Complex Total Ankle Arthroplasty.

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Complex Total Ankle Arthroplasty

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KEYWORDS

• Avascular necrosis • Malalignment of the ankle • Total ankle replacement • Valgus ankle deformity • Varus ankle deformity

KEY POINTS

- With continued evolution in implant design and improved techniques, the indications for total ankle replacement continue to expand.
- Thorough preoperative planning and a meticulous surgical technique are paramount to achieving good outcomes in complex total ankle replacement cases.
- Research has confirmed that preoperative deformities can be addressed at the time of prosthesis implantation with results comparable to neutrally aligned ankles.
- Avascular necrosis no longer represents an absolute contraindication to total ankle replacement.

INTRODUCTION

Despite the high failure rates associated with first-generation ankle implants,[1–5] continued evolution in implant design and refined surgical techniques have produced marked improvements in outcomes.[6–8] Studies comparing arthrodesis and total ankle replacement (TAR) have demonstrated similar improvements in pain and functionality,[6–8] and others have shown that TAR offers the added benefits of maintaining range of motion, restoring normal kinematics, and limiting adjacent joint degeneration.[9–11]

With superior implants and an increased understanding of ligamentous balancing and component alignment, the indications for TAR continue to expand to include cases of increasing complexity.[12,13] In fact, many factors once considered relative

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or absolute contraindications can now be successfully addressed at the time of prosthesis implantation or in a staged fashion.

Even though malalignment is commonly encountered with end-stage ankle arthritis, significant preoperative varus and valgus deformities (>10°) have historically been considered a relative contraindication.[14,15] In the presence of a preexisting deformity, uneven stress distributions can give way to aseptic loosening, edge loading, and premature implant failure.[14,15] More recent studies, however, have shown that a stable, plantigrade foot can be obtained with appropriate ligament balancing, correction of associated deformities, and replacement of the ankle joint.[16–18]

Avascular necrosis (AVN) of the talus has also been considered an absolute contraindication for TAR,[19–22] given the potential for talar component subsidence and early implant failure.[19,20] However, AVN has become much less of a concern with newer prosthetic designs that provide increased surface coverage of the talus,[13] and with the recent introduction of custom-made long-stem components capable of incorporating into the calcaneus and replacing the body of the talus,[23] complete AVN is no longer considered a contraindication by many surgeons.[13]

Within, complex TAR cases are discussed, detailing the preoperative planning process as well as the techniques needed to achieve a stable TAR.

PATIENT EVALUATION OVERVIEW

A firm understanding of the patient's deformity is necessary to achieve the best possible outcome. The physical examination should include a thorough weight-bearing and non-weight-bearing examination. During the weight-bearing examination, the surgeon should assess the position of the ankle relative to the extremity and take note of the position of the heel, mid foot, and forefoot. The surgeon should assess proximal leg and knee deformity as well, including genu varum and valgus and any femoral or hip disorders. Evaluating the position of the proximal leg, knee, and thigh will allow the surgeon to understand the mechanical axis of the extremity, which will assist with intraoperative positioning of the implant. During the non-weight-bearing examination, the surgeon should take note of any peritalar arthritis as well as the mobility of the subtalar and midtarsal joints. The mobility of the peritalar joints will dictate whether additional bony procedures will need to be performed. It is the surgeon's preference as to when these additional procedures are performed. The authors prefer to stage procedures, such as subtalar and talonavicular arthrodeses. This method allows total ankle patients to enter physical therapy as soon as the sutures are removed from the skin. They will, however, often perform osseous procedures, such as calcaneal slide osteotomies, at the time of TAR.

Weight-bearing ankle radiographs should be a routine part of the preoperative evaluation. In the setting of deformity, the weight-bearing radiographs allow the surgeon to assess whether the varus or valgus deformity is congruent or incongruent. Incongruent varus and valgus deformities are defined as those with talar tilt on a weight-bearing radiograph of more than 10° in either direction.[24] Advanced imaging, such as MRI and computed tomography, are also routinely used as part of the preoperative evaluation. These imaging modalities allow the surgeon to assess subchondral bone cysts and periarticular soft tissue structures, such as the deltoid ligament, lateral collateral ligaments, and tendons. Understanding the viability of these structures is important for intraoperative balancing in the setting of deformity.

THE VARUS ARTHRITIC ANKLE

Of the frontal plane deformities, the varus ankle is widely considered the more manageable deformity to treat. As mentioned in the previous section, the surgeon must consider whether the deformity is congruent (<10° tibiotalar malalignment) (**Fig. 1**) or incongruent (>10° tibiotalar malalignment) (**Fig. 2**). Congruent varus ankles are usually due to the talus driving into the tibia. They may have some lateral ligamentous instability and some medial deltoid tightness. When treating the congruent varus ankle, a deltoid peel is performed. By removing the deep deltoid from the talus with a surgical blade or elevator, talar alignment is restored relative to the tibia. Care must be taken to get to the posterior deltoid and the posterior tibial tendon sheath. The sheath of the posterior tibial tendon often needs to be released, because this may be a point of adhesion preventing the talus from being reduced into alignment. Sizing with the appropriate polyethylene component will ensure tensioning/balancing of the lateral collateral ligament structures. It is rare in the authors' experience to have to reconstruct the lateral ligaments in a congruent varus ankle.

The incongruent varus ankle may require more work to restore the tibiotalar alignment. A deep deltoid peel is still incorporated, but often needs to be augmented with a vertical malleolar osteotomy, as described by Doets and colleagues.[25] This osteotomy allows the medial malleolus to slide distally, taking the tension off of the medial side of the ankle. This technique is performed when the polyethylene component is being sized, to ensure proper balancing of the ankle joint. When this osteotomy is performed, it is often necessary to lengthen the posterior tibial tendon, release the sheath of the posterior tendon, and tighten the lateral ligament structures. Again, each

Fig. 1. Congruent varus ankle with less than 10° tibiotalar malalignment.

Fig. 2. Incongruent varus ankle with greater than 10° tibiotalar malalignment.

of these procedures is performed while the polyethylene component is being sized to ensure proper balancing.

When soft tissue balancing has been performed and the bone structures remain mechanically malaligned, it may be necessary to incorporate osteotomies or fusions during the TAR or in a staged fashion. In the setting of distal tibial malposition, the principles of limb deformity and CORA (center of rotation and angulation) must be followed. In severe cases of distal tibial deformity, the supramalleolar osteotomy can be performed to restore the mechanical alignment to the limb. In cases where the tibial alignment is maintained, but foot alignment is poor, procedures, such as hindfoot fusions and osteotomies (eg, calcaneal slide), may be used to restore the position of the foot relative to the leg and ground and to eliminate edge loading stress across the prosthetic.

Although rarely encountered in the authors' experience, tendon transfers may be used to help augment the repair of an incongruent varus ankle. The 2 most common tendon transfers used are the posterior tibial tendon to peroneus brevis tendon and the flexor hallucis longs to the fifth metatarsal. These tendon transfers can support the correction of the deformity in a dynamic fashion, but can be technically challenging to perform.

THE VALGUS ARTHRITIC ANKLE

Correcting the arthritic valgus ankle can be one of the more challenging procedures that a foot and ankle surgeon can perform. Similar to the varus joint, the surgeon must first recognize whether the joint is congruent valgus (Fig. 3) or incongruent valgus (Fig. 4). It is the authors' experience that the valgus ankle is more commonly

Fig. 3. Congruent valgus ankle with less than 10° tibiotalar malalignment.

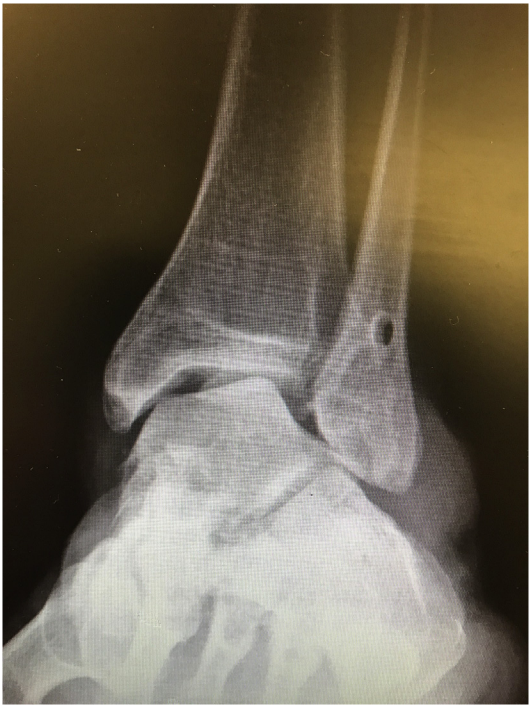

Fig. 4. Incongruent valgus ankle with greater than 10° tibiotalar malalignment.

incongruent, and with that comes an insufficient deltoid ligament, and in many instances, a short fibula. Although the release of the deltoid ligament is the cornerstone to the successful treatment of the varus ankle, the valgus ankle produces an incompetent deltoid ligament that needs to be tensioned appropriately with polyethylene sizing. If the deltoid ligament needs to be reconstructed, the authors prefer to perform the deltoid ligament advancement in a staged procedure before the TAR. While performing the TAR, the lateral soft tissue structures often need to be released from the lateral talus and distal fibula.

The surgeon also must assess the length of the fibula as well as the position of the hind foot and mid foot in relation to the ground and leg. In the setting of significant valgus, a short fibula must often be lengthened with a Z-lengthening osteotomy (**Fig. 5**). In many instances, the surgeon may find that staged subtalar and talonavicular fusions will help create a plantargrade foot before treating the arthritic valgus ankle.

The authors have found that it is far more difficult to achieve long-term survivorship in the valgus ankle compared with the neutral or varus ankle. The role of the incompetent deltoid ligament presents a unique challenge to the foot and ankle surgeon. The deltoid ligament is extremely difficult and unpredictable to reconstruct, and far too often, surgeons new to ankle arthroplasty will try to “balance” the joint by using an oversized polyethylene component. When the polyethylene component is oversized, the joint line of the ankle is moved distally, which changes the biomechanics of the joint and may cause excessive polyethylene wear with resultant aseptic loosening of the prosthetic, and ultimately, subsidence of one or more of the prosthetic components.

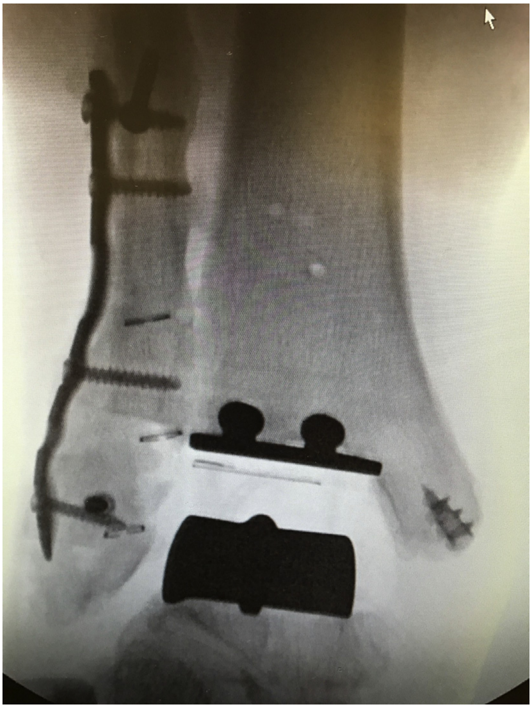

Fig. 5. Postoperative film with final components and Z-lengthening osteotomy.

ANKLE ARTHROPLASTY WITH TALAR AVASCULAR NECROSIS

Total ankle arthroplasty in the setting of AVN of the talus presents a unique challenge to the foot and ankle surgeon. A stable bone-implant interface is critical for the successful outcome of ankle arthroplasty. Unlike the hip and knee, the ankle joint has far less bone stock available to accept a prosthetic component, so any compromise to the viability of underlying bone must be investigated. Recent advancements in component design and trial and error have demonstrated that arthroplasty with talar AVN can be successful.

When considering TAR in a patient with a history of talar AVN, the surgeon must assess the extent of AVN involvement and the percentage of viable bone, as this will guide clinical decision making (**Fig. 6**). If AVN is limited to the superior portion of the talar body and can be eliminated with the talar bone cut, ankle arthroplasty can be performed. If AVN extends below the level of the superior border of the talar neck, arthrodesis may be advisable.[26] The authors prefer arthrodesis in the latter scenario.

In the presence of nonviable bone, subsidence of the talar component is inevitable given the lack of structural support. However, successful TAR can be performed when the implant is sufficiently supported (**Fig. 7**).[27,28] Lee and colleagues[27] presented 2 cases where revascularized talar bodies underwent successful mobile bearing TAR. The results suggest that necrotic bone healing to the upper border of the talar neck provides adequate support for a talar component.[27] More recently, Devalia and colleagues[28] demonstrated the success of a 2-staged approach where subtalar joint arthrodesis was followed by TAR to address arthritis and AVN of the talus. The investigators concluded that subtalar joint arthrodesis improved talar vascularity and

Fig. 6. T1-weighted image revealing extensive talar body AVN.

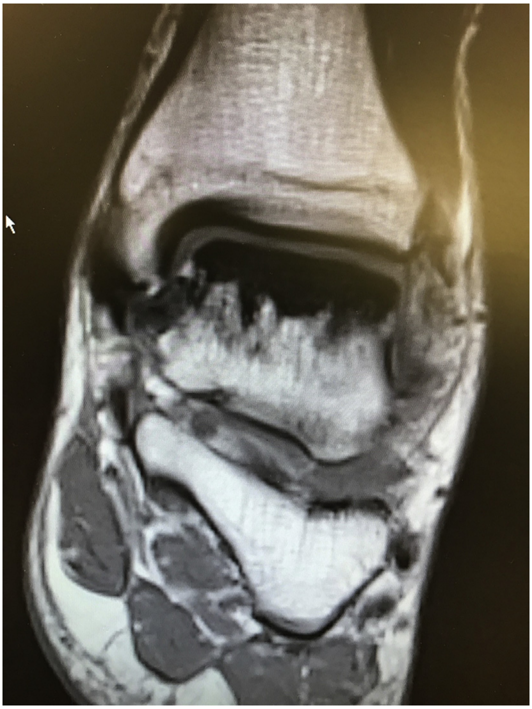

Fig. 7. T1-weighted image showing superior talar body necrosis.

increased the success of TAR in this cohort. Although limited to 3-year follow-up, the study presents a promising option when faced with osteonecrosis.

In a talus with compromised vascularity, there is a risk of damaging the remaining blood supply with TAR implantation.[29,30] Oppermann and colleagues[30] mapped out the microvascular supply of the talus and demonstrated the negative influence of chamfered components on the deep talar body blood supply. When performing TAR in patients with AVN, flat-cut talar components that are able to resect necrotic bone without violating the deep vasculature should be considered.

In cases of advanced talar AVN, viable options for primary and revisional TAR have been demonstrated. Schuberth and colleagues[31] had good results when reinforcing the talar body with metallic rods and bone cement augmentation. Short-term success has also been reported with the use of a total talar prosthesis for a failed TAR with talar collapse.[32]

Osteonecrosis of the talus presents many challenges to the success of TAR. However, when tibiotalar adjacent joint arthritis is present, all efforts should be made to preserve the ankle joint. Reasonable alternatives to arthrodesis have been reported in this setting. Careful planning and proper imaging of the ankle can lead to successful outcomes with joint replacement.

SUMMARY

The evolution of current generation total ankle prosthetics has afforded many patients suffering from end stage degenerative joint disease of the ankle the opportunity to function with decreased pain and improved function. Although prosthetic guidance, instrumentation, and education have all improved greatly over the last 30 years, both surgeons and patients can experience significant complications when ankle deformity is not managed correctly. The authors follow a rigid protocol to address frontal plane deformity and AVN.

In the setting of incongruent varus, TAR is performed irrespective of the size of the deformity, as long as the following criteria are met:

1. The foot is able to be reduced/corrected back to a neutral, plantigrade foot.
2. The bone quality of the joint is sufficient to support a prosthetic long term.
3. Any periarticular soft tissue structural damage can be repaired either at the time of ankle replacement or in a staged fashion.

The valgus ankle does not grant the same freedom as the neutral or varus ankle. If the valgus ankle has become incongruent, patients are typically limited to ankle arthrodesis. The exception includes patients who have a mild incongruent valgus that can be reconstructed into a congruent valgus or neutral ankle in a staged fashion.

As described in the previous section, AVN presents its own unique challenges. The introduction of a “flat top talar” component allows surgeons to perform TAR in select AVN cases. When AVN is limited to the superior portion of the talar body, the surgeon can remove compromised bone with the talar cut and proceed with prosthesis implantation. Given the results of Oppermann and colleagues,[30] the investigators do not advocate a chamfered talar component for patients with talar body AVN, but rather a flat-cut talar component that avoids violating the deep vasculature. Finally, patients who have talar body AVN that extends below the level of the superior border of the talar neck are excluded from ankle arthroplasty.

Foot and ankle surgeons who are performing arthroplasty should become confident and comfortable with patients suffering from neutral joint arthritis and progressively increase to patients suffering from frontal plane deformity. In line with this recommendation, the authors suggest starting with the varus ankle and progressing to cases of increasing complexity. Sound clinical judgment should be exercised when dealing with AVN of the talus.

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