HINTEGRA Revision Arthroplasty for Failed Total Ankle Prostheses

Surgical Technique

Beat Hintermann, MD, Lukas Zwicky, MSc, Markus Knupp, MD, Heath B. Henninger, PhD, and Alexej Barg, MD

Based on an original article: *J Bone Joint Surg Am.* 2013 Jul 3;95(12):1166-74.

Introduction

In our experience, revision ankle arthroplasty with a three-component total ankle prosthesis following a failed total ankle replacement has provided encouraging midterm results with substantial pain relief while preserving the range of motion of the replaced ankle.

Ankle arthrodesis has long been considered the “gold standard” treatment in patients with a failed total ankle replacement¹⁻⁴. Revision arthroplasty is a viable salvage option for failed total ankle replacement. Our technique for revision ankle arthroplasty with a three-component total ankle prosthesis in patients with a failed total ankle replacement is done in the following stages.

Step 1: Preoperative Assessment and Planning

Determine the treatment using a decision algorithm.

- Carefully assess the form, position, and instability of the foot and ankle (Figs. 1-A and 1-B) with regard to deformities, previous surgical scars, and remaining motion. Use a goniometer to determine the ankle range of motion during weight-bearing^{5,6}. Test hindfoot stability manually with the patient sitting.
- Use standard weight-bearing radiographs in three planes (Figs. 2-A, 2-B, and 2-C) and a hindfoot alignment view⁷ for standardized assessment of varus and valgus rotation of the hindfoot (Fig. 2-D). Use computed tomography (CT) or single-photon emission CT (SPECT)^{8,9} to evaluate for bone defects due to loosening of prosthetic components, to identify the source of pain due to osseous impingement

(Fig. 2-E), and to assess degenerative changes of the adjacent joints.

- Determine the treatment using the decision algorithm in Figures 3-A and 3-B.
- Plan the fabrication of a custom talar implant in type-3 defects using CT scans and standard radiographs of the contralateral, unaffected ankle.

Step 2: Patient Positioning

Use spinal or general anesthesia, administer intravenous antibiotics, position the patient supine, and apply a tourniquet.

- Use spinal or general anesthesia during the reconstruction.
- Use a single prophylactic dose of intravenous antibiotics within twenty minutes prior to the start of surgery.
- Position the patient supine on a radiolucent operating table.
- Apply a tourniquet on the ipsilateral thigh and exsanguinate the limb prior to inflating the tourniquet.
- Prepare and drape the limb below the knee.

Step 3: Surgical Approach to the Failed Prosthesis

Use an anterior approach to expose the failed ankle prosthesis.

- Use the primary incision to expose the ankle joint. For most current total ankle designs, the anterior approach is used¹⁰. In cases where an alternative lateral approach has been used (e.g., for insertion of an ESKA ankle

prosthesis), use a standard anterior ankle approach.

- Make an anterior longitudinal incision (10 to 14 cm) to expose the retinaculum. Identify the anterior tibial tendon and incise the retinaculum along the lateral border of the anterior tibial tendon. Pay attention to the tibialis anterior vascular bundle, which runs behind the extensor hallucis longus or between the extensor hallucis longus and the extensor digitorum longus¹¹.

Step 4: Removal of the Prosthesis

Remove the polyethylene insert, the talar component, and the tibial component, making sure to not compromise any remaining bone stock.

- Remove the polyethylene insert (in cases in which a three-component ankle prosthesis with a mobile bearing was used).
- Verify the stability of the metallic components.
- Remove unstable components, making sure not to damage the remaining bone stock. If necessary, use an impactor to disengage the implant from the host bone.
- On the talar side, the impactor can be inserted percutaneously from the plantar aspect of the foot to meet the anterolateral corner of the implant (Fig. 4-A).
- In patients with a stemmed tibial component, create a window through the anterior cortex to remove the tibial component (Fig. 4-B).
- Revise a stable tibial implant in the following cases:
 - If the tibial component is malpositioned in the coronal plane (e.g., in varus or valgus) or sagittal plane (e.g., anterior or posterior tilt) such that it would not allow for a well-balanced ankle.
 - If the articulating surface of the tibial implant is damaged (e.g., due to metallic wear).
 - If the polyethylene insert would not be covered by the tibial component during the whole range of motion (which may result in edge loading of the insert with subsequent pathologically increased wear), which is typically the case for a tibial component placed too medially, too laterally, or in a malrotated position.
- Revise a stable talar component in the following cases:
 - If the talar component is malpositioned in the coronal plane (e.g., in varus or

valgus) or sagittal plane (e.g., a too anterior or a too posterior position) such that it would not allow for a well-balanced ankle.

- If the talar component is malrotated such that it would not allow for appropriate mechanical play.
- If the articulating surface of the talar implant is damaged (e.g., due to metallic wear).
- Once one or both metal components have been removed, carefully debride the bone surfaces (Fig. 4-C) and gutters. Resect the posterior aspect of the capsule of the tibiotalar joint, and be careful not to damage the neurovascular structures.
- After debridement of the bone surfaces, verify your preoperative planning by assessing the amounts of the talar and tibial osseous defects. When a large bone defect is encountered, adapt the treatment accordingly.

Step 5: Revision Ankle Arthroplasty

Prepare the tibial and talar bone stock to obtain solid osseous surfaces, and use the appropriate prosthetic components.

- Prepare the tibial bone stock:
 - Position the tibial cutting block, using the anterior intersection line of the ankle as a reference, the tibial tuberosity rod for alignment in the coronal plane, and the anterior tibial rim to align the rod in the sagittal plane.
 - Adjust the resection block with the aim of minimizing bone removal on the circumferential cortex of the distal tibial metaphysis (Fig. 5-A).
 - Fill the central defect with cancellous bone, allograft, or demineralized bone matrix (Fig. 5-B) to create a flush osseous surface (Figs. 5-C and 5-D).
- Prepare the talar bone stock:
 - If the bone stock on the talar side is considered sufficient for the use of a standard component, defects and cysts should be debrided and the surface should be minimally trimmed with use of a small saw or rongeur to accommodate the undersurface of the new component (Fig. 6).
 - If the bone stock is considered deficient (Fig. 7-A), minimal flat resection is done with the saw. While holding the foot precisely in the neutral position,

complete a cut parallel to the tibial resection (Fig. 7-B).

- Position the talar resection block for revision components on the flat resection surface on the talus under fluoroscopic control, and fix it to the talus with pins (Fig. 7-C).
- Create the medial and lateral cuts and remove bone fragments.
- Fill any central defects with cancellous bone, allograft (Fig. 7-D), or demineralized bone matrix paste (DBX; Synthes, Oberdorf, Switzerland).
- Use screw fixation to enhance the stability of the allograft (Fig. 7-E).
- In the case of extended bone defects, prepare the bone surface according to the custom implant geometry¹².
- Insert the talar component:
 - Select the type and size of component according to the plan and previous preparation of the bone stock.
 - In the case of residual small defects on the prepared surfaces, place demineralized bone matrix on the undersurface of the talar component, insert the component while using the pegs as guides, and impact it to achieve firm fixation to the bone (Fig. 8-A).
- Insert the tibial component:
 - Select the type and size of component according to the plan and previous preparation of the bone stock.
 - In the case of residual small defects on the prepared surfaces, apply demineralized bone matrix on the undersurface of the tibial component, insert the component while using the pegs as guides, and impact it to achieve firm fixation to the bone.
 - If primary stability of the tibial component is critical, use two screws for additional fixation. We avoid the use of interference screws if at all possible when concerns about interference forces arise.
- Place the polyethylene insert:
 - Select the size of polyethylene insert according to the size of the talar component.
 - Select the polyethylene insert thickness with the use of trial implants. The goal is to achieve sufficient stability against varus and valgus rotational forces by tensioning the collateral ligaments;

avoid overtightening to reduce the risk of postoperative pain.

- Place the selected polyethylene insert and verify the position of all implant components with fluoroscopy (Fig. 8-B)

Step 6: Additional Surgical Procedures (If Necessary)

If necessary, perform arthrodesis of adjacent joints, correcting osteotomies of the distal parts of the tibia and fibula, calcaneal osteotomy, and/or ligamentoplasty.

Arthrodesis of Adjacent Joints

- Preoperatively assess the adjacent joints with regard to painful osteoarthritis, stiffness causing deformity, and instability.
- If osteoarthritis is detected clinically and radiographically, use SPECT and/or a test local anesthetic injection to confirm that it is the source of pain.
- Perform any arthrodesis prior to the revision arthroplasty.

Subtalar Arthrodesis

- Expose the subtalar joint through a minimal lateral approach.
- Do not debride the sinus tarsi in order to avoid damage to the vascular supply of the talar body.
- Use the Hintermann distractor¹³⁻¹⁵ (Integra, Plainsboro, New Jersey/Newdeal, Lyon, France) to open the joint.
- Debride the articular surfaces to subchondral bone. In the case of sclerosis, use a drill to perforate the sclerotic bone.
- Use bone-grafting or demineralized bone matrix if necessary.
- Use two or three screws for rigid fixation of the talus to the calcaneus in an appropriate position.

Talonavicular Arthrodesis

- Extend the anterior approach to the ankle distally by 2 to 3 cm.
- Use the Hintermann distractor¹³⁻¹⁵ to open the joint.
- Debride the articular surfaces to subchondral bone. Perforate any sclerotic bone with drill holes.
- Use bone graft or demineralized bone matrix if necessary.

- Use two or three screws for rigid fixation of the navicular to the talar head. Be certain to maintain the forefoot in a neutral position.

Combined Arthrodesis

- Combine the subtalar and talonavicular arthrodeses when both joints have evidence of symptomatic osteoarthritis^{16,17}.

Syndesmotic Arthrodesis

- Expose the syndesmosis through an anterior approach.
- Debride the tibial and fibular sides with an osteotome and/or saw.
- Close the syndesmosis with a strong clamp. Use an interpositional autograft or allograft if desired.
- Fix the fusion site with two or three percutaneously inserted screws. Use a fibular plate in the case of poor bone quality to enhance the compression force of the screws.

Osteotomy of the Distal Part of the Tibia

- When needed, perform an osteotomy of the distal part of the tibia prior to the revision arthroplasty¹⁸.
- Use the osteotomy to correct a recurvatum deformity, realigning the distal part of the tibia in the sagittal plane. With this procedure, the center of mass is brought forward and over the talus (Fig. 9).
- Use the same anterior approach to expose the distal part of the tibia.
- Determine the plane of osteotomy as planned preoperatively with fluoroscopy, and insert a Kirschner wire approximately 4 cm proximal to the joint line. The direction of the Kirschner wire insertion follows the dotted line shown in Fig. 9.
- Make an incomplete cut with an oscillating saw parallel to the Kirschner wire, being careful to preserve the posterior aspect of the cortex.
- Place two Kirschner wires proximal and distal to the osteotomy site. Use a Hintermann distractor over two Kirschner wires to open the osteotomy until the desired correction is achieved.
- Insert a wedged allograft.
- Use rigid plate fixation such as a T-plate with locking screws.

Osteotomy of the Distal Part of the Fibula

- Perform a fibular osteotomy after the revision arthroplasty if the fibula is too long, resulting in lateral ankle instability.

- Expose the fibula through a separate longitudinal lateral approach.
- Make an oblique cut, starting anterodistally just above the syndesmosis and extending posteroproximally.
- Fix the plate to the fibula distally. Then apply compression (manually or with a compression device) to the osteotomy site and, once the desired length has been achieved, secure the proximal aspect of the plate.

Ligamentoplasty

- Assess the stability of the ankle after the revision arthroplasty.
- If there is distinct laxity that could permit dislocation of the polyethylene insert, expose the distal part of the fibula through the anterior approach:
 - Insert an osseous anchor on the anterior aspect of the distal part of the fibula.
 - Use a nonresorbable suture to reattach any attenuated ligament structures.
- When there is marked laxity of the lateral ankle ligaments (without an over-length fibula), expose the distal part of the fibula and the lateral ligaments through a lateral and slightly curved approach:
 - Insert an osseous anchor into the anterior aspect of the distal part of the fibula.
 - Use a nonresorbable suture to reattach the attenuated ligament structures.
 - Use a free plantaris tendon graft to augment the remaining incompetent ligament structures¹⁹.

Calcaneal Osteotomy

- Clinically reassess the alignment of the heel after the revision arthroplasty.
- Add an osteotomy of the calcaneus when the heel remains in a valgus or varus position.
- Use a lateral approach to the calcaneus. Place the incision approximately 1 cm posterior and parallel to the peroneal tendons, avoiding the branches of the sural nerve.
- Insert a small Hohmann retractor on the plantar aspect of the calcaneus and a second one over the calcaneus in the dorsal concavity.
- Use an oscillating saw to create the osteotomy.
- For a valgus heel, medialize the tuberosity with a Hohmann retractor after mobilizing it with a lamina spreader²⁰.

- For a varus heel, lateralize the tuberosity with a Hohmann retractor after mobilizing it with a lamina spreader (Fig. 10).
- Secure the correction with one or two cannulated 5.5 or 7.5-mm screws (Fig. 11).

Step 7: Closure of All Incisions

Close all incisions.

- Close the wound by suturing the tendon sheath and retinaculum and the skin.
- Use drainage without suction.
- Use a soft wound dressing to avoid any pressure so as not to compromise wound healing.

Step 8: Postoperative Care

A short leg splint is worn for two days, followed by partial weight-bearing; the ankle is protected in a splint at night and with a walking boot during the day for six to eight weeks.

- Close the extensor retinaculum with interrupted absorbable sutures.
- Close all incisions with interrupted, nonresorbable sutures and apply a well-padded short leg splint to support the foot in a neutral position for two days.
- Allow partial weight-bearing with the ankle protected in a splint at night and with a walking boot during the day for six to eight weeks.
- Thereafter, allow full weight-bearing and initiate physiotherapy.

Results

Between 2000 and 2010, 117 ankles in 116 patients (fifty-six female and sixty male; mean age, 55.0 ± 12.0 years) who presented with a failed total ankle arthroplasty after a mean of 4.3 ± 3.9 years were treated by revision arthroplasty with use of the HINTEGRA three-component total ankle prosthesis¹². The indications for revision were problems with the metallic components (sixty ankles, 51%), the bone (twenty-eight ankles, 24%), or the soft tissues (twenty ankles, 17%) or infection (nine ankles, 8%). The talar component was revised in 104 ankles (89%) and the tibial component, in 106 (91%). Early complications included a fracture of the malleoli in two ankles and a dislocation of the polyethylene insert in one. Seventeen (15%) of the revision arthroplasties were revised again, usually because of component loosening. For the remaining 100 ankles (85%), the

mean American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot score improved from 44 ± 18 points preoperatively to 72 ± 19 points ($p < 0.01$) at the time of the latest follow-up (mean, 6.2 years). With loosening of components as the end point, the estimated survival of the revision arthroplasties at nine years was 83%. The key for success was firm anchorage of the components to primary bone stock.

What to Watch For

Indications

- A failed ankle prosthesis due to component loosening with or without ongoing subsidence.
- Limited bone loss on both the tibial and the talar side.
- Preserved range of motion.

Contraindications

- Acute localized soft-tissue or deep infection.
- Major bone defects that would not allow for appropriate fixation of metal components.
- Severe vascular or neurological deficiency in the affected extremity.
- Unmanageable instability of the hindfoot.

Pitfalls & Challenges

- *Tendon laceration.* Expose the ankle joint carefully by protecting the anterior tibial tendon and extensor hallucis longus tendon. Remove the posterior scarred capsule carefully to avoid damage to the flexor hallucis longus tendon.
- *Injury to neurovascular bundles.* Expose the ankle joint carefully to avoid damage to the neurovascular bundle. Go directly behind the anterior tibial tendon to the bone and expose the lateral aspect of the distal part of the tibia by sharp dissection. Remove the posteromedial scarred capsule carefully to avoid damage to the tibial nerve.
- *Preserve circumferential bone.* Remove the prosthetic components carefully to avoid damage to the native bone, as that bone will be needed circumferentially for successful anchoring of the revision implants.

Clinical Comments

- Often an infection cannot be clinically excluded preoperatively. In these cases a two-stage approach is safer. The retrieved implants are investigated with sonification for potential bacteriologic contamination²¹. Also, biopsy specimens of bone and soft tissue are

subjected to bacteriologic analysis. A gentamicin-impregnated methylmethacrylate spacer is used temporarily until the sterility of the wound is ensured (Fig. 12).

- The use of larger implants may compensate for extensive bone loss. However, the larger the prosthesis, the greater the biomechanical moment generated at the bone-implant interfaces. Thus, we try to use the smallest implants possible; we prefer to shorten the fibula and, in selected cases, the medial malleolus in lieu of using a larger implant.

- The use of screw fixation may enhance primary stability of the implants. However, we have no evidence of advantages with the use of screws; therefore, we cannot recommend for or against screw fixation.
- The success of revision arthroplasty strongly depends on the degree to which the surgeon can balance the ankle joint. Therefore, we have become more aggressive with the use of additional osseous correcting procedures. In particular, we feel strongly that valgus misalignment should not remain and should be corrected at the time of arthroplasty.

Beat Hintermann, MD

Lukas Zwicky, MSc

Markus Knupp, MD

Clinic of Orthopaedic Surgery, Kantonsspital Baselland Liestal, Rheinstrasse 26, CH-4410 Liestal, Switzerland

Heath B. Henninger, PhD

Harold K. Dunn Orthopaedic Research Laboratory, Department of Orthopaedics, University of Utah, 590 Wakara Way, Salt Lake City, UT 84108

Alexej Barg, MD

Department of Orthopaedic Surgery, University Hospital of Basel, Spitalstrasse 21, CH-4031 Basel, Switzerland. E-mail address for A. Barg: alexejbarg@mail.ru

Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. One or more of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article

References

1. Culpán P, Le Strat V, Piriou P, Judet T. Arthrodesis after failed total ankle replacement. *J Bone Joint Surg Br.* 2007 Sep;89(9):1178-83.
2. Hopgood P, Kumar R, Wood PL. Ankle arthrodesis for failed total ankle replacement. *J Bone Joint Surg Br.* 2006 Aug;88(8):1032-8.
3. Kotnis R, Pasapula C, Anwar F, Cooke PH, Sharp RJ. The management of failed ankle replacement. *J Bone Joint Surg Br.* 2006 Aug;88(8):1039-47.
4. Thomason K, Eyres KS. A technique of fusion for failed total replacement of the ankle: tibio-allograft-calcaneal fusion with a locked retrograde intramedullary nail. *J Bone Joint Surg Br.* 2008 Jul;90(7):885-8.
5. Hintermann B, Barg A, Knupp M, Valderrabano V. Conversion of painful ankle arthrodesis to total ankle arthroplasty. *J Bone Joint Surg Am.* 2009 Apr;91(4):850-8.
6. Lindsjö U, Danckwardt-Lillieström G, Sahlstedt B. Measurement of the motion range in the loaded ankle. *Clin Orthop Relat Res.* 1985 Oct;(199):68-71.
7. Saltzman CL, el-Khoury GY. The hindfoot alignment view. *Foot Ankle Int.* 1995 Sep;16(9):572-6.
8. Knupp M, Pagenstert GI, Barg A, Bolliger L, Easley ME, Hintermann B. SPECT-CT compared with conventional imaging modalities for the assessment of the varus and valgus malaligned hindfoot. *J Orthop Res.* 2009 Nov;27(11):1461-6.
9. Pagenstert GI, Barg A, Leumann AG, Rasch H, Müller-Brand J, Hintermann B, Valderrabano V. SPECT-CT imaging in degenerative joint disease of the foot and ankle. *J Bone Joint Surg Br.* 2009 Sep;91(9):1191-6.
10. Barg A, Knupp M, Henninger HB, Zwicky L, Hintermann B. Total ankle replacement using HINTEGRA, an unconstrained, three-component system: surgical technique and pitfalls. *Foot Ankle Clin.* 2012 Dec;17(4):607-35. Epub 2012 Oct 12.
11. Solomon LB, Ferris L, Henneberg M. Anatomical study of the ankle with view to the anterior arthroscopic portals. *ANZ J Surg.* 2006 Oct;76(10):932-6.

12. Hintermann B, Zwicky L, Knupp M, Henninger HB, Barg A. HINTEGRA revision arthroplasty for failed total ankle prostheses. *J Bone Joint Surg Am.* 2013 Jul;95(12): 1166-74.
13. Hintermann B, Barg A, Knupp M, Valderrabano V. Conversion of painful ankle arthrodesis to total ankle arthroplasty. Surgical technique. *J Bone Joint Surg Am.* 2010 Mar;92(Suppl 1 Pt 1):55-66.
14. Barg A, Brunner S, Zwicky L, Hintermann B. Subtalar and naviculocuneiform fusion for extended breakdown of the medial arch. *Foot Ankle Clin.* 2011 Mar;16(1):69-81. Epub 2010 Dec 30.
15. Sarker SF, Walsh SP. The use of the Hintermann™ Distractor in distal radius osteotomy. *J Hand Surg Eur Vol.* 2013 Feb 12. Epub 2013 Feb 12.
16. Knupp M, Schuh R, Stufkens SA, Bolliger L, Hintermann B. Subtalar and talonavicular arthrodesis through a single medial approach for the correction of severe planovalgus deformity. *J Bone Joint Surg Br.* 2009 May;91(5):612-5.
17. Knupp M, Stufkens SA, Hintermann B. Triple arthrodesis. *Foot Ankle Clin.* 2011 Mar;16(1):61-7.
18. Knupp M, Stufkens SAS, Bolliger L, Brunner S, Hintermann B. Total ankle replacement and supramalleolar osteotomies for malaligned osteoarthritis ankle. *Tech Foot & Ankle.* 2010;9(4):175-81.
19. Pagenstert GI, Hintermann B, Knupp M. Operative management of chronic ankle instability: plantaris graft. *Foot Ankle Clin.* 2006 Sep;11(3):567-83.
20. Stufkens SA, Knupp M, Hintermann B. Medial displacement calcaneal osteotomy. *Tech Foot & Ankle.* 2009;8(2):85-90.
21. Trampuz A, Piper KE, Jacobson MJ, Hanssen AD, Unni KK, Osmon DR, Mandrekar JN, Cockerill FR, Steckelberg JM, Greenleaf JF, Patel R. Sonication of removed hip and knee prostheses for diagnosis of infection. *N Engl J Med.* 2007 Aug 16;357(7):654-63.

Figures

Fig. 1-A

Anterior view of the feet showing swelling and valgus deformity of affected left ankle.

Fig. 1-B

Posterior view of the feet showing swelling and valgus deformity of affected left ankle.

Fig. 2-A

Preoperative anteroposterior weight-bearing radiograph showing an unbalanced ankle with medial translation of the talus.

Fig. 2-B

Preoperative lateral weight-bearing radiograph of the foot and ankle showing loosening of the tibial component.

Fig. 2-C

Preoperative anteroposterior weight-bearing radiograph of the foot showing slight external rotation of the talar component.

Fig. 2-D

Preoperative weight-bearing radiograph (alignment view) showing lateral offset of the calcaneus.

Fig. 2-E

Preoperative SPECT showing hot spots in the medial and lateral gutters. (This is not the same patient as shown in Figs. 1-A through 2-D).

Fig. 3-A

Decision algorithm for revision arthroplasty (talar component) for a patient with a failed total ankle replacement (TAR).

Fig. 3-B

Decision algorithm for revision arthroplasty (tibial component) for a patient with a failed total ankle replacement (TAR).

Fig. 4-A

Removal of a talar component with use of an impactor in a right ankle.

Fig. 4-B

Creation of a window to remove the stemmed tibial component in a right ankle.

Fig. 4-C

Debridement of bone surfaces in a right ankle.

Fig. 5-A

Minimal resection on the tibial side with use of the tibial resection device in a right ankle.

Fig. 5-B

Allograft bone block inserted into the central defect in a right ankle.

Fig. 5-C

Impaction of the allograft with a lamina spreader in a right ankle.

Fig. 5-D

Creation of a flush resection surface in a right ankle.

Fig. 6

Trimming of talar bone stock to accommodate a standard talar component in a right ankle.

Fig. 7-A

Photograph and preoperative radiographs showing a massive bone defect on the talar side after removal of a subsided talar component in a left ankle.

Fig. 7-B

Freehand parallel cut to the tibial resection surface while holding the foot precisely in a neutral position in a left ankle.

Fig. 7-C

Revision resection block mounted to the created flat osseous surface in a left ankle (with fluoroscopic verification).

Fig. 7-D

Impaction of allograft into a central defect with use of a lamina spreader in a left ankle.

Fig. 7-E

Fixation of the allograft with use of headless screws in a left ankle.

Fig. 8-A

Insertion of a talar component with demineralized bone matrix on its undersurface with use of the pegs as guiding tools in a left ankle (with fluoroscopic verification).

Fig. 8-B

Final position after insertion of the tibial component and polyethylene insert showing a balanced ankle and an appropriate position of the implants in a left ankle (with fluoroscopic verification).

Fig. 9

Top: Preoperative weight-bearing radiographs show a destabilized ankle in the sagittal plane after subsidence and anterior tilt of the tibial component, and a talar component positioned too far anteriorly. Bottom: Postoperative weight-bearing radiographs show a well-stabilized ankle after anterior opening-wedge osteotomy of the distal part of the tibia and appropriate positioning of the components. Solid line = weight-bearing axis of the tibia. Center of the circle = center of mass of the talus.

Fig. 10

Intraoperative image demonstrating the osteotomy and mobilization of the calcaneal tuberosity. This is a lateral approach to a left ankle.

Fig. 11

Top: Preoperative weight-bearing radiographs show substantial loosening of a total ankle prosthesis with subsidence of the talar component and varus malalignment of the hindfoot. An allograft with screw fixation has been used on the talar side. Bottom: Postoperative weight-bearing radiographs show a well-stabilized ankle after a lateral sliding osteotomy of the calcaneus and appropriate positioning of the prosthetic components.

Fig. 12

A cement spacer containing gentamicin has been inserted into the osseous defect after resection of a failed total ankle prosthesis because infection was suspected in a left ankle.

Fig. 1-A

Fig. 1-B

Fig. 2-A

Fig. 2-B

Fig. 2-C

Fig. 2-D

Fig. 2-E

A – Bone defect < 18mm – talar body preserved

Solution : TAR - standard component

B – Bone defect 19-24mm - talar body partially destroyed

Solution : TAR - revision component

C – Bone defect >25mm – talar body destroyed

Solution : TAR - custom made component

Fig. 3-A

A – Bone defect < 10mm

Solution : TAR - standard component

B – Bone defect 10-14mm

Solution : TAR - revision component 8mm

C – Bone defect 15-19mm

Solution : TAR – revision component 12mm

Fig. 3-B

Fig. 4-A

Fig. 4-B

Fig. 4-C

Fig. 5-A

Fig. 5-B

Fig. 5-C

Fig. 5-D

Fig. 6

Fig. 7-A

Fig. 7-B

Fig. 7-C

Fig. 7-D

Fig. 7-E

Fig. 8-A

Fig. 8-B

Fig. 9

Fig. 10

Fig. 11

Fig. 12