Surgical Strategies: Lateral Ligament Reconstruction as Part of the Management of Varus Ankle Deformity with Ankle Replacement

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SYNOPSIS

Improved designs and surgical technique has led to much better mid-term and longer term outcomes than the first generation ankle replacements of the 1970’s. However, there remains multiple recent papers discussing the many potential complications with total ankle replacement surgery. As we proceed into the future, one should be cognizant of the pitfalls and know how to deal with the difficult ankles, especially varus and valgus deformities. There should also be a clear understanding that the greater the varus or valgus, the more challenging the procedure, and the less predictable the outcome of a total ankle replacement.

Key Words: Ankle Replacement; Deformity Management; Varus

INTRODUCTION

As Total Ankle Replacements (TAR) becomes a mainstream management for ankle arthritis, it is of critical importance to know the limitations of the chosen implant design while understanding the challenges common to this procedure. There have been a slowly increasing number of surgeons performing ankle replacements. Adequate training is extremely important, not only to shorten the steep learning curve, but also to point out and provide solutions to the many potential pitfalls.

Chronic lateral ligament instability is probably one of the most common reasons for primary ankle arthritis. Other common causes include trauma and rheumatoid arthritis, though these etiologies are less likely to result in a ligamentous unstable varus deformity. Not all of these ankles will present with a severe, or fixed, ankle varus. It is not uncommon to have an ankle with a fairly symmetric wear pattern, but very significant lateral instability at the time of the TAR. If there is a suggestion of instability from the history or the clinical examination, it is worthwhile to do preoperative stress radiographs. There are, however, situations where it is not apparent preoperatively, and only becomes obvious once the ankle is prepared and all the osteophytes removed. It should be part of the surgeon’s routine while performing an ankle replacement to test the ankle for varus and valgus stability when the trial components are in place.

The focus of this paper will be to address those patients with varus instability. However, one should exercise caution in performing ankle replacement in individuals with more than 20 degrees of varus. It is the author’s opinion that varus of more than 20 degrees, especially if it is due to instability, is better treated with an ankle arthrodesis. In our own initial series from 1995 to 2000 consisting of 200 agility ankle replacements, there were 20 patients with preoperative varus of more than 20 degrees. This population had a 50% failure rate, and was converted to an ankle fusion within 3 years. A further seven patients developed a recurrence of varus that will invariably lead to increased wear through edge loading and earlier failure of the replacement. The early failure rate in standard, non varus or valgus ankles during the same time period was 8%, mainly due to syndesmosis non-unions. Wood et al. also showed in their series a significantly higher failure rate of ankle replacements done for severe deformity. Occasionally varus will be due to pure bone erosion of the tibial plafond (Figure 1). This patient population is easily corrected through the bone cuts required by the TAR system. Most of these patients will be post-traumatic in origin, and laxity is seldom a problem.

When it comes to a ligamentously lax ankle, the challenge in the future will not be whether an ankle replacement is a viable option, but whether an ankle replacement is the correct option in a specific situation.

The goal of this article is to discuss the lateral ligament reconstruction technique when performing a total ankle...
Fig. 1: Most of the varus in this ankle is due to true post-traumatic bone erosion. The patient sustained a severe pilon fracture 10 years ago, and presented with a stiff painful ankle. Clinical examination showed no varus/valgus instability and limited plantar- and dorsiflexion with the usual dense scar tissue from multiple surgeries. This should be easily corrected by the normal tibial bone cut required for a TAR.

replacement. However, with any varus ankle, multiple factors can play a role, and they will be briefly discussed.

Leg alignment
Varus or valgus of the lower leg will have an impact on the alignment of the foot. It is recommended to take full-length standing X-rays of both lower extremities as part of the preoperative work-up. Any deformity in the leg will negatively affect the ankle by tilting the ankle joint which can lead to shear stresses within articular cartilage, as well as changes in contact pressures.

Tarr\(^5\) found distal tibial deformities create the highest contact pressures with sagittal plane deformities having the greatest effect. A 15-degree anterior bow causes a 40% increase in contact pressure, while a posterior bow of 15 degrees cause 42% increase.\(^3\) Correcting these deformities will reduce the contact pressure on the replaced ankle, and there is evidence in the literature that it might also delay the need for an ankle replacement if done as a first portion of a staged ankle reconstruction.\(^2,4\)

Foot alignment
A stable, plantigrade foot is an essential part of a successful ankle replacement. In a varus ankle, any cavovarus

Fig. 2: A–C. A very severe varus malunion of a tibia and fibula fracture with subsequent ankle arthritis is shown. It is obvious that the alignment needs to be corrected before an ankle replacement can be done.

Fig. 3: A. Varus ankle mainly due to erosion of the medial tibia. B. It was possible to correct the alignment and ligament balance of the ankle with a distal tibia bone cut perpendicular to the long axis of the tibia and tensioning of the ligaments with a larger size polyethylene insert.
issues should be addressed before or at the time of the TAR. Specific attention should be given to the muscle balance of the foot. It is not uncommon in the older population to have a longstanding tibialis posterior tendon dysfunction, and it should be addressed either as part of, or prior to, the ankle replacement. The preoperative radiographs should include weightbearing foot X-rays. The lateral ankle view in particular should include the entire foot. This will be shown in case illustrations later in the text.

Management of varus deformities

Deformity correction should be performed from proximal to distal. Lower leg varus of more than 10 degrees should be corrected prior to dealing with the ankle utilizing corrective osteotomies. There is no hard science about what level of deformity warrants a correction before a TAR is done. Tarr and coworkers showed the increased force in the ankle with angular malalignment, and one could make a case that any degree of deformity needs correction before an ankle replacement. Not all varus ankles are created equal. The varus deformity could be due to bone erosion alone, a combination of bone erosion and lateral instability, or due to primarily ligamentous instability. Frank Alvine, MD developed a very useful classification system for varus ankles and their management in ankle replacements (unpublished data).¹

Stage 1 ankle varus is due primarily to medial bone erosion, minimal lateral ligamentous instability and minimal medial or lateral ectopic bone formation (Figure 3A).

The bone cuts will resolve the varus bone erosion. The initial distal tibia bone cut should be perpendicular to the long axis of the tibia, and not parallel to the joint line (Figure 3, B and C). This usually means that very little bone is removed from the medial tibial plafond, while more bone is removed from the lateral side. There should be adequate tensioning of the ligaments to ensure stability of the ankle.

One should always test the medial and lateral ligament stability once the trial components are in place. If there is a
The peroneus brevis tendon is kept intact at its distal insertion into the fifth metatarsal. It is harvested as far proximal as possible.

In Stage 2 varus instabilities, a combination of factors contribute to the difficulty obtaining initial reduction and correction. The medial malleolus is often eroded and there is shortening or contracture of the deltoid ligament, medial capsule, and tibialis posterior tendon sheath. On the lateral side there is almost invariably large osteophyte built-up in the gutter, both on the lateral side of the talus and the medial side of the fibula (Figure 4).

An aggressive gutter debridement is required to allow the talus to rotate back into the mortise. If it is still not possible to rotate the talus back in place after an adequate debridement, one can assume the medial structures are tight (Figure 5).

The deep deltoid is released from the talus by sliding an osteotome or knife down the medial border of the talus until the entire deep portion is released. On occasion even the significant discrepancy in medial/lateral stability, it mandates correction.

A Brostrom type lateral ligament repair is done as the first part of the ligament reconstruction. With the initial dissection, the soft tissue flap is left intact on the talus and calcaneus. A and B, The drilling and placement of a suture anchor into the fibula. C to E, the advancement and suture of the soft tissue flap as a single layer into the fibula.
superficial deltoid needs to be released, but this should be done respecting the surrounding structures, specifically the posterior neurovascular bundle, and tibialis posterior tendon. Once the ankle joint is mobile and passively correctable to neutral in the mortise, the hindfoot alignment is evaluated. If there is a tendency to a varus deformity below the ankle, a laterализing or lateral closing wedge calcaneal osteotomy should be done to improve the mechanical axis.

At this point the ankle ligament balance is evaluated. If there is an obvious difference (more than 5 degrees) with varus versus valgus stress, a lateral ligament reconstruction should be performed. A modified Brostrom lateral ligament repair is generally not sufficiently strong to maintain ankle stability after an ankle replacement. It may be used as an adjunct, but only has value as an isolated procedure if the instability is very subtle.

Fig. 8: The peroneus brevis is used in a non-anatomic repair. A, The tunnel created over the Brostrom repair. B and C, The tendon routed over the Brostrom repair to the anterolateral aspect of the distal tibia, proximal to the tibial component. The foot is then reduced, and while applying adequate tension to the transferred tendon, it is stapled onto the tibia (D and E). The stump is folded back on itself and sutured down. Stability is tested to ensure equal medial and lateral tension (F).

Fig. 9: The peroneal retinaculum is repaired to prevent subluxation of the tendons.
Several techniques have been advocated in the past, including recreating an “anatomical” repair with drill holes in the footprints of the ATFL, CFL and fibula while using allo- or autograft. My experience with these techniques has been less than satisfactory. The reasons are not clear, and the best, albeit not proven, explanation might be that the TAR is a non-anatomical construct, and the forces over the ankle replacement are different than a normal ankle. One of the reasons for my struggles with conventional non-anatomic repairs might be the fact that most of them were done with the Agility ankle replacement. Due to the design of the Agility the fibula can’t be used for the normal drill holes. Now that more ankle replacement choices are available in the USA, these conventional methods might be easier to use, but we have found no compelling reason to explore that option due to the success with the current technique. An added advantage of our technique is the simplicity and speed of the procedure, both important after a complex and sometimes time consuming replacement surgery. A very simple, but highly reproducible technique is therefore advocated.

A separate lateral incision is used to expose the lateral side of the ankle and peroneal tendons. Through this incision the lateral gutter debridement is done or completed. Once the final ankle replacement components are in place, a modified Brostrom type lateral repair is done (Figures 6 and 7).

As a rule, one half of the peroneus brevis tendon is harvested. If the tendon has signs of pathology or a tear, the entire tendon is used to ensure maximum strength. It is also assumed that a diseased tendon would not work as a motor, but could be used for a static repair. The distal attachment is kept intact, and the tendon is harvested as far proximal as possible. The peroneus brevis is then routed over the modified Brostrom repair from the lateral side of the ankle to the anterolateral tibia. Under adequate tension it is secured with a staple onto the tibia (Figure 8). This is a non-anatomic repair and will limit inversion, but not necessarily anterior drawer stability. The modified Brostrom repair appears to add enough anterior translational stability in addition to the inherent anterior stability of the implant.
Once the ankle ligaments are stable, the foot alignment should be assessed. If there is forefoot driven hindfoot varus (a plantarflexed first ray) a dorsal closing wedge ostectomy should be done of the first metatarsal. If it is felt that some of the varus is due to an overpull of the peroneus longus tendon, the longus should be lengthened or preferably tenodesed to the brevis to act as an evertor instead of a first ray plantarflexor (Figure 9).

The following are case examples. The first case (Figure 10) is a 62-year-old male who was a running back in high school and college. He sustained multiple ankle sprains and stated that he always had “unstable” ankles. By the end of his career he would roll his ankle without even experiencing much pain. Over time he became increasingly limited in his ability to do recreational activities, and was severely limited due to pain prior to the replacement. On examination his ankle was in obvious varus with no lateral stability.

Figure 11 shows a patient with a history of a cavus varus foot with multiple ankle ligament sprains in the past. Ten years prior to the replacement a Brostrom lateral ligament repair as well as a dorsiflexion ostectomy of the first metatarsal was done. He did fine for a few years, but developed an increasing varus deformity with a failure of his ankle ligament repair.

Even though it may be technically possible, the author emphasizes caution in attempting to replace an ankle joint with more than 20 degrees of varus. The complication rate, especially early failure, is unacceptably high in the author’s hands. The patient should not leave the operating room until all the contributing deformities are corrected, and the ankle should be perfectly stable.

The proposed lateral ligament repair is a non-anatomic repair and we do not advocate its use for any other ankle instability pattern other than ankle replacements. It is not in the anatomical planes of either of the lateral ligaments, and will reduce the function of a normal ankle. Even the best artificial ankle is still “non-anatomic”, and the proposed repair proved to add excellent stability without apparent compromise in ankle function. The essence of the repair is a strong check reign against inversion, while the modified Brostrom part of the repair limits the anterior translation of the ankle. As mentioned before a modified Brostrom repair alone has not proven strong enough for total ankle replacement, mainly due to the fact that it can’t adequately resist the inversion force. To date we have used the described repair in 38 ankle replacement patients, with only one failure. This occurred in a case where the staple backed out of the tibia, and one can assume the tendon slipped due to insufficient fixation.

It is possible to overtighten the tendon transfer, especially if there is partial deltoid ligament insufficiency. As with any ligament balancing procedure, care should be taken to test the stability before final fixation. There should be equal medial and lateral joint movement when the tendon is secured. If the lateral side is over tightened it could create a valgus force in the joint which is equally undesirable. Care must be
taken not to pull the foot into external rotation, though we have not noticed a functional problem when that result was encountered.

The peroneus brevis is a secondary stabilizer of the ankle against inversion/varus. It is always a concern that using the peroneus brevis as a lateral ligament substitute could create a very complicated problem if the repair fails. Other than the one failure so far, this has not proven to be a problem. The one failure was salvaged with revision fixation, while a conversion to a fusion was discussed but not needed.

REFERENCES