Bone augmentation for revision total ankle arthroplasty with large bone defects

A technical note on 10 cases

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Until recently, revision arthrodesis was the standard salvage procedure for failed total ankle arthroplasty (TAA) (Groth and Fitch 1987, Kotnis et al. 2006, Culpan et al. 2007, Doets and Zurcher, 2010, Henricson and Rydholm 2010). However, recent studies have investigated the efficacy of revision TAA (Espinosa and Wirth 2013, Hintermann et al. 2013 , Zgonis 2013) but most of them have not specifically addressed the problem of deficient bone stock. This technical note shows how to perform revision TAA in patients with substantial bone loss.

Patients and method

Treatment algorithm and surgical technique

Bone loss was quantified on a CT scan for preoperative planning. Large bone defects were reconstructed with structural iliac autograft and iliac crest spongiosa, stabilized as needed with screws and plates, and TAA was performed with primary or revision components. Intravenous cefuroxime (1.5 g) was administered preoperatively and then continued postoperatively every 8 h for 72 h.

The procedure was performed either as a 1-stage or a 2-stage revision. The previous anterior ankle incision was used, passing between the anterior tibial tendon medially and the extensor hallucis longus tendon laterally. The ankle was cleaned of ventral scar and osteophytes and the loosened implants were removed. Necrotic tissue was debrided. Talar dome necrosis or defect was treated with a revision flat cut implant. Bony defects/cysts in the talar body were filled with spongiosa. For larger structural defects at the tibial plafond, medial and lateral malleolus mono- or bicortical autografts were used and fixed by press-fit, or with screws or plates. Concomitant hindfoot deformity, which is recognized as a major part of the etiology of failure, was corrected by osseous realignment procedures in 3 cases. Soft tissue procedures, in particular gastrocnemius-soleus release, were used in 4 cases to further increase range of motion.

1-stage revision

In 6 patients in whom the bone defect did not affect mechanical stability of the components (i.e. if the malleoli or limited areas of the talar body were affected), 1-stage revision TAA was performed together with bone augmentation. Bone cysts, especially on the talar side, were filled with autologous iliac crest spongiosa. Deficient non-weight-bearing areas on the tibia or walls of the malleoli were reconstructed with mono- or bicortical iliac crest blocks of appropriate size, and fixed by press-fit or with screws or plates. We used revision implants (Hintegra; Integra LifeSciences, Plainsboro, NJ) with a flat talar component with fixation pegs and tibial components of different thicknesses for appropriate reconstruction of the physiological joint line.

2-stage revision

In 4 patients in whom the bone defect was in the weight-bearing area of the tibial plafond and the talar body, a 2-stage revision TAA was chosen. The first stage involved iliac crest bone augmentation of the ankle (bone restoration step); in the second stage 3–4 months later, a revision TAA was implanted. In the first stage, the bone defect was measured and a bicortical autologous iliac crest graft was harvested and fixed in the ankle with 3.5-mm cortical screws to the tibial plafond or talar body. Malleoli and talar defects were reconstructed as described above for the 1-stage reconstruction approach. A conventional polyethylene inlay served as a temporary

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Demographic details of the patient cohort

Patient no.	Primary prosthesis	Years until revision	Revision stages	Bone augmentation
1	Agility	2	1	Tibia: 2× monocortical
2	Hintegra	8	2	Talus: bicortical, spongiosa
3	Hintegra	10	2	Talus/tibia: bicortical
4	Salto	4	1	Tibia: 1× monocortical; Talus/tibia: spongiosa
5	Buechel-Pappas	6	1	Tibia: bicortical; Talus: spongiosa
6	Hintegra	4	1	Talus: spongiosa
7	Hintegra	5	1	Talus: monocortical
8	Agility	8	1	Tibia: 2× bicortical
9	Hintegra	2	2	Tibia: 2× bicortical; Talus: spongiosa
10	STAR	11	2	Tibia: spongiosa

spacer between the tibia and talus. Patients were allowed partial weight bearing with a walker. 3–4 months after the first operation, osseointegration of the bone augmentation was determined by CT scan. In cases with integration of the bony grafts, the second stage was performed: hardware removal and implantation of TAA revision components.

Rehabilitation

Postoperatively, the ankle was immobilized in a walker with partial weight bearing for 8 weeks. A low-molecular-weight heparin was administered during the time of partial weight bearing. Active and passive motion of the ankle was encouraged. A rehabilitation program was continued after walker removal—for at least 4 months, including walking exercises and stretching and strengthening of the triceps surae.

Patients (Table)

Between 2007 and 2011, 10 patients (mean age 52 (29–71) years, 6 women) with aseptic loosening of TAA associated with extensive bone loss at the tibia, the talus, or both, presented at our foot and ankle service. The TAA had been in place for mean 6 (2–11) years. In all cases, the preoperative diagnosis was posttraumatic osteoarthritis (OA). There were 4 Hintegra prostheses (Integra LifeSciences), 2 STAR prostheses (Small Bone Innovations Inc., Morrisville, PA), 2 Agility prostheses (DePuy Orthopedics Inc., Warsaw, IL), 1 Buechel-Pappas prosthesis (Endotec, South Orange, NJ), and 1 Salto prosthesis (Tornier, Montbonnot Saint Martin, France). Mean follow-up time after revision surgery was 48 (30–74) months.

Results

No intraoperative or perioperative complications were noted. 2 patients (nos. 4 and 6) with 1-stage revision had a conversion to tibiotalocalcaneal arthrodesis 30 months and 35 months after the revision because of persistent ankle pain, but without any signs of aseptic loosening. In the remaining 8 patients, the ankle revision implant was still in place at the latest follow-up. 2 patients had hardware removal in their malleoli. 1 patient developed painful periarticular ossifications, which were treated with open debridement 3 months after the initial revision (no. 7).

At the final follow-up, in 8 patients both tibial and talar components were radiographically stable (Figure). The average visual analog scale (VAS) value decreased from 6.2 to 0.9 ($p < 0.001$). 4 ankles were pain-free at the latest follow-up. The AOFAS hindfoot score increased from 39 (18–56) preoperatively to 84 (72–97) postoperatively ($p < 0.001$). The mean preoperative and postoperative ROM values were comparable for dorsiflexion (4° (–20 to 30) and 7° (0–15), respectively; $p = 0.8$) and plantar flexion (28° (10–45) and 24° (10–30, respectively); $p = 0.2$).

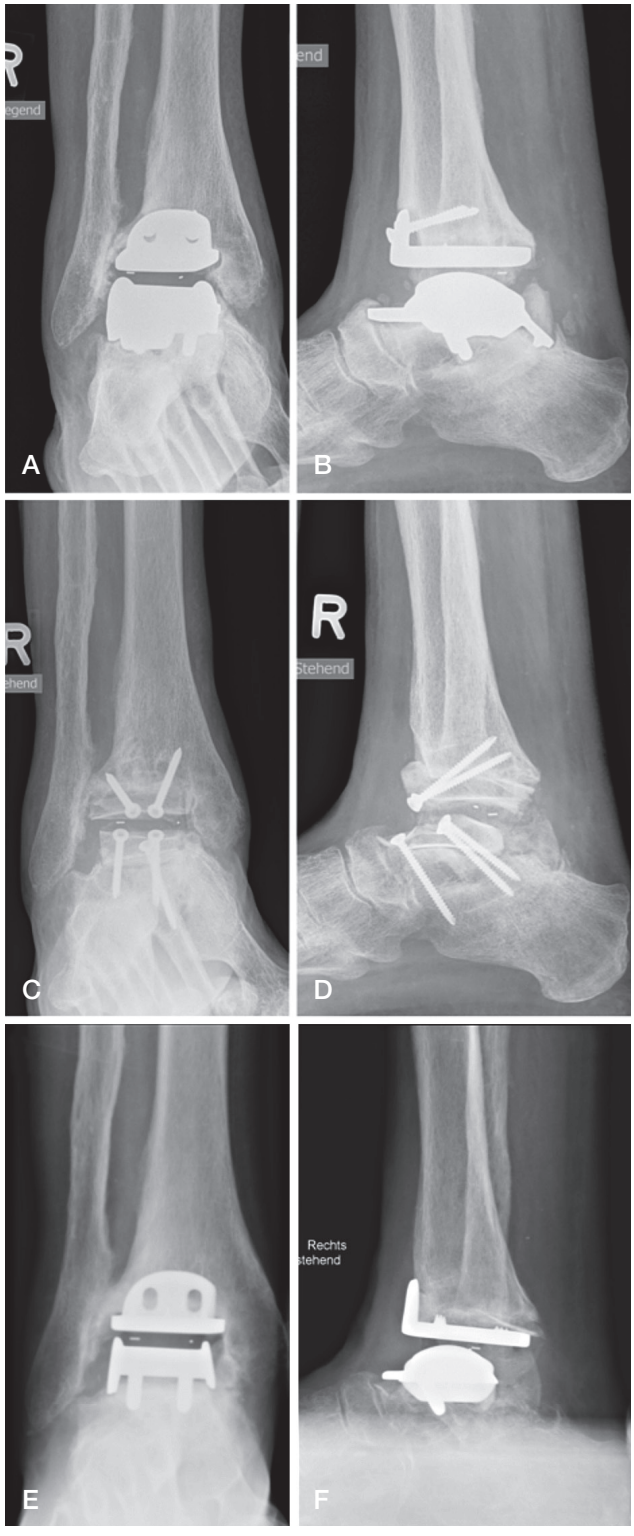
Discussion

Both arthrodesis and revision arthroplasty for failed TAA may be technically challenging, because of large bone defects. Conversion to ankle arthrodesis is considered to be the standard salvage procedure. However, it is associated with a high rate of complications such as non-union and poor outcome (Groth and Fitch 1987, Kitaoka and Romness 1992, Hopgood et al. 2006). In the past decade, revision TAA has emerged as a treatment option (Hintermann et al. 2013). One possible advantage of revision TAA is preservation of ankle motion, which may reduce the risk of development of OA in adjacent joints (Fuchs et al. 2003). Concerning the problem of revision TAA in cases of excessive bone loss, little has been published and this has mostly focused on custom-made components and cement augmentation of cysts (Myerson and Won 2008, Lampert 2011, Hintermann et al. 2013, Ellington et al. 2013, Roukis and Prissel 2014, Prissel and Roukis 2014).

In this technical note, we describe a treatment that aims to restore bone stock, thus allowing the use of commercially available primary or revision TAA implants. Autologous structural iliac crest bone augmentation, as a 1- or 2-stage approach, may reduce the amount of bone defect sufficiently—resulting in good bone stock for the implanted revision TAA system.

The 8 patients who still had the TAA in place had substantial pain relief and functional improvement. Half of the patients had no pain. Range of motion was limited but was comparable to that in other revision TAA studies (Hintermann et al. 2013). This clinical outcome is comparable to what has been reported for salvage arthrodesis in similar cases (Hopgood et al. 2006, Culpan et al. 2007, Schill 2007).

Adequate bone stock was successfully restored. At an average follow-up of 4 years, 2 of 10 cases had to be converted to tibiotalocalcaneal arthrodesis because of persistent pain with substantial arthrofibrosis, but not loosening.



A and B. Aseptic loosening of both components 10 years after initial implantation in a 59-year-old man (case no. 3).
C and D. Bony defects were reconstructed with tricortical iliac crests grafts.
E and F. 3 months later, arthroplasty using revision components was performed. At the 5.5-year follow-up, there were no signs of prosthesis loosening and there was satisfactory clinical outcome.

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