Indications

A review of 2,240 total ankle arthroplasties (TAAs) from multiple studies with adequate follow-up reveals implant survivorship rates ranging from 70% to 98% at 3 to 6 years and from 80% to 95% at 8 to 12 years. This finding implies that the surgeon who manages ankle arthroplasty must be familiar with revision arthroplasty as well as the conversion of failed TAA to ankle arthrodesis.

All total joint arthroplasties have an increasing failure rate as the interval from implantation increases. The mode of failure varies with the duration of implantation; infection and malalignment predominate early on, whereas aseptic loosening dominates in the later stages. Aseptic loosening occurs as a result of osteolysis, which is characterized by a chronic granulomatous inflammatory response that is stimulated and maintained by implant-derived wear debris. Symptoms generally do not occur before osteolysis has progressed to the point of implant loosening. Overwhelming data in the arthroplasty literature indicate that implant wear particles are the initiator of osteolysis. Any particulate wear debris, including polyethylene, polymethyl methacrylate, or metallic particles, can initiate an osteolytic reaction. The choice of prosthesis and bearing surface affects the composition, size, shape, and concentration of the generated particulate matter. Polyethylene, the predominant particulate debris, is dispersed with joint motion and then occupies the effective joint space. The authors of a 2012 study documented between 100,000 and 500,000 particles released for each step taken by a patient with a polyethylene acetabular cup and a metallic femoral head. The risk factors for osteolysis are male sex, younger age, obesity, polyarthritis, genetic predispositions, and some metallic hypersensitivity. Revision arthroplasties are performed for malalignment, infection, and other reasons, but this chapter reviews only osteolysis and subsidence as the reasons for revision.

Several studies have described implant migration, subsidence, and radiolucencies. However, all these studies are based on serial radiographs, and radiographic changes in the position of the prosthesis or radiolucencies do not necessarily indicate potential implant failure. Several studies have indicated that progressive lucencies or cysts may be managed with bone grafting with successful implant retention provided that the original implant is well fixed. The authors of one study, in an attempt to categorize the complications after TAA, published an algorithm based on a review of 2,386 ankles from 20 separate studies. High-grade complications included aseptic loosening, deep infection, and implant failure, all of which were associated with failure of the TAA. Medium-grade complications included technical errors in alignment, subsidence of the prosthesis, and postoperative fracture and were associated with a moderate failure rate. Low-grade complications included intraoperative fractures and wound healing problems; these complications had a negligible effect on outcome.

Not all prosthetic failures require arthrodesis of the ankle. In a meta-analysis of 13 studies comprising 801 mobile-bearing and 304 fixed-bearing ankle arthroplasties, implant failure was reported in 108 patients (9.8%) at an average of 5.2 years postoperatively. Sixty-seven (62%) of the failed arthroplasties were managed with revision arthroplasty, and only 39% required conversion to arthrodesis.

Contraindications

Inadequate motor innervation or muscle strength to power the ankle joint may
Degenerative Conditions of the Ankle

Alternative Treatments

Osteolysis with areas of extremely small cystic change do not require revision. In these patients, long-term observation can be used to see if these areas enlarge. In addition, the author of this chapter has on occasion used bisphosphonate therapy to slow down and, in one case, reverse, osteolysis. If osteolysis and cyst formation occur in the setting of a well fixed and stable prosthesis, then the cyst may be grafted with or without revision of the metallic components of the ankle prosthesis.

Techniques

Setup/Exposure

• Typically, the location of the osteolysis dictates the exposure. The surgeon should use an approach that allows the most direct access to the area or areas of osteolysis in a safe manner.
• For nearly all revision arthroplasties, the author of this chapter performs a second anterior arthrotomy using the original approach.
• If the patient has previously had wound healing problems, preoperative consultation with a plastic surgeon can be extremely helpful. Occasionally, the author has sent the patient to have a free flap created before the revision arthroplasty procedure to provide adequate skin coverage and decrease the chances of postoperative infection or skin slough.

Instruments/Equipment/Implants Required

• For implant removal, the equipment is critical.
• A thin reciprocal saw allows precision cuts around the barrels of the STAR (Scandinavian Total Ankle Replacement; Stryker) prosthesis as well as the Agility (now available as Agility LP; DePuy) tibial component and the baseplate for the INBONE (Wright Medical Technology) and Salto Talaris (Tornier) implants.
• Straight and curved thin osteotomes can be used to get under the tibial component of the STAR and Salto Talaris prostheses.
• A standard set of impactors can be used to remove the stem of the INBONE prosthesis.
• A pin distractor is nearly always needed to create enough space to remove the polyethylene in a manner that minimizes bone resection.
• An oscillating saw is necessary to create a cortical window in the anterior tibia to allow removal of the tibial stem of the INBONE prosthesis.
• Implants are necessary for revision of an Agility prosthesis. Generally, this involves an INBONE II (Wright Medical Technology) prosthesis with a long tibial stem. Revision of the STAR prosthesis can be accomplished with standard instrumentation when only the tibial component requires removal; however, if the talar component is revised, it is probably best to use an ankle with a flat-top talar revision component, such as in the Salto XT or the INBONE prosthesis. Revision of a Salto talar component can be easily accomplished with the use of a Salto XT, which is a flat-top talar component.
• In addition, bone graft mixed with vancomycin or bone graft substitutes is necessary to fill any defects in the tibia or talus. On occasion, methyl methacrylate may be indicated if the bone is sufficiently weak.

Procedure

Revision with Retention of the Original Metal Implant

• Preoperative planning for revision TAA should include a thorough physical examination, with particular attention paid to any previous skin problems or wound healing problems.
• The patient’s neurovascular status must be carefully assessed, and adequate motor units to power a revision arthroplasty must be available.
• Weight-bearing AP, lateral, and Saltzman radiographs are critical for the overall assessment of the alignment.
• In addition, if excessive knee varus or valgus or overall lower extremity malalignment is a concern, full-length standing radiographs that include the hip, knee, and ankle are necessary.
• Radiographic changes indicating osteolysis are generally more easily seen around the tibial component than around the talar component because most talar components are fixed with fin, barrel, or stemmed devices and the talar component therefore frequently obscures the bony anatomy beneath the talar cap.
• For this reason, the author of this chapter obtains thin-cut CT scans of all patients who are considered for revision arthroplasty. The CT scan allows for the detection of cysts in both the tibia and the talus (Figure 1).
• Assessing the amount of osteolysis and the potential subsidence of the prosthesis can help the surgeon decide whether revision surgery or arthrodesis is a better option.
• In patients with some older prostheses, such as the Agility prosthesis,
so much resorption may have occurred under the talus that the remaining bone stock is inadequate to allow revision arthroplasty. This type of subsidence can be seen with any prosthesis, especially if the initial arthroplasty was performed on a flat-top talus and the talar cut removed a significant portion of the superior dome of the talus.

- Other prostheses (e.g., Buechel-Pappas; formerly manufactured by Endotec), unless they were recently implanted, may be heavily ingrown, such that removing the talar prosthesis is impossible without a flat cut that would further remove talar bone. This scenario, too, may make revision surgery nearly impossible.

- After the CT scan and physical examination are complete and the surgeon has verified that the patient’s pain is originating from the ankle and not from the subtalar joint or potentially from medial or lateral gutter impingement, the next step is planning for the revision arthroplasty.

- The revision is performed through the same incision, which in most patients is the anterior retinaculum over the extensor hallucis longus tendon.

- Adequate exposure medially and laterally to allow visualization of the medial and lateral gutters and the medial and lateral malleoli is critically important. In most patients, the anterior ankle capsule is extremely thick and frequently has been invaded with granulomatous material that may necessitate its complete excision (Figure 2).

- Ideally, the capsule would be preserved, but preservation is rarely possible.

- As in any revision arthroplasty, obtaining intraoperative cultures and frozen tissue for pathology is important (Figure 3).

- In patients with mobile-bearing prostheses, the polyethylene component can generally be easily removed unless it is fractured. If difficulty is encountered or the polyethylene has fractured, using a pin distractor will allow separation of the joint so that the posterior portion of the polyethylene can be easily removed.

- In patients with the fixed-bearing Salto Talaris prosthesis, the polyethylene can generally be removed using a small osteotome to lever the polyethylene off the rails on the tibial side (Figure 4). A specially designed clamp is available for polyethylene removal, but the author of this chapter does not find it useful.

- In patients with the INBONE or Agility prosthesis, drilling out the insertional ridges on the tibial...
component may be necessary. A cortical screw can then be placed in the anterior center of the polyethylene component, and with strong traction, the polyethylene can be removed without damaging the tibial component (Figure 5).

- At this point, the stability of the tibial and talar components must be assessed. This assessment is best done by using probes and small osteotomes placed on the edge of the prosthesis (Figure 6).
- Despite the fact that the CT scan may show significant osteolysis, in the author’s experience, many of the components are well fixed and can be left in place as long as the granulation tissue that is invading the bone and producing the osteolysis can be removed and the defect can be filled (Figure 7).
- On the tibial side, the cysts tend to occur in the medial malleolus and laterally above the tibial component. Frequently, a cortical window must be made above the tibial component to remove the granulation tissue.
- In patients with stemmed prostheses, a cortical window in the tibia is almost always necessary to expose the intramedullary component (Figure 8).
- If the talar component seems to be well fixed and large lytic areas beneath the talar cap are seen on the CT scan, a bone trephine can be used to create a cortical window either anteromedially or anterolaterally (Figure 9). This method provides access to the posterior surface of the components that cap the talus. From this approach, granulomatous material can be excised using a curet and rongeurs.
- In addition to removing all granulomatous material from around the tibia and the talus, any granulomatous material that is in the posterior aspect of the joint or on the posterior capsule must be removed. To access the posterior capsule, pin distractors to provide greater access within the ankle and curved curets to get around the corners of the

![Figure 4](image1.png)  
**Figure 4** Intraoperative photograph shows removal of polyethylene from a Salto Talaris prosthesis without damaging the tibial component.

![Figure 5](image2.png)  
**Figure 5** Intraoperative photograph shows drilling along the rails of the polyethylene insert of an INBONE prosthesis, which allows for polyethylene removal without explanting of the tibial stem.

![Figure 6](image3.png)  
**Figure 6** Intraoperative photographs show a probe used to assess the stability of the tibial (A) and talar (B) components in the revision of a total ankle arthroscopy with a STAR (Scandinavian Total Ankle Replacement) prosthesis.

![Figure 7](image4.png)  
**Figure 7** Intraoperative photograph shows a pin distractor applied to both the tibia and the talus; this allows a curet to be placed through the tibial cyst from the anterolateral tibia down to the tibial component. Note the bone strands that extend to the porous cylinder on the tibial component, maintaining tibial prosthesis stability.
prosthesis are frequently necessary (Figure 10).  
- If both the tibial and talar components are well fixed, the resorbed area of bone must be replaced with either crushed cancellous bone graft or a bone substitute that will provide and help maintain structural integrity around the prosthesis. Calcium phosphate products, injected as a liquid and allowed to harden, have been successfully used to provide support in areas of osteolysis (Figure 11).

**REVISION ARTHROPLASTY WITH A POORLY FIXED COMPONENT**

- If both components are loose, removal of the prosthesis is required, and the type of revision arthroplasty must be chosen.
- In patients with a failed Agility prosthesis, the author of this chapter has used only the INBONE prosthesis for revision. The author believes that the incorporation of a stem onto the tibia can provide good stability (Figure 12). Furthermore, most patients who require revision of TAA with an Agility prosthesis have significant talar bone loss.
- A minimal flat-top cut as is made with the INBONE prosthesis will often leave enough bone remaining that the short (10-mm) talar stem can be easily accommodated. This fixation, together with the new INBONE II anterior prong talar fixation and the deep sulcus polyethylene, can provide excellent stability.
- Other options are to use just anterior prong fixation, omitting the stem, or a longer (14-mm) talar stem and perform arthrodesis of the subtalar joint.
- For the Salto Talaris prosthesis, custom tibial stems have been available from the manufacturer in 30- and 40-mm segments with a tibial base plate increased by a thickness of 4 mm. These stems allow the surgeon to accomplish revision of a loose tibial component by
freshening up the distal surface of the tibia, cutting an anterior window, and inserting the custom prosthesis with a standard polyethylene insert.

• For revision of TAA in patients with a STAR prosthesis, if the tibial component is loose, the tibia can be recut using regular instrumentation, and the tibial component can be moved superiorly (Figure 13). However, the thickest revision polyethylene insert available is only 14 mm. If the defect exceeds this width, revision surgery with implantation of an INBONE prosthesis must be considered.

• In the author’s experience, revision of TAA in patients with an INBONE prosthesis can generally be accomplished only through revision to another INBONE prosthesis with a longer tibial stem and thicker polyethylene components.

Wound Closure

• A layered closure is paramount to avoid catastrophic wound complications.

• If an anterior approach is used, special attention should be paid to closure of the retinaculum. This closure may be challenging because of scarring and diminished tissue compliance resulting from previous surgery.

Postoperative Regimen

Revision arthroplasties are treated the same as primary ankle replacements. The procedure is generally done under a popliteal catheter block, which
allows for postoperative pain relief. A suction drain is used for the first 24 hours after the procedure. The author of this chapter places the patient in a short leg cast immediately postoperatively. Patients are discharged the day after revision arthroplasty and are seen in the clinic 3 weeks postoperatively. At that time, the cast is removed, and the wound is inspected. If only polyethylene exchange or bone grafting of the cyst was performed, partial weight bearing is allowed at 3 weeks postoperatively, and full weight bearing is allowed at approximately 6 weeks. If the tibial or talar components needed revision or other procedures were performed, the patient is generally kept in a cast for 6 weeks, and partial weight bearing is initiated at 6 weeks, with full weight bearing at 12 weeks.

Avoiding Pitfalls and Complications

The foremost concern during revision arthroplasty is to do no harm. Care of the soft tissues is of critical importance. The initial surgical exposure for all ankle arthroplasties has resulted in substantial wound problems. These anterior incisions can be troublesome for a revision arthroplasty and may require special techniques, such as the use of a preoperative free flap or consultation with a plastic surgeon. In addition, at the time of revision, the surgeon must handle the soft tissues with great care and not allow continuous retraction on the skin, which may result in necrosis.

It is critically important that the surgeon exercise great care when removing the implanted prosthesis so as to not sacrifice tibial or talar bone. Removal is best accomplished by using a very thin reciprocal saw to cut around the metallic components and thin osteotomes and gentle distraction techniques. Finally, as with primary insertion of a prosthesis, overall alignment of the revised component is critical. Malpositioning of the components allows for premature wear and failure of the revision.

Bibliography


Degenerative Conditions of the Ankle


