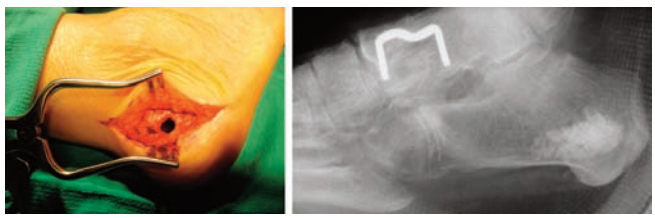


Figure 15 A and B. Intra-operative and postoperative pictures .