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Exploring the Possibilities of the Custom Total Ankle Total Talus Replacement (TATTR): Short-Form Technique for Adjunctive Lateral Ligamentous Reconstruction With TATTR

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Introduction

Generally favorable short- and mid-term outcomes have been reported for the use of the custom 3-dimensionally (3D)-printed total talus replacement (TTR) in the appropriately selected candidate.[3] In cases of talar avascular necrosis (AVN) in the setting of concomitant tibiotalar joint arthritis, the tibial component of a total ankle has been added above the total talus implant, and this construct is referred to as a total ankle total talus replacement (TATTR).[1,2] Generally, this procedure involves a surgical approach to the ankle and talus, total talectomy, distal tibia resection and preparation, and placement of TTR implant with the addition of the tibial component of the total ankle and a polyethylene liner. Although this procedure is in its infancy and few reports outline its efficacy, especially in the long term, TATTR may represent the only motion-preserving option available for some patients.

Achieving ligamentous stability after total ankle replacement (TAR) is a critical factor to ensure long-term durability and success after this procedure.[5,8] Lateral ligamentous reconstruction has been described with favorable outcomes in conjunction with TAR.[6] Given the similarities between the TATTR and the TAR, one must assume that ligamentous stability must be achieved in both situations to ensure the most optimal outcome. Further contributing to ligamentous instability after TTR, during any procedure involving removal of the native talus bone (ie, TTR and TATTR), the talar attachment to the anterior talofibular ligament (ATFL) is released from the native talus, along with the anterior (deep) and posterior (superficial and deep) tibiotalar components of the deltoid ligament and underlying talocalcaneal ligaments. Thus, achieving ligamentous stability after TATTR may represent an additional challenge when compared to TAR. Although there is a paucity of TATTR literature, early and mid-term results of TTR have indicated component subsidence and posterolateral ankle discomfort as potential complications seen after this procedure.[3] Although further research is needed to evaluate whether ligamentous repair techniques in TATTR may reduce complication risk, restoration of native ligamentous stability may represent a promising avenue to improve outcomes after these procedures.[4,7]

To address the concern for ligamentous instability after TATTR, we present a technique for concomitant modified Brostrom procedure with custom TATTR through a set of curved tunnels at the lateral talus to pass suture needles at the talar insertion of the native ATFL ligament. This procedure is a modification of the technique presented by Regauer et al[4] in a fresh-frozen cadaver specimen using 4 eyelets on

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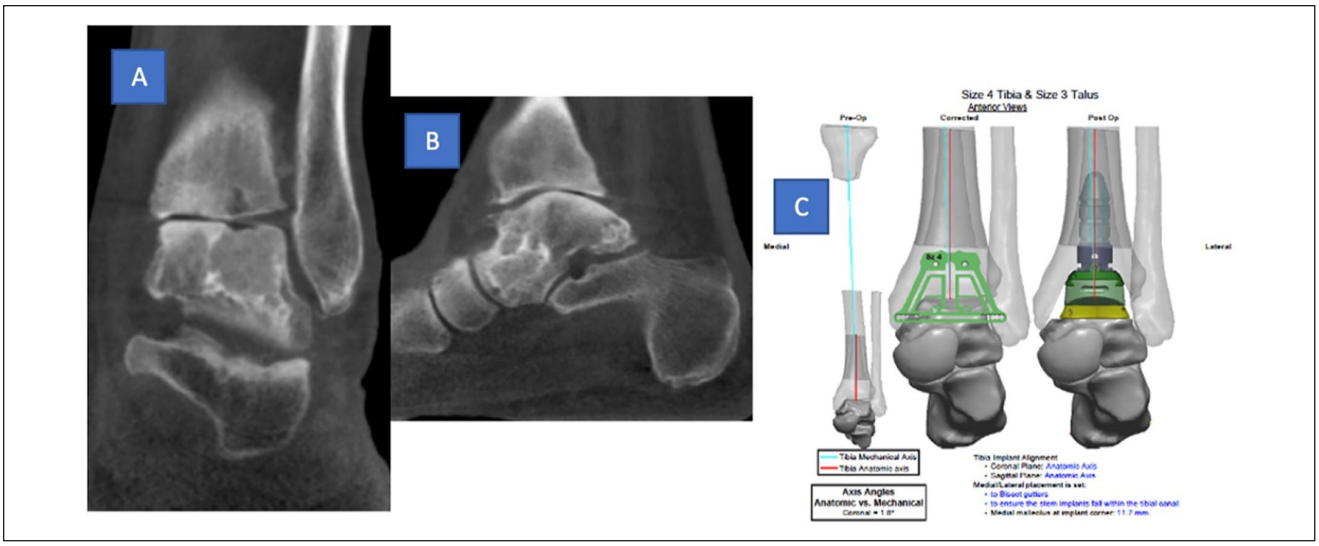

Figure 1. Preoperative ankle (A) coronal and (B) sagittal reconstruction images demonstrating the relevant pathology, along with (C) preoperative computed tomography–based total ankle replacement planning for intramedullary-referenced tibial componentry.

a TT implant as a part of a TATTR to replicate the ligament attachment points for the ATFL, deltoid, and interosseous talocalcaneal ligaments using FiberTape (Arthrex, Inc, Naples, FL) with aperture fixation in the distal fibula, medial malleolus, and calcaneus, respectively.

Technique

Our tibial-sided implant of choice is a fixed-bearing, intramedullary-referenced, component with preoperative CT guidance/navigation for improved implant stability and accurate tibial component-sizing and positioning. Thus, a preoperative plan for the tibial component is created based on the CT scan from the affected side, and we then work with the selected 3D-printing company (Restor3D, Inc, Durham, NC) to design the TTR using the affected and normal ankle anatomy measured on the bilateral CT scans (Figure 1). Three TTR implant options of varying size and dimension are created from various metal alloys to account for any intraoperative discrepancies in fit. To plan for the possible need for a concomitant, modified Brostrom procedure, a set of curved tunnels at the lateral talus are built into the talus implant to pass suture needles at the talar insertion of the native ATFL ligament. A roughened, ongrowth surface at this location on the TTR provides a healing surface for the ligament.

The tibial component and TTR are implanted through a standard anterior ankle approach. After implantation of TATTR, stability is assessed with varus stress testing. If despite optimization of the TT and polyethylene trials, there remains lateral ankle laxity relative to the deltoid complex, we perform a novel modified Brostrom technique (Figure 2). The TT implant is removed after trialing. A standard, curvilinear incision is made over the distal fibula and exposure is carried down to the lateral ankle capsuloligamentous layer. This layer is then carefully raised from the distal fibula. The periosteal layer is also raised proximally in curved fashion to allow for improved exposure to the distal fibula anterior margin. A rongeur is used to expose a bleeding surface devoid of fibrous tissue for ligament to bone healing.

Two, crossing flat-braided sutures (SutureTape; Arthrex, Inc, Naples, FL) are passed through a separate tunnel at the lateral aspect of the implant. The TT implant is then reduced into the ankle joint and the 4 suture limbs are passed through the lateral incision via the capsuloligamentous window. This pair of sutures is carefully passed through the isometric point on the capsuloligamentous layer at the talar insertion site and then tied. This restores the talar attachment point of the ATFL complex, which will allow for more effective tensioning back to the distal fibula.

Now, using a smaller thickness polyethylene liner to maintain relative position of the TT implant, a modified Brostrom reconstruction is possible. Two soft tissue anchors (DX FiberTak; Arthrex, Inc, Naples, FL) are placed at the ATFL and CFL attachment points on the distal fibula in standard fashion. The sutures are passed through the lateral capsuloligamentous sleeve and tied sequentially while holding the ankle in slight dorsiflexion and eversion with a posterior drawer. Before finalizing this reconstruction by passing the tied sutures through the elevated periosteal layer on the distal fibula, we retrial polyethylene liners until the appropriate thickness is identified that yields appropriate joint stability, balance, and range of motion. The trial liner is removed, joint irrigated

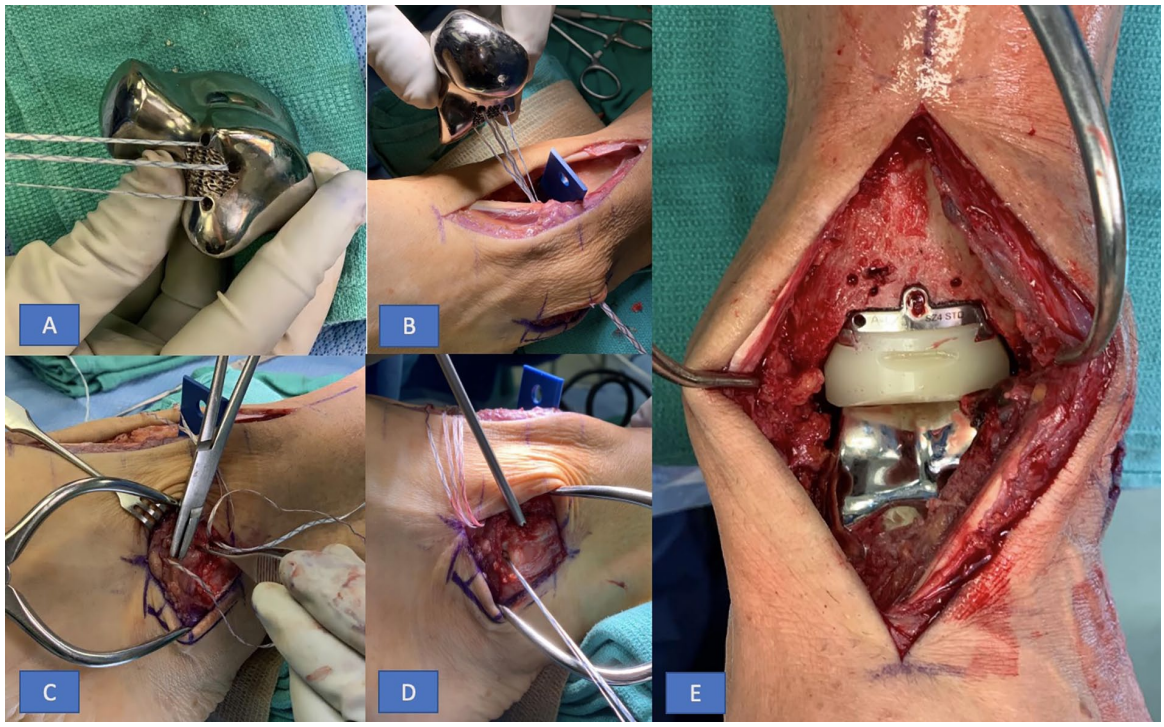

Figure 2. (A) Intraoperative photograph showing suture passage through ATFL attachment point on total talus implant. (B) Implanting total talus and shuttling sutures through lateral ankle incision. (C) Sewing native ATFL back to anatomic talar attachment point, followed by (D) tensioning ATFL back to distal fibula via suture anchor fixation. (E) Final total ankle total talus replacement construct. ATFL, anterior talofibular ligament.

out, and the final polyethylene liner brought onto the field and implanted. The lateral ankle ligament reconstruction is finalized, and excess suture trimmed.

Postoperative protocol for this technique follows our standard protocol for TAR, with touchdown weightbearing for 2 weeks followed by weight bearing as tolerated thereafter. We have performed this adjunctive technique in several patients, all of whom have had satisfactory outcomes, without subluxation or dislocation even and with no evidence of excessive joint laxity. Specifically, we have used this adjunctive technique on 2 other patients who received a total talus replacement. Both have been progressing well postoperatively without complications at their 8- and 18-month follow-up visits, respectively.

Conclusion

We present a technique to address the concern for ligamentous instability after TATTR through concomitant modified Brostrom procedure secured via a set of curved tunnels at the lateral aspect of the talus prosthesis to pass suture at the talar insertion of the native ATFL ligament. Although mid- to long-term data are lacking for the TATTR, achieving proper balance between ligamentous stability and implant overconstraint will be paramount to ensuring optimal outcomes after this procedure.

Ethical Approval

Ethical approval was not sought for the present study because it is a Technique Tip.

Declaration of Conflicting Interests

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