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Commercially Available Trabecular Metal Ankle Interpositional Spacer for Tibiotalocalcaneal Arthrodesis Secondary to Severe Bone Loss of the Ankle

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ABSTRACT

Retrograde tibiotalocalcaneal nailing arthrodesis has proved to be a viable salvage procedure; however, extended bone loss around the ankle has been associated with high rates of nonunion and considerable shortening of the hindfoot. We present the surgical technique and the first 2 cases in which a trabecular metal™ interpositional spacer, specifically designed for tibiotalocalcaneal nailing arthrodesis, was used. The spacer can be implanted using either an anterior or a lateral approach. An integrated hole in the spacer allows a retrograde nail to be inserted, which provides excellent primary stability of the construct. Trabecular metal™ is a well-established and well-described material used to supplement deficient bone stock in surgery of the spine, hip, and knee. It has shown excellent incorporation and reduces the need for auto- and allografts. The trabecular metal™ interpositional ankle spacer is the first trabecular metal spacer designed specifically for ankle surgery. Its shape and variable size will make it a valuable tool for reconstructing bone loss in tibiotalocalcaneal nailing arthrodesis.

Tibiotalocalcaneal (TTC) arthrodesis with retrograde intramedullary nailing has proved to be a viable treatment option for providing solid and well-aligned fusion of the ankle and subtalar joint, re-establishing the ability to walk and participate in activities of daily living (1–4). In the presence of large osseous defects or extended bone necrosis, TTC arthrodesis is a challenging procedure, with high rates of nonunion, reportedly as great as 26% (5–8). TTC arthrodesis in these cases can result in considerable shortening of the affected leg, with, possibly, amputation as the only salvage option (5–8). Cases that often present with large bone defects include patients with failed total ankle replacement and concomitant subtalar involvement, large avascular talar necrosis or bone loss after fractures, and diabetic patients with end-stage Charcot arthropathy of the hindfoot (1,9–11).

Few reports have discussed the problem of large bone loss and necrosis with TTC arthrodesis. The use of large structural iliac crest autografts, distal fibula autografts, femoral head allografts, and bone cement have been described as treatment options to fill the void of missing bone (5–8,12). Because the first 3 options lack vascularity, nonunion and secondary collapse of the reconstructed hindfoot has been reported in up to 24% of cases (9,13,14). Donor site morbidity should not be underestimated when harvesting large structural autografts from the iliac crest, because it has been reported to be as high as 15% to 48% (15–20). Additionally, the anatomy often limits the shape and availability of amenable autografts.

Allograft options carry a risk of disease transmission and have immunogenic issues (13,21). Bone cement as an artificial spacer is an inert foreign body that does not integrate with the surrounding bone and is thus not a good long-term solution.

For the hip, knee, and spine, tantalum trabecular metal™ (TM) has been used as a structural spacer to provide long-term stability and integration into the surrounding bone (22–25). Tantalum is biocompatible, and its mechanical properties have been extensively studied (26–29). Its 3-dimensional structure consists of a series of interconnected dodecahedron pores that resemble cancellous bone. The elastic modulus (3 GPa) is more similar to cancellous bone (0.1 to 1.5 GPa) than either titanium (110 GPa) or cobalt-chrome alloys (220 GPa) (30,31), and its osteoconductive properties enable bone apposition, ingrowth, and remodeling (30,32,33). In a study using a TM specimen retrieved from a human hip, D'Angelo et al (30) showed

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Conflict of Interest: Prof. Valderrabano is a technical expert for Zimmer® (Warsaw, IN).

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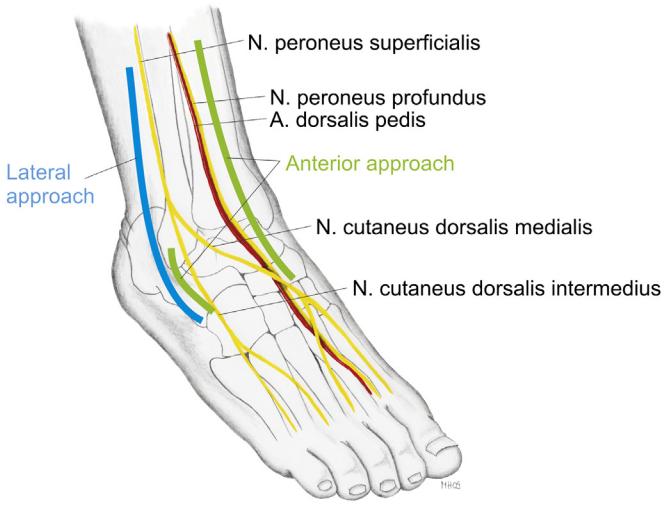

Fig. 1. Surgical approach. Either a standard anterior approach between the tendons of musculus tibialis anterior and musculus extensor hallucis longus combined with a small lateral incision for subtalar preparation *(green)* or an extended lateral approach *(blue)* can be used. The structures at risk are the nervus peroneus profundus and superficialis and arteria dorsalis pedis. Implantation of the retrograde nailing system will further endanger the plantar nerves, depending on the design of the nail (straight more than curved).

that 3 years after implantation, 95% of the trabecular voids in an acetabular cup were filled with bone. This rate was far greater than that reported for porous coated cups (34,35). Moreover, TM has been shown to have lower complication rates than the iliac crest autograft, because it avoids donor site morbidity (36,37).

Only 4 studies have reported the use of TM to bridge bone defects in foot and ankle surgery (13,21,38,39). These TM spacers were originally designed for other applications or were custom made and did not take into account the needs of hindfoot surgery in terms of morphology and anatomic shape.

In the present technical note, we report the use of the first Communauté Européenne–certified TM ankle interpositional spacer (Zimmer®, Warsaw, IN) that was designed specifically for use in retrograde nail TTC arthrodesis.

Surgical Technique

The patient is placed in the supine position on a radiolucent operating table. General or regional anesthesia can be used for this procedure. A pneumatic tourniquet is applied on the ipsilateral thigh. Zimmer's surgical technique and the saw guides indicate an anterior approach; however, the spacer can be implanted from a standard anterior or an extended lateral approach, allowing optimization of the surgical procedure according to the individual patient (Fig. 1). In patients in whom an anterior approach has been used for the index procedure (e.g., total ankle replacement), we suggest using the same incision. Preparation of the subtalar joint can be performed by a small lateral incision over the sinus tarsi. For patients with skin problems (i.e., previous complicated wound healing in the area, previous reconstructive skin and/or muscle flaps) or if the fibula must be osteotomized and used for additional stabilization of the ankle, a single lateral approach centered over the distal fibula can be used (Fig. 2).

In cases in which the indication for TTC arthrodesis is failure of total ankle replacement, the prosthesis should be removed first. Next, the bony surfaces are debrided, and all necrotic bone, scar, and connective tissue is removed. Fresh bony surfaces are then prepared on all 4 sides in the anteroposterior view. This can be done with either the cutting guide provided by the manufacturer or freehand if the

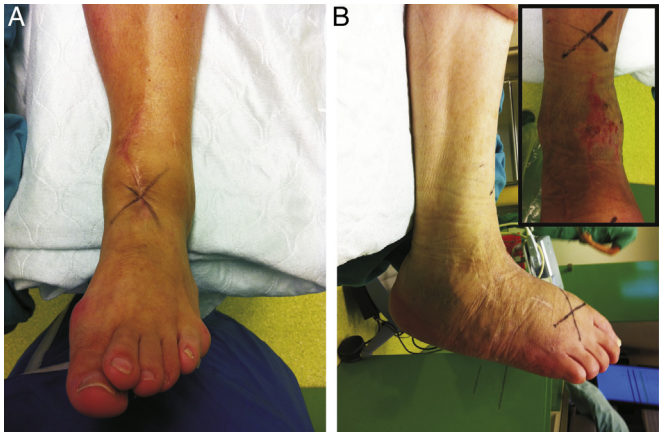

Fig. 2. Surgical approach. (*A*) Case 1. The patient had a failed total ankle replacement in place that had been implanted through an anterior approach. Thus, the old scar was used for preparation of the ankle and implantation of the trabecular metal™ spacer; a short lateral incision was added for subtalar preparation. (*B*) Case 2. A chronic eczematic lesion over the anterior ankle *(Inset)* precluded an anterior approach. Thus, a single lateral incision was used to prepare the ankle and subtalar joint and to implant the trabecular metal™ spacer.

cutting guide is too bulky for the anterior incision, or if a lateral approach has been used.

X-ray compatible spacer templates of the various available sizes are then used to determine the appropriate size of the TM spacer. Care should be taken to restore the hindfoot height but not to overtighten the soft tissues. The spacer is currently available in 5 heights (7.5, 25, 30, 35, and 40 mm) and 3 widths (small, medium, and large) and has a 14-mm hole to allow the intramedullary nail to pass through (Fig. 3; additional information available at: http://www.zimmer.com/content/pdf/en-GB/zimmer_tm_ankle_interpositional_spacer_and_tm_ankle_fusion_spacer_surgical_technique.pdf).

The retrograde TTC arthrodesis nail is prepared and inserted in a standard fashion using the plantar approach. Care should be taken to center the nail in the middle of the talus in both the anteroposterior and the lateral directions, because the center of the nail defines the center of the TM spacer. The spacer is then implanted and the nail inserted through the hole in the spacer. Standard locking techniques are used both distally and proximally. Cancellous bone from the fibula or the resected areas can be used to fill any small gaps medially and laterally to the spacer. If additional stability is needed, the fibula can

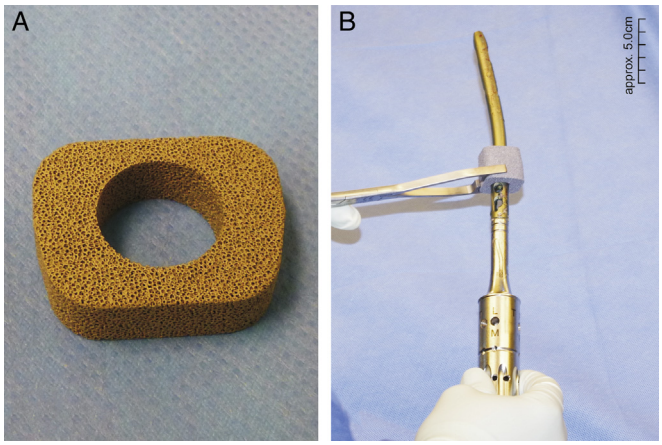

Fig. 3. Trabecular metal™ ankle interpositional spacer. (*A*) The cuboid spacer includes a 14-mm hole to allow an intramedullary retrograde tibiotalocalcaneal arthrodesis nail to pass. (*B*) Assembly of the tibiotalocalcaneal arthrodesis nail and trabecular metal™ spacer.