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Technique for Talectomy and Total Talus Replacement

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Introduction

Talar body collapse and associated osteoarthritis results in pain and functional impairment. Historic treatments for severe talar collapse have included talectomy, arthrodesis, and amputation.[3] Talar prostheses were introduced as a reconstructive option to preserve native anatomic relationships and hindfoot motion. Early models replaced only the talar body with or without a connection to the head and neck but were associated with talar head collapse.[1,6]

The first reported total talus replacement (TTR) was composed of alumina ceramic.[7] Current materials include cobalt chrome, stainless steel, and titanium.[4,8] Modern implants are typically patient-specific 3D-printed designs based on computed tomography of the patient's contralateral talus.[4] TTR is fast becoming a versatile surgical option, with studies demonstrating overall good short- and midterm outcomes with expanding indications.[2,3,8]

Although seemingly straightforward, talectomy and TTR have surgical nuances and require a thoughtful approach. Avoiding iatrogenic injury to adjacent articular cartilage when performing talectomy is important for successful outcomes. Furthermore, protection of tendinous structures and neurovascular bundle is critical. After talectomy, appropriate distraction techniques in conjunction with thoughtful instrument design facilitate TTR implantation. We present our preferred surgical technique for talectomy and implantation of a custom talus for isolated TTR that articulates with the native tibial plafond.

Preoperative Evaluation

The most common indication for TTR is talar collapse due to avascular necrosis. Avascular necrosis may result from traumatic extrusion, talar neck/body fracture, medication use, substance abuse, or can be idiopathic.[2-4] The anterior approach is commonly used. Poor soft tissues anteriorly should be considered a relative contraindication unless an alternate approach is used. Additionally, the absence of normal malleolar anatomy is a relative contraindication to TTR. Active infection is an absolute contraindication.

Preoperative evaluation should include anteroposterior, lateral, and mortise radiographs of the affected side. Relatively healthy cartilage on the tibial plafond, calcaneal facets, and at the navicular articulation is important for successful TTR. In addition to plain radiographs demonstrating normal joint spaces, we obtain computed tomography scans as well as magnetic resonance imaging to ensure the above.

Computed tomography of the contralateral ankle is obtained to determine implant geometry. Implants are generally produced in 3 sizes: 90%, 95%, and 100% volume. Although design and manufacturing of TTR to mate with commercially available total ankle tibial components is beyond the scope of this work, several considerations are important. First, the TTR must be both size matched and appropriately contoured to articulate with the polyethylene insert. Second, materials should be considered. Although different materials are being used for TTR including titanium alloys and ceramics, cobalt chrome is usually the metal of choice for talar components in most total ankle replacement systems. As such, the same material should be

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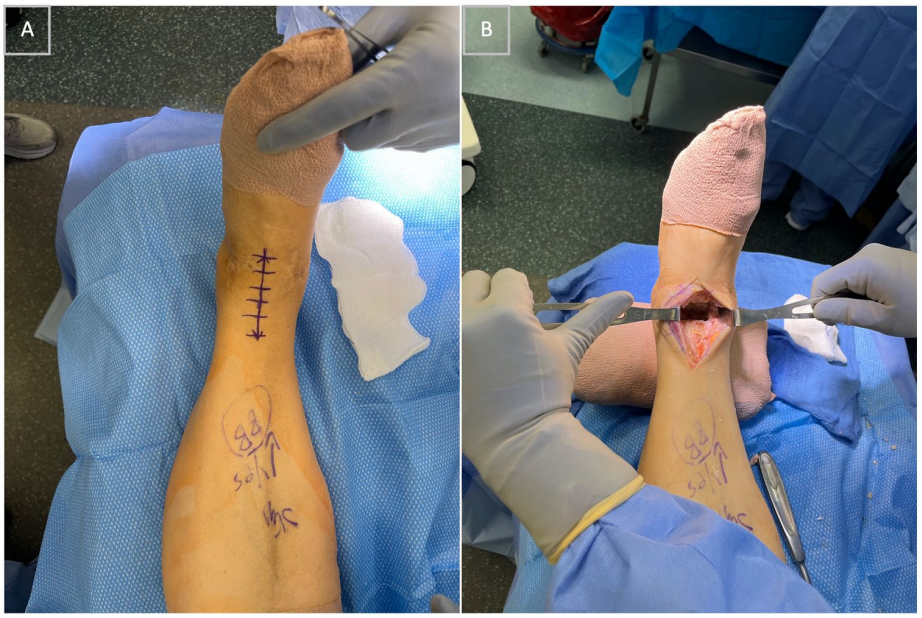

Figure 1. (A) Marked incision for anterior approach for talectomy and total talus replacement. (B) Exposure of tibiotalar joint after anterior approach. The tibialis anterior (TA) is retracted medially whereas the deep neurovascular bundle is retracted laterally with the extensor hallucis longus (EHL) and extensor digitorum longus (EDL).

used when manufacturing a TTR that is to be matched to polyethylene.

Surgical Technique

Positioning and Exposure

The patient is positioned supine. A tourniquet is used for hemostasis. General anesthesia with full muscular paralysis is recommended to facilitate ankle distraction. A standard anterior approach is employed (Figure 1, A and B). The deep neurovascular bundle should be protected. Dissection is carried out through the capsule in line with the incision to expose the talus. The ankle and talonavicular capsular tissues are preserved to allow for coverage over the implant. All ligamentous attachments should be sharply dissected off the talus to avoid destabilization of the ankle by over-releasing the deltoid and lateral ligament complexes at their tibial and fibular insertions.

Although the above is our preferred technique, other approaches can be employed depending on previous scarring and/or other soft tissue considerations. For example, anteromedial or anterolateral approaches can be used. However, talectomy and TTR placement is more challenging from these approaches. Similarly, a transfibular approach can be considered, although this requires fibular osteotomy with subsequent repair.

Talectomy

The talus is most easily removed segmentally. The approach to morcellation may depend on the anatomy of the specific talus; however, we have found a particular sequence to be efficient in most cases (see supplemental video). First, the neck is osteotomized in the coronal plane (Figure 2A) with a saw and completed with an osteotome. Completion with an osteotome is advisable to protect the articular surfaces of the anterior calcaneal facet. This neck osteotomy allows placement of a clamp or corkscrew distally into the cancellous bone of the head/neck for removal of the talar head (aided by distraction). Next, the talar body is osteotomized in the axial plane to remove the talar dome (Figure 2B). The remaining talar body is easier to access and is sectioned into quadrants created by 2 lines: a longitudinal line dividing it into medial and lateral halves, and a transverse line dividing it into superior and inferior halves (Figure 2C). Sectioning should be done with care to avoid iatrogenic injury to the cartilage of the tibial plafond, malleoli, and calcaneus. Additionally, tendinous structures should be protected. The superior quadrants/fragments are easiest to remove, followed by the inferolateral fragment. The inferomedial fragment is the most difficult to remove because of strong posterior insertions of the deep deltoid and capsule. A curved osteotome or elevator may be used to bluntly release attachments. After removal of all 4 quadrants, a pituitary rongeur can be used to

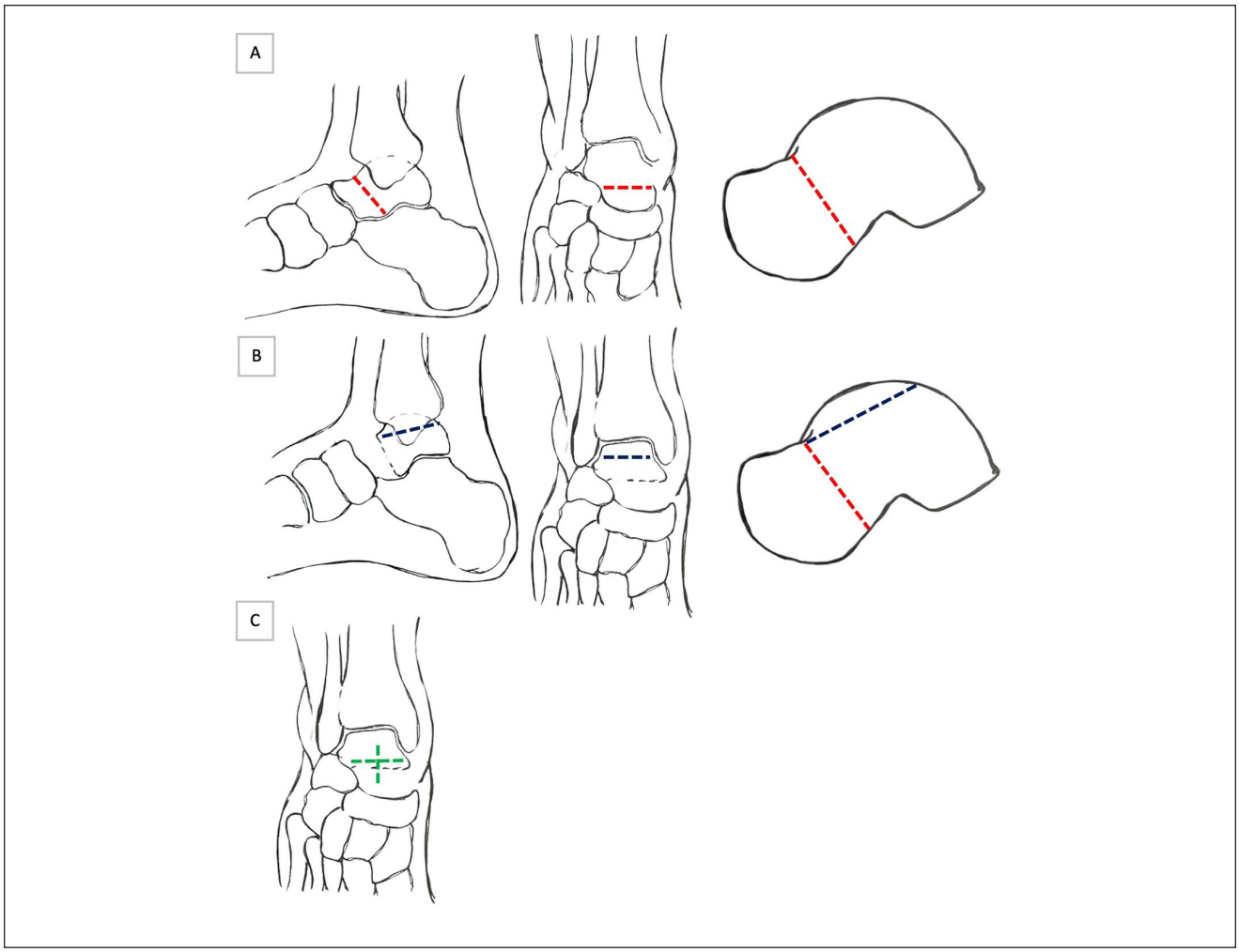

Figure 2. Osteotomies for talectomy. (A) Coronal plane osteotomy through the talar neck for removal of the talar head. (B) Axial plane osteotomy through the talar body for removal of the talar dome. (C) Coronal view illustrating sectioning of the remaining talar body into quadrants.

remove any remaining posterior bone fragments. Care must be taken to protect the posteromedial neurovascular bundle.

Once all talar fragments are removed, the surgical field is irrigated. We recommend deflation of the tourniquet at this point to ensure hemostasis.

Trialing and Implant Insertion

It is our preference to insert the 95% volume trial first as this allows for quick assessment of whether up- or downsizing is required. Insertion is facilitated by applying a plantarflexion moment with axial distraction to the ankle over the posterior bump, which acts like a fulcrum. We have a femoral distractor (DePuy-Synthes, Raynham, MA) available if more forceful distraction is required. Alternatively, a transcalcaneal Schanz pin can be used. Once the trial is inserted, the ankle is taken through its range of motion and stability is assessed in both the sagittal and coronal planes. Once an appropriate size is determined, the ankle is irrigated, and the final implant is inserted (see supplemental video). Range of motion and implant position are again assessed radiographically (Figure 3). If required, a tendo-Achilles lengthening or gastrocnemius recession should be performed at this time.

The talar trials are typically made of a nylon composite, which has a different coefficient of friction compared with the true implant. Therefore, although volumetrically identical, the final implant can often feel slightly looser than the corresponding trial. If this is the case, we recommend upsizing and trialing again to see if a larger implant is preferred. The trials are designed with a handle oriented parallel to the talar dome; an oblique orientation makes trial insertion difficult (Figure 4). Assessment of range of motion is enabled if the trial has a removable handle.

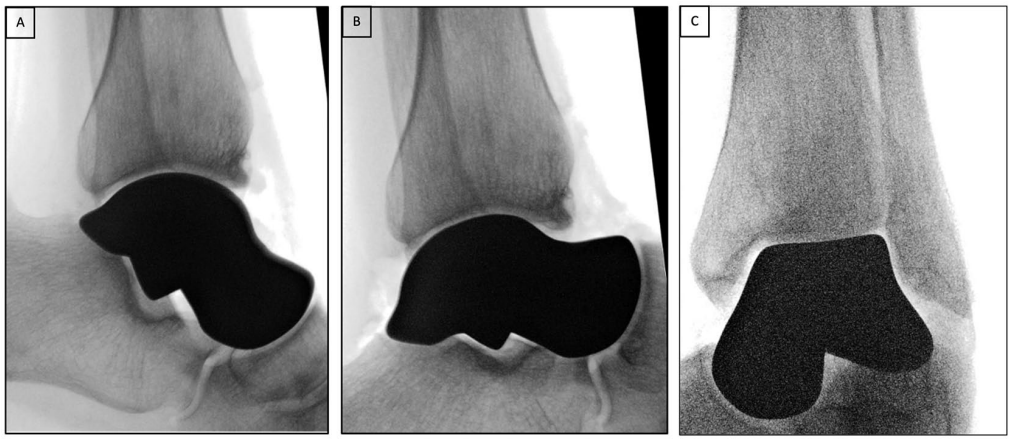

Figure 3. Range of motion of the final implant is tested under fluoroscopy after insertion and removal of the removable handle. (A) Plantarflexion. (B) Dorsiflexion. (C) Mortise view. Note: Osteophytes that cause impingement on the implant should be removed; far lateral osteophytes not impacting range of motion may be left in place (as seen in panels A and B).

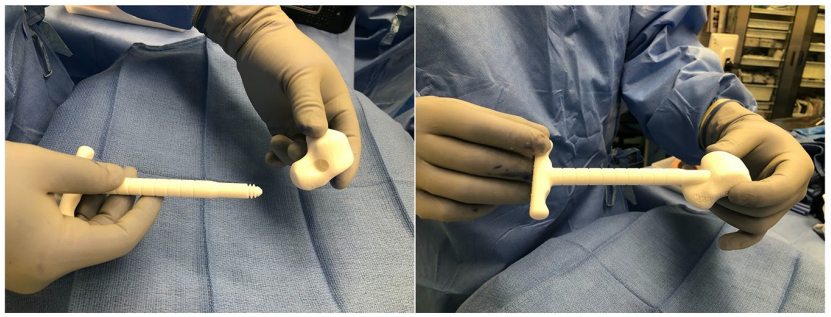

Figure 4. Total talus nylon composite trial in situ, designed with handle oriented parallel to talar dome to allow for ease of insertion.

Additionally, we recommend slots for a secure handle be incorporated into the design of the final implants (Figure 5). Inserting the implant without a handle is not only difficult but introduces the risk of dropping the implant. These slots also allow for effective implant removal if needed to up- or downsize to optimize final fit. In cases where a handle has not been designed, an emesis basin under the leg may be placed to catch the implant if dropped during insertion.

Layered closure is recommended, making sure to reapproximate the joint capsule and the extensor retinaculum independently.

Postoperative Management

The extremity is splinted for the first 2 weeks. Progressive weightbearing may start at 2 weeks, with full weightbearing allowed at 4-6 weeks. Patients may return to normal activities at 3 months.

The most common reported complication of TTR is development of adjacent joint osteoarthritis.[5] Other reported complications include fixed hindfoot varus, superficial peroneal neuroma, persistent deformity, infection, and delayed wound healing.[2-4]

Conclusion

TTR is a versatile surgical option, and our preferred technique allows for efficient talectomy and TTR placement. The senior author has treated 18 patients with TTR. Patients had a mean age of 46 years (range: 17-70). Patients included 10 women and 8 men, with a predominance of right-sided pathology (12). Fourteen patients underwent TTR for talar avascular necrosis and 3 patients for talar neck nonunion. One patient underwent TTR for an open extruded talus that was not salvaged at the time of injury. Three patients sustained postoperative complications. One patient sustained a

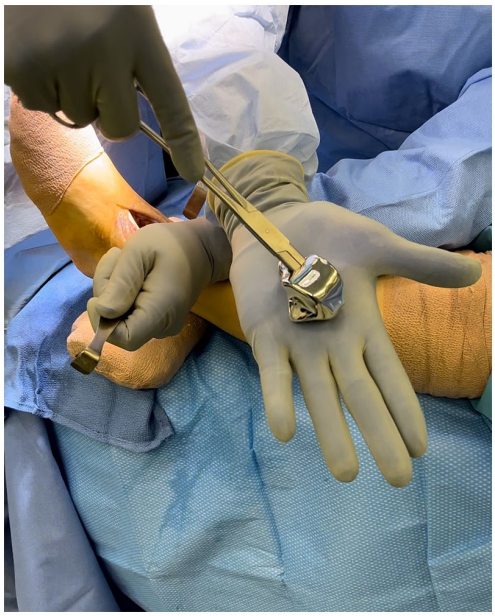

Figure 5. Final implant being inserted with the aid of a removable secure instrument. A slot for the grasping instrument is incorporated into the design of the implant for ease of insertion and to reduce risk of dropping the implant. Furthermore, removal of the actual implant if needed is facilitated by use of a grasping instrument.

postoperative infection requiring implant removal and antibiotic-eluting cement spacer placement. One patient developed impingement and required additional bony debridement. Finally, 1 patient developed significant stiffness and required a percutaneous tendo-Achilles lengthening.

Ethical Approval

Ethical approval was not sought for the present study.

Declaration of Conflicting Interests

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Supplemental Material

Video 1.
A supplemental demonstrating steps of the procedure. The video has three parts. First, a cadaveric model is used to demonstrate the described technique for talectomy, in which the talus is removed in piecemeal using 4 sequential osteotomies. Second, an intraoperative video clip demonstrates the technique for insertion of the final total talus implant. Slots for a secure handle have been incorporated into the design of the prosthesis. Third, an intraoperative video clip shows a technique for removing the final total talus implant if necessary for resizing. If no slot for a secure handle is available in the implant, a Verbrugge clamp can be used to grasp and remove the implant.

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