

## Total Ankle Replacement in Varus Ankle Osteoarthritis

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### Abstract

About 50% of the cases with degenerative osteoarthritis of the ankle are asymmetric. Varus ankle osteoarthritis is far more frequent than valgus ankle osteoarthritis. Most of the cases of ankle osteoarthritis have posttraumatic aetiology. It is important to understand the deformity completely, and to distinguish simple deviations in the coronal plane from more-dimensional, complex cavovarus deformities involving the midfoot and the forefoot. Concomitant ligament and tendon imbalances and pathologies need to be identified and analysed. Correction planning needs to include the mechanical axis of the complete leg. Muscular imbalances need to be identified.

Even substantial deformities in varus ankle osteoarthritis can be treated with total ankle replacement successfully, if a plantigrade foot with balanced ligaments and tendons can be achieved. The corrective procedure may include realigning osteotomies, fusions, and correction of tendon and ligament pathologies.

**Keywords:** Total ankle replacement; Arthritic varus ankle; Corrective osteotomies; Supramalleolar osteotomies; Calcaneal osteotomies

### Introduction

Deviation of the mechanical axis of the ankle is one of the most important causes for revision surgery in total ankle replacement [1,2]. In the last years the spectrum of indications for total ankle replacement has widened parallel to relevant improvements in implant design and operative technique.

Hence more and more patients with complex deformities and axis deviations receive a total ankle replacement [3]. About 80% of the cases with ankle osteoarthritis are of posttraumatic origin [4]. In 50% of the patients with advanced arthritic changes of the ankle joint there are axis deviations in the frontal plane. Varus deformities are about 6.5 times more frequent than valgus deformities [4]. To achieve good results it is essential to consider the special features of ankle replacement in varus ankle osteoarthritis. This review therefore shows a structured approach to deformity analysis and treatment in varus ankle osteoarthritis.

### Preoperative planning

Most authors limit total ankle replacement to patients with a deformity in the coronal plane of maximally 10° [5]. A failure rate of 50% with conversion to ankle fusion within 3 years in patients with a varus deformity of 20° or more preoperatively [6]. Coronal deformities of 15° or more as a contraindication for ankle replacement [7]. They described a high incidence of edge loading, instability and subsequent implant failure in this patient group.

In general correcting the osseous malalignment and restoring the ligament and tendon balance should allow achieving results

comparable to those of neutrally aligned ankles. This is supported by the results [1,8].

For correction planning the complete mechanical axis of the lower limb needs to be taken into consideration. It is of particular importance to identify axis deviations at the level of the knee, as their correction at a later stage would also affect the alignment of the foot and the ankle. Therefore we recommend to correct deformities at different levels of the lower limb from proximal to distal [5].

In the clinical examination malalignment of the hindfoot and the forefoot needs to be identified. The range of motion of the ankle joint, the subtalar joint and of the midfoot needs to be examined. It is important to have a thorough look on the arterial and venous circulation of the foot and the soft tissue mantle, as varus ankle osteoarthritis requires additional corrective surgery in many cases, making separate skin incisions necessary. Pre-existing scars need to be noted and included in the planning of the surgical approach [5].

We routinely perform dorso-plantar and lateral standing x-rays of the affected foot, a mortise view of the ankle and a Saltzman hindfoot alignment view [9], to be able to assess the infra-malleolar alignment of the foot. Standing views of the whole leg are necessary to get reliable information about the mechanical axis of the lower limb.

Location and extent of the deformity are defined using the CORA-principle (Center of Rotation and Angulation). Axis deviations in every plane need to be respected in the planning, and corrected if necessary [10,11]. It is essential to distinguish isolated deformities in the frontal plane from complex cavo-varus type deformities that affect the whole foot [10]. Usually there is a combination of osseous deformities with muscular imbalances, notably between the tibialis posterior muscle and the short peroneal muscle. The pull of the tibialis posterior is intensified whereas the short peroneal muscle is weakened [10]. Quite frequently the force of the long peroneal muscle is augmented, with a weak tibialis anterior muscle, leading to an

increased plantarflexion of the first metatarsal. This worsens the deformity in the sense of a forefoot induced hindfoot deformity [10].

The load axis and the point of heel strike are medialized, and the talus is horizontalized. This induces frequently ventral impingement of the ankle joint inhibiting dorsal extension significantly. Moreover the tension of the heel cord is commonly increased, which further contributes to the impaired dorsal extension [10].

In addition to the osseous malalignment ligament and tendon pathologies need to be identified and addressed in the correction [5,10,12].

The amount of the deformity and its exact localisation needs to be determined. Range of motion and ligament stability of the ankle need to be inspected. It is essential to distinguish rigid from flexible hindfoot deformities. The Coleman Block Test can be used for correct differentiation [10].

Our standard approach for total ankle replacement is the interval between the tibialis anterior tendon and the extensor hallucis longus tendon [13].

### Extraarticular deformity proximal to the ankle joint

Extraarticular deformities proximal to the ankle joint are usually of posttraumatic origin and originate from malunited distal tibial fractures. They should be corrected at the level of the deformity, according to the CORA-principle. Depending on the level of the deformity, sometimes a separate skin incision is necessary. An appropriate distance to the other skin incisions should be considered. In most of the cases extending the standard anterior approach for ankle replacement proximally will allow for sufficient exposure. Varus deformities of the distal tibia can be corrected either with a medial opening wedge supramalleolar osteotomy, a dome osteotomy or a lateral closing wedge supramalleolar osteotomy [14-16]. In our practice we prefer the medial opening wedge osteotomy as the lateral closing wedge osteotomy requires an additional osteotomy of the fibula [17]. Usually correction of larger deformities with a tibia malalignment of 10° or more requires a corrective fibula osteotomy to achieve a physiological alignment and a centred ankle joint [11,17].

It is crucial to consider the size and position of the prosthetic implants to be still able to implant them after deformity correction.

Even though supramalleolar corrections and joint replacement can be performed as a one-step procedure we usually prefer a two-step approach in middle stage osteoarthritis. Quite frequently restoring the mechanical alignment and the ligament and tendon balancing may improve hindfoot biomechanics resulting in substantial pain relief to that extent, that the joint replacement can be relevantly postponed [10,18-21]. Quite naturally this does not apply for cases of marked degenerative changes, where the talus and the tibia are in bony contact over the complete joint line - a significant improvement of the patient's pain with realignment surgery only is not realistic there.

### Deformity at the level of the ankle joint

In deformities at the level of the ankle joint congruent deformities need to be distinguished from non-congruent deformities [5]. In congruent joints the deformity is caused by a deviation of the axis of the distal tibia or an erosion of the joint surface. The talus is tilted in relation to the tibia axis, not to the distal tibia joint axis [5].

In non-congruent varus ankle osteoarthritis the talus is tilted in addition in relation to the joint axis of the distal tibia. There are frequently lateral ligament instabilities and contracted medial ligaments of the ankle [10]. In some cases the increased pressure on the medial part of the joint will even erode the medial malleolus [5].

In congruent deformities malalignment of maximally 10° can be corrected with neutralizing saw cuts of the distal tibia to achieve a plantigrade joint [10]. This will require the use of a significantly higher inlay and will transfer the centre of rotation of the ankle joint proximally [10]. Congruent deformities of more than 10° require additional corrective osteotomies [10]. The medial ligament complex is quite often contracted and needs to be released to be able to correct the talar tilt. The first step of ligament balancing is to remove the medial osteophytes. This will already release some of the tension on the medial ligaments [10]. A complete subperiosteal release at the ligament insertion at the medial malleolus [22]. Alternatively the medial ligaments can be released very gently at the distal insertion using an osteotome [8]. In cases with eroded or dysplastic medial malleolus the lengthening osteotomy of the medial malleolus is a very elegant option to restore the shape of the medial malleolus [23]. It basically consists of a subtotal medial malleolus osteotomy which allows adduction of the malleolus to the necessary extent to release the tension of the delta ligament. The bone defect can be filled with autologous graft or allograft and the osteotomy is stabilized using two percutaneous screws [23].

After correcting the ligaments on the medial side of the joint, ligament tension on the lateral side needs to be examined. In some cases a good medial release and the use of a bigger PE-Inlay is sufficient to tighten the lateral ligaments. The use of two laminar spreaders on either side of the joint helps to judge the ligament balance [5]. If there is a persistent lateral laxity and instability anatomic reconstruction of the lateral ligaments should be performed [24]. Sometimes the local soft tissue like ligament remnants, scar tissue and the extensor retinaculum do not allow a sufficient ligament reconstruction. Roukis [25] has described a technique for a modified Evans peroneus brevis transfer to reconstruct the lateral ligaments. We prefer to use tendon grafts from other anatomic localisations like the plantaris tendon [26-29] or the hamstrings [29] instead as we want to preserve the ankle-stabilizing function of the peroneus brevis.

If the function of the short peroneal muscle is impaired it should be restored with a peroneus longus to brevis transfer [10]: the tendon of the peroneus longus is exposed using an incision over the cuboid. Then it is cut distally, and reinserted proximally to the base of the 5th metatarsal and a tenodesis to the peroneus brevis tendon is done proximally. It is crucial to perform the tendon transfer with the foot in maximally everted and slightly plantar flexed position [8,27]. Thereby a relevant strengthening of the peroneus brevis function can be achieved.

Some cases with extensively contracted medial soft tissue structures will need a lengthening of the tendon of the tibialis posterior. A very elegant operative technique using a recession of the tibialis posterior at the musculotendinous junction allowing for a safe and consistent lengthening of the tendon [28].

### Deformity distal of the ankle joint

After correcting the deformity proximal to the ankle joint and at the level of the ankle joint it is necessary to examine the foot intraoperatively for relevant inframalleolar deformities or midfoot

deformities [10]. Persisting inframalleolar varus deviation can be caused by deformities of the calcaneus, the subtalar joint or imbalances of the muscles acting on the hindfoot, like a contracted tibialis posterior tendon or an impaired function of the peroneus brevis muscle.

If the heel stays in varus position, we perform a lateral sliding osteotomy of the heel. This surgical procedure should be performed in patients with flexible subtalar joint without relevant degenerative changes. Depending on the deformity, the heel can be shifted 8-14 mm. In big deformities removing a lateral based wedge of bone (Dwyer osteotomy) may increase the power of the correction [30,31]. A z-shaped osteotomy of the calcaneus in large deformities allowing to correct the underlying malalignment in several planes at a time [32].

In patients with a rigid inframalleolar malalignment or relevant degenerative changes of the subtalar joint we use a corrective subtalar fusion or a triple arthrodesis to restore alignment [10,17].

In cavovarus deformity of the foot 1<sup>st</sup> ray is quite commonly plantar flexed with marked forefoot pronation. This influences the hindfoot as a “fore-foot-driven hindfoot-deformity”. We treat these cases with a dorsal extending osteotomy of the medial cuneiform [33] or of the proximal 1st metatarsal [33,34]. Usually a release of the plantar fascia is necessary for efficient closing of the osteotomies [35]. Osteotomies of the medial cuneiform allow for a greater correction than those of the 1<sup>st</sup> metatarsal.

In varus ankle osteoarthritis the gastroc-soleus complex is frequently shortened. The Silfversklöld-test [36] allows distinguishing a shortening of the gastrocnemius from a shortening of the heel-cord. We usually use the gastroc-soleus recession as described by Baumann [37] to address shortening of the gastroc-soleus, and triple hemisectioning of the achilles tendon in cases with shortened achilles tendon [38]. If the hindfoot is in a varus position, doing 2 cuts of the hemisectioning on the medial side lengthens the lateral part of the heel cord more than the medial, which weakens the varus force of the Achilles tendon [38] and thus supports the correction.

### Postoperative protocol

Immediately postoperatively the patients receive a sterile wound dressing and an immobilizing splint. After 48 hours the wound dressing is changed. Depending on additional surgery the patient is immobilized with a below knee cast or a stabilizing orthosis for 6-8 weeks postoperatively. If corrective osteotomies or fusions are performed, or if the bone is very weak the weight bearing is limited to 15 kg for 6-8 weeks. In the case of ligament or tendon reconstructions we recommend 4 weeks of immobilization.

### Limits of deformity correction

The initial reports after ankle replacements in varus ankle osteoarthritis have been quite disappointing [7,39]. The results published currently are more encouraging, if additional surgery is used to achieve a neutral alignment of the ankle.

The results of ankle replacements with up to 10° deformity in one group with ankle replacements with a coronary deformity of 11-30° in a 2nd group [1]. In 123 patients they could not find significant differences in range of motion or complication rate after a mean follow up of 4 years. Did not find significant differences in the postoperative results comparing congruent and non-congruent varus arthritic ankles that had been treated with a total ankle replacement [8]. They used a

stepwise approach to correct osseous and soft tissue malalignment. 23 total ankles with a preoperative varus of 10° to 28° had been compared with 22 neutrally aligned ankles. After a mean follow-up of 27 months no significant difference between the two groups could be identified in the clinical and radiological results [8].

### Summary

In patients with varus hindfoot alignment and degenerative ankle osteoarthritis congruent deformities need to be distinguished from non-congruent deformities. The mechanical axis of the lower limb needs to be respected as the inframalleolar alignment. Deforming forces proximally and distally need to be identified. Ankle replacement with promising results is possible even in patients with relevant axis deviations if a plantigrade position of the foot with balanced soft tissue can be achieved. Osseous and soft tissue balancing can require osteotomies, fusions, ligament reconstructions and tendon transfers of hindfoot and midfoot.

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