JFAS Instructional Course

Total Ankle Replacement with Severe Valgus Deformity: Technique and Surgical Strategy

John M. Schuberth, DPM 1, Jeff C. Christensen, DPM 2, Chad L. Seidenstricker, DPM 3

1 Chief, Foot and Ankle Surgery, Department of Orthopedic Surgery, Kaiser Foundation Hospital, San Francisco, CA
2 Attending Surgeon, Division of Podiatric Surgery, Department of Orthopedic, Swedish Medical Center-First Hill Campus, Seattle, WA
3 Third-Year Resident, Division of Podiatric Surgery, Department of Orthopedic, Swedish Medical Center-First Hill Campus, Seattle, WA

A R T I C L E   I N F O

Level of Clinical Evidence: 5
Keywords:
ankle arthritis
ankle arthroplasty
deltoid ligament
pes valgus

A B S T R A C T

Correction of severe valgus deformity of the foot and ankle with ankle replacement is challenging. We describe the controversies and specific issues of surgical management and provide a detailed surgical strategy for management of this common deformity. A reliable technique for deltoid reconstruction is also described and illustrated in detail.

© 2017 by the American College of Foot and Ankle Surgeons. All rights reserved.

Most osteoarthritic ankles have some degree of coronal plane malalignment (1). Varus deformity occurs in 55% of all arthritic ankles, and the incidence of valgus deformity is 8% (1). Although no clear guidelines exist, 15° of pre-existing coronal plane deformity has been suggested as the limit for ankle arthroplasty, with 20° to 25° suggested as the absolute cutoff point (2,3). Others believe no amount of pre-existing coronal plane malalignment is unacceptable if osseous realignment and ligamentous stability can be achieved (4–6).

Ankle arthroplasty with intrinsic valgus is challenging and often fails because of an insufficient deltoid ligament complex (5). Several techniques for reconstruction of the chronically failed deep deltoid have been described, with inconsistent reliability and undefined limitations (4,7–13). Wide variability exists among these referenced techniques, further clouding our understanding of the optimal ligament reconstruction. Furthermore, longstanding ankle valgus deformation leads to a coiled distortion of the hind- and midfoot, placing additional valgus thrust on the prosthesis.

A durable, reliable, and reproducible method of reconstruction might allow for higher success rates of arthroplasty in valgus osteoarthritic ankles and expand the indications to include those with greater degrees of deformity. We describe a strategy for replacement of the valgus osteoarthritic ankle with medial ligament insufficiency that involves anatomic deep deltoid ligament reconstruction with a double-stranded tendon allograft combined with osseous realignment.

Operative Strategy

In general, correction of the moderate to severe valgus ankle with compensated pedal deformity suggests a 2-stage surgical approach. The first stage of the reconstruction involves talar derotation, restoration of the medial ligamentous structures, and reversal of the coiled pes valgus deformity. Although reversal of this complex segmental osseous malalignment is complicated, it is an obligate maneuver to achieve a plantigrade foot. The fundamental theme of this first stage is to obtain neutralization of the talus within the ankle mortise. Accordingly, the talus serves as the reference to which the rest of the osseous components are repositioned through selective arthrodesis of the mid- and hindfoot joints.

Most often the heel will be in a severe valgus attitude, both from the valgus position of the talus in the mortise and from varying degrees of subluxation of the subtalar joint. Longstanding deformity further potentiates the difficulty of correction. When the talus and heel are realigned to the long axis of the tibia, the varus posture of medial column of the foot worsens. The reversal of this complex deformity represents the most difficult challenge even to an experienced surgeon. The process of uncoiling the medial column down to the supporting surface begins with talonavicular fusion. A significant percentage of the varus position can be eliminated but usually unmitigated residual deformity remains, primarily because of the adapted calcaneocuboid joint and the remaining medial column. Although the “medial double” arthrodesis has gained popularity, in our experience, hind- and midfoot neutrality cannot be achieved with
this procedure in isolation (14–21). The subtalar fusion from a medial approach enables a medially based wedge resection of the posterior and anterior or middle facets, but it does not allow for medial translation of the calcaneus without incorporation of the calcaneo-cuboid joint. This is usually necessary to optimize the alignment. Furthermore, the obligate “wedging” created by the medial resection can create a varus rotation to the calcaneocuboid complex.

It should also be noted that curettage preparation of the midtarsal joints is inadequate to reduce the deformities because of the long-standing, coiled adaptation of the hind- and midfoot. Planar cuts of the talonavicular and calcaneocuboid joints are necessary to neutralize the midfoot deformity. Derotation of the midtarsal joint through the axis created by the planar resections often results in a plantigrade foot. In very severe cases, additional medial column fusion could be necessary if residual varus or an unsupportive first ray...
is present. Any uncompensated residual varus deformity will be poorly tolerated and will place valgus stress on the prosthesis. In those instances, naviculocuneiform arthrodesis is performed.

The final step of the first stage is deltoid ligament reconstruction. In most instances, the superficial deltoid can be identified but is usually attenuated. However, the deep deltoid is not repairable and must be reconstructed with tendon allograft. We favor the double-strand technique, with 2 limbs of allograft tendon anchored to the medial surface of the talus and tibia, respectively.

The second stage of the reconstruction involves placement of the prosthesis 6 to 8 weeks after the initial operation. To reduce the risk of infection, the cast or splint is removed at 4 to 6 weeks postoperatively such that the patient can condition the skin envelope before implantation. During this interval, the patient is instructed to cleanse the lower leg with a mild soap and gently scrub the leg to facilitate removal of the flakes of skin. Lotions or skin conditioners should be avoided to allow for good adherence of the skin preparation solution at surgery.

Insertion of the prosthesis is performed in standard fashion with the implant of choice. However, the surgeon should carefully evaluate for any residual mid- or hindfoot deformity that would place valgus stress on the medial structures. Most often, some residual elevation of the medial column will remain and should be addressed after the prosthesis is in place. Mild heel valgus can usually be ignored if the deltoid reconstruction is solid and the mid- and forefoot are plantigrade. The specific steps of the 2-stage protocol are summarized in the Table.

**Operative Technique**

The medial aspect of the foot and ankle is exposed through a long curvilinear incision over the medial midline of the distal tibia and extended as needed to the first metatarsal base, following the bony anatomy. Full-thickness skin flaps are developed to expose the affected joints (Fig. 1). A large Steinmann pin or Shantz screw is placed into the talus to lever it out of valgus and into a neutral position in the ankle mortise (Fig. 2). In some instances, a small incision over the lateral gutter is needed to liberate the talus by widening the gutter or release of soft tissue contracture (Fig. 3). Once talar neutrality has been attained, correction is secured by placement of transarticular fixation and/or polymethylmethacrylate cement. Fixation is placed across the ankle in an oblique fashion from the medial cortex of the tibia and targeted to the lateral process of the talus (Fig. 4A). When using a Steinmann pin, it should be cut off and bent for easy retrieval at the second stage of the operation (Fig. 4B). If cement is used, it is placed in the lateral void created by repositioning of the talus (Fig. 4C). The cement can be placed in isolation or can incorporate the transarticular...
fixation (Fig. 4D). In either case, the talus can be placed into a slight varus position within the mortise (Fig. 4B). Once the talus is secure in the mortise, selective arthrodesis procedures can be performed. The heel, mid-, and forefoot are aligned to the neutralized talus (Fig. 5). Fixation of the arthrodesis sites should be carefully planned such that the fixatives will not encroach on the superior aspect of the talus. This will avoid obligate removal of the fixation before preparation of the talus during total ankle replacement (Fig. 5D).

Once the osseous procedures have been completed, the deltoid ligament complex can be reconstructed. The posterior tibial tendon sheath has been released and the tendon has been retracted inferiorly to visualize the superficial deltoid complex. A transverse midsubstance incision is made into the superficial deltoid to expose the deep deltoid ligament complex. Two insertion points on the medial surface of the talus should be chosen to create a channel to accept a strand of the allograft. The posterior pin should be at the posterosuperior aspect of the medial talar body and the anterior pin should be at the anterior superior portion of the medial talus, inferior to the medial articular surface. These insertion points should be low enough that the attached allograft will not be compromised by preparation of the talus during ankle replacement. The guide pins should be placed at each chosen insertion point and perpendicular to the medial surface of the talus (Fig. 6A). The talar insertion holes are then drilled 17 mm deep with a 5.5-mm drill to allow insertion of 5.5-mm × 15-mm plastic or nonmetallic interference screws to secure the allograft tendon allograft.

The respective ends of the tendon allograft are then prepared for passage into the talar channels. Usually, a single tendon allograft of the hamstring or peroneus longus will have enough volume and length to serve as the deep deltoid ligament. The graft is divided into
Fig. 6. A series of intraoperative photographs demonstrating the technique of deltoid reconstruction. (A) Placement of the guide pins for creation of the talar tunnels. (B) The 2 tibial guide pins converge and the central limb of the Y-tunnel is drilled. (C) A tendon passer is threaded into each of the inferior tibial tunnels to retrieve the allograft. (D) The allograft is then pulled proximally. Note the whip stitch to maintain structural integrity. (E) The anterior limb of the tendon graft is tensioned. (F) Both tendon grafts have been passed through the central proximal tunnel. (G) Photograph and diagrammatic representation of the final construct. Note the preserved superficial deltoid cuff, which will be oversewn to the medial malleolus.
roughly equal lengths of about 8 cm. Each strand is placed individually on a tendon graft preparation table. A whip stitch is placed in 1 end of each graft at approximately 15 mm. This will prevent the tendon from “bunching” as it is inserted with the anchor. The resorbable interference screws are inserted according to manufacturer’s instructions in each talar channel.

Two guide pins are placed into the medial malleolus for creation of the tibial channels. The insertion points are the anterior and posterior colliculi, respectively (Fig. 6B). They should converge as they are driven proximally to create a V shape, and exit 5 to 6 cm proximally to the tip of the malleolus. Tibial tunnels are created with a 4.0-mm drill over the guidewires. A third tunnel is created at the proximal aspect, completing the inverted Y shape that will connect the 2 tibial tunnels and allow a common exit point. This third tibial tunnel is then drilled with a 4.0-mm cannulated drill. Using a tendon passer, each talar strand is passed from distally to proximally out the common exit point (Fig. 6C,D). The strands of the graft are placed under tension by pulling them proximally (Fig. 6E). The tension of the allograft is captured by insertion of an appropriately sized, resorbable interference screw into each tibial tunnel (Fig. 6F,G). The excess tendon graft is then cut off at the proximal exit point. If it is available, the superficial deltoid cuff is then repaired over the deep deltoid reconstruction after plication.

Case Example

The radiographic progression of a 74-year-old male with long-standing degenerative joint disease of the ankle is shown in Fig. 7. He was in otherwise excellent health and had marked limitation of daily

Fig. 7. Case example of severe valgus ankle with a longstanding pes planovalgus foot. (A) Preoperative mortise radiograph of the ankle. Note the significant lateral position of the hindfoot. (B) Lateral view of the ankle. (C) Preoperative anteroposterior view of both feet, demonstrating severe collapse of the left foot. (D) Intraoperative fluoroscopic view showing attainment of alignment. (E) Immediate postoperative mortise radiograph after triple arthrodesis and deltoid reconstruction. (F) Postoperative lateral radiograph. (G) Mortise radiograph 7 years after treatment. In this case, all the metallic fixatives were retrieved at ankle replacement. (H) Lateral view of the foot. (I) Anteroposterior view of the foot.
activity and ambulation. His symptoms were not adequately controlled with bracing. His severe multiplanar deformity was rigid, and no functional activity of the tibialis posterior was present. At 8 years postoperatively, he was enjoying a very active lifestyle and world-wide travel.

Discussion

The operative strategy and technique we have described provides a stable, balanced total ankle replacement in the severe valgus arthritic ankle. The strong construct double-strand arrangement and individual fixation points in both the talus and the medial malleolus resist external rotation and lateral translation and protect from valgus tilt. Several other investigators have emphasized the importance of alignment in ankle arthroplasty and proper ligament balancing when addressing coronal plane deformity (4,12). We believe this strategy can be applied to valgus ankles with any level of deformity, provided the tenets described are followed. However, some reports have attempted to establish limits on the amount of valgus deformity that can be corrected in a reliable manner (2,3).

The 2-stage protocol is not appealing to patients for a variety of reasons, especially the prolonged period of non-weightbearing. Although we have surgically treated patients with valgus ankles in a single stage, those situations are reserved for patients with less severe valgus deformities or intact deltoid ligamentous complexes. This subgroup of patients usually requires less osseous mid- and hindfoot realignment, thereby lessening the surgical footprint. Although unproved, our empirical observations from >2000 ankle replacements suggest that complications are more frequent when one attempts a single-stage correction of the foot deformity with ankle replacement (Fig. 8). However, several conflicting findings from simultaneous hindfoot fusion and total ankle replacement have been reported (22–24). Lewis et al (22) reported greater complication rates and lower functional outcomes in patients undergoing simultaneous surgery. However, Kim et al (23) reported no significant differences between the 2 strategies. Nonetheless, the need for further risk stratification and the establishment of odds ratios for simultaneous versus staged surgery are evident.

The second-stage operation is performed 6 to 8 weeks after the index procedure. A 3- to 6-month hiatus between foot and ligament
Fig. 8. (A) Immediate postoperative radiograph of an ankle after simultaneous triple arthrodesis and total ankle replacement. (B) Photograph of same ankle 3 weeks postoperatively, showing severe compromise to the soft tissue envelope.

Fig. 9. (A) Preoperative anteroposterior radiograph of a left ankle with deltoid attenuation. (B) Postoperative radiograph 2.5 years after ankle replacement without medial reconstruction. Note the slight lateralization of the tibial tray.
reconstruction and ankle replacement has been suggested (3). However, this can lead to stretching of the deltoid ligament if any unmitigated valgus thrust is present from residual deformity or increased wear on the lateral tibial plafond that can lead to rocking of the talus within the mortise and bone resorption and softening. We believe that a narrow gap between the index operation and the total ankle replacement procedure allows the best chance to optimally tension the ligaments and minimize the chance of tissue creep or overt failure of the allograft.

It has also been proposed that one of the strands of the allograft be anchored into the sustentaculum tali to simulate the superficial deltoid (8). The increased lever arm for valgus thrust from the subtalar fusion suggests that this variation might be more mechanically sound; however, we have not used this construct (12). Instead, we are very careful to preserve the superficial deltoid cuff during the surgical exposure (Fig. 6G) and then plicate the cuff over the allograft for an additional medial tether. Moreover, anchoring 2 strands of allograft directly to the talus re-creates a more natural representation of the deep deltoid (25). We also do not advocate the use of nonanatomic stabilization procedures, because they can create an unnatural tether that limits the range of motion (26,27). Regardless of the choice for the pattern of medial ligament reconstruction, we emphasize the absolute necessity of obtaining a plantigrade foot with a competent medial column.

Autologous grafting, in particular, the peroneus longus, has also been reported for deltoid reconstruction (9–11). Although these investigators would leave the insertion of the tendon intact, that will dampen or eliminate the dynamic stabilization of the medial column. These studies did report successful long term follow-up in cases of mild to modest preoperative valgus deformity. However, the long-term effects of this on the loss of correction in the case of a more severe deformity is not known. In contrast, the use of autologous tissue might lessen the tendency for tissue creep and attenuation. We do pretension the allograft before implantation to dampen the likelihood of creep.

The specific indications for deltoid ligament reconstruction remain obtuse. Many patients present with longstanding valgus pedal deformities and asymmetric wear of the lateral plafond, yet appear to have no attenuation or instability of the deltoid ligament. It has been our experience, and that of others (5), that many of these patients can undergo single-stage reconstruction without allograft reconstruction of the deltoid with long-term success (Fig. 9).

Many of our patients underwent implantation without reversal of the pedal deformity, provided the medial ligamentous complex was completely stable. Many patients with moderate peritalar subluxation will have negligible valgus thrust on the deltoid (Fig. 10). It is thought that the inherent flexibility mitigates any retrograde valgus thrust on the deltoid ligament and implant interfaces. However, we do not recommend this strategy, in general, unless the valgus pedal deformity is flexible, particularly through the midtarsal and subtalar joints. To date, these subsets of patients have not been adequately studied to determine the absolute necessity of medial ligament reconstruction or the wisdom of ignoring various degrees of peritalar subluxation.

The other methods that are available that may enhance the likelihood of success in the valgus ankle include the selection of an inherently stable implant or one that minimizes disruption of the deltoid during routine preparation of the talus (28). Other intraoperative maneuvers such as leaving the medial gutter completely native, lateralization of the tibial tray (Fig. 9B), or insertion of a thicker polyethylene bearing might be helpful but should not be relied on in cases of insufficient ligament support or unmitigated rigid pedal deformity.

In conclusion, it has been shown that realignment of the valgus ankle to a neutral position and restoration of stable medial ligaments allows for successful placement of an ankle prosthesis with modest survival parameters (3–6,29). The strategy and techniques we have described are reliable, mechanically sound, and readily reproducible. This might allow for more universal application of the replacement of ankles with severe, incongruent valgus deformities.

Fig. 10. (A) Preoperative anteroposterior radiograph showing severe ankle valgus and adaptive, stable pes valgus. (B) Postoperative radiograph 6 years after isolated total ankle replacement. No significant valgus thrust to the deltoid ligament was present. In this case, the fibular buttress might have buttressed the hindfoot from valgus migration; however, the exact role of this concept is unknown.
References