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 monoor 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 weightbearing 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...
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.

**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.
Culpan P, Le S, V, Piriou P, Judet T. Arthrodesis after failed total ankle replacement. J Bone Joint Surg Br 2007; (89): 1178-1183.

Doets H C, Zuricher A W. Salvage arthrodesis for failed total ankle arthroplasty. Acta Orthop 2010; (81): 142-147.

Ellington J K, Gupta S, Myerson M S. Management of failures of total ankle replacement with the agility total ankle arthroplasty. J Bone Joint Surg Am 2013; (95): 2112-2118.

Espinosa N, Wirth S H. Revision of the aseptic and septic total ankle replacement. Clin Podiatr Med Surg 2013; (30): 171-185.

Fuchs S, Sandmann C, Skwara A, Chylarecki C. Quality of life 20 years after arthrodesis of the ankle. A study of adjacent joints. J Bone Joint Surg Br 2003; (85): 994-998.

Groth H E, Fitch H F. Salvage procedures for complications of total ankle arthroplasty. Clin Orthop Relat Res 1987; (224): 244-250.

Henricson A, Rydholm U. Use of a trabecular metal implant in ankle arthrodesis after failed total ankle replacement. Acta Orthop 2010; (81): 745-747.

Hintermann B, Zwicky L, Knupp M, Henninger H B, Barg A. HINTEGRA revision arthroplasty for failed total ankle prostheses. J Bone Joint Surg Am 2013; (95): 1166-1174.

Hopgood P, Kumar R, Wood P L. Ankle arthrodesis for failed total ankle replacement. J Bone Joint Surg Br 2006; (88): 1032-1038.

Kitaoka H B, Romness D W. Arthrodesis for failed ankle arthroplasty. J Arthroplasty 1992; (7): 277-284.

Kotnis R, Pasapula C, Anwar F, Cooke P H, Sharp R J. The management of failed ankle replacement. J Bone Joint Surg Br 2006; (88): 1039-1047.

Lampert C. [Ankle joint prosthesis for bone defects]. Orthopade 2011; (40): 978-983.

Myerson M S, Won H Y. Primary and revision total ankle replacement using custom-designed prostheses. Foot Ankle Clin 2008; (13): 521-538.

Prissel M A, Roukis T S. Management of extensive tibial osteolysis with the Agility total ankle replacement systems using geometric metal-reinforced polymethylmethacrylate cement augmentation. J Foot Ankle Surg 2014; (53): 101-107.

Roukis T S, Prissel M A. Management of extensive talar osteolysis with Agility total ankle replacement systems using geometric metal-reinforced polymethylmethacrylate cement augmentation. J Foot Ankle Surg 2014; (53): 108-113.

Schill S. [Ankle arthrodesis with interposition graft as a salvage procedure after failed total ankle replacement]. Oper Orthop Traumatol 2007; (19): 547-560.

Zgonis T. Revision total ankle replacement. Clin Podiatr Med Surg 2013; (30): 15.

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.