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Three-Year Follow Up Utilizing Tantal Cones in Revision Total Knee Arthroplasty

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ABSTRACT

There still is no consensus on the treatment of choice in revision knee arthroplasty associated with severe femoral and/or tibial bone loss. A total of 44 patients underwent revision knee arthroplasty procedures using porous tantalum cones (TM cones) to reconstruct tibial and/or femoral bone defects. At latest follow up after 37 months (32–48), 38 patients remained in the study. Tibial and femoral bone loss was categorized according to the AORI-Classification. The average preoperative KSS improved from 34 (range, 6–90) to 63 points (range, 7–90 points). The VAS improved from 7.5 to 4.8. Two patients required a re-revision due to aseptic loosening. There was no correlation between the different types of knee prosthesis implanted. Our study shows favourable clinical and radiological outcomes using TM cones in managing significant bone loss in revision total knee surgery.

Although the clinical results of primary total knee replacement continue to be excellent, the number of revision procedures required will increase substantially [1,2]. Revision arthroplasty can be challenging, especially in the presence of bone defects, instability, infection, dysfunction or the extensor mechanism, periarticular arthrofibrosis [3] or general severe diseases [4]. Interestingly reports do reflect, that many revisions could have been avoided, based on technical errors during the primary procedure, leading to major postoperative limitations, as mentioned before [5]. Nevertheless, infections, arthrofibrosis or unspecific pain complaints often lead to revision as well. Related osseous defects of femur and tibia might occur by stress shielding, particulate wear debris, chronic infection or even intraoperative at time of extraction and adherence of the previous implant [6,7].

Several surgical techniques have been described to address bone loss in revision knee arthroplasty. However, traditional methods have not always been sufficient to cover adequately bone defects that extend into the metaphysis or even the diaphysis. Smaller contained defects might be filled with cement or bone local bone grafting. Larger defects traditionally have been treated for with modular augments or bulk structural allograft, alternatively impaction bone-grafting with or without mesh augmentation has been established [3,6,8–13]. Hinged, rotating hinge and larger custom implants are reserved for massive bone loss for which periarticular bone replacement is indicated or cases with ligamentous instability [6,8,11,14–17].

The general use of porous tantalum cones (TM cones) in the area of TKA revision has gained recent popularity within the last few years. Consequently some very few studies evaluating its early clinical results are available, with promising results so far [18–20].

Porous metal tantalum provides a new tool for modular reconstruction in these cases [20]. Important characteristics of tantalum include its negative charge and interconnective pores, which form a scaffolding and surface for osteoblast-mediated bone ingrowth [21,22]. The lower modulus of elasticity (3 MPa) and high (70–80%) porosity allow for a more uniform stress transfer and the potential for diminished stress shielding [23]. Basic science research has also demonstrated a lower bacterial adherence, and increased leukocyte activation, when compared to other orthopaedic metal implant materials, which might be related to the porous structure and negative charge of this metal construct [6,24].

The purpose of this study was to determine the initial short-term results of TM cones in the management of femoral and tibial bone defects in revision TKA.

Materials and Methods

This study was approved by the institutional review board. A total of 44 patients underwent revision knee arthroplasty procedures using TM cones to reconstruct tibial and/or femoral bone defects. From those 44 patients, 25 were females and 19 males with an average age of 72 years (range 44–85 years). The procedures were performed from 2007 to 2009 in our institution. At latest follow up, 38 patients

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remained in the study, five patients were lost to follow-up and one patient past away.

The 38 patients had an average number of previous major operative procedures performed prior to revision of 4 (range 1–7 procedures). Two patients had one procedure, 4 patients had 2 procedures, 7 patients had 3 procedures, 9 patients had 4 procedures, 8 patients had 5 procedures, 4 patients had 6 procedures and 4 had 7 procedures prior to our revision. These procedures included unicompartmental knee arthroplasty (8 patients), primary total knee arthroplasty (30 patients), revision total knee arthroplasty (132 surgeries, 36 patients) or major ligament reconstruction (4 patients). The indications for the revision procedures included aseptic loosening of the tibial component (12 patients), aseptic loosening of the femoral component (12 patients) and aseptic loosening of both components (14 patients). In 3 patients additional impaction bone grafting was incorporated with the use of the TM cones.

Two revision knee joint systems were implanted, the Rotational Knee Prosthesis (Roknep); Endo-Model (LINK, Germany, Hamburg) and the Hinge Knee System (Toknep); Endo-Model (LINK, Germany, Hamburg). Eighteen patients (41%) underwent revision knee arthroplasty using the rotational knee prosthesis with the hinge knee system implanted in 26 patients (59%). The choice of implant was based on preexisting ligament instability and global knee laxity, degree of bone loss, overall osseous quality and age of the patient. The hinge knee system was predominantly used in knees with a preexisting valgus deformity and patients older than 75 years; the rotational knee system was implanted in all other patients.

TM cones were generally available in different sizes, widths and heights for tibial and femoral defects. Impacting TM cones into the metaphyseal region of the tibia and femur offers high stability against rotation forces of the implant and allows for osseous ingrowth from the adjacent host bone. Generally we see an indication of TM-cones in the presence with relevant bone loss in the epiphyseal-/metaphyseal intersection of the tibia and the femur. Those defects typically appear after various revisions with larger implant sizes and fixation methods. Mid- and long-term stability of any revision implant relies on the metaphyseal stability, with or without additional long stemmed support. As rotational stability is mandatory for an adequate fixation of the implant, cementing alone does not reveal an optimal solution. Local bone grafting, as known from the impaction bone grafting in this region with reliable stability, is not possible. Thus our indications include these large cavitary defects of cancellous and cortical bone as described by some authors before [11,20].

The appropriate cone size was selected after trialling with positioning trials, cones with the largest area of contact to the host bone were selected (Fig. 1). A high-speed burr was used to contour any bony prominences to ensure an optimal fit of the TM cones to the host bone, if necessary (Fig. 2). However, this technique should generally be limited to an absolute minimum, while counteracting the general idea of bone preservation in revision TKA. Most importantly it has to be mentioned, that an initial press-fit insertion of the cones into the host bone is absolutely mandatory, to ensure ingrowth.

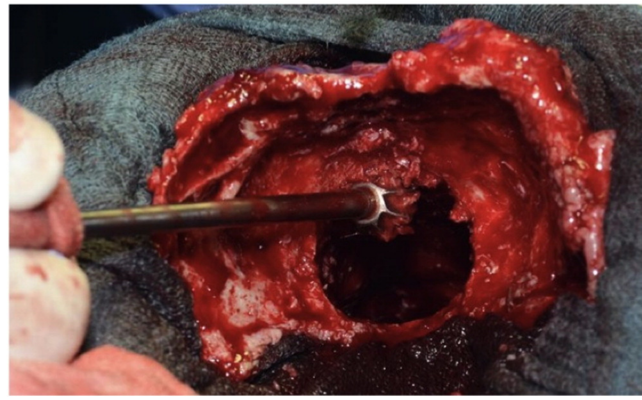

Fig. 2. Use of a high-speed burr to ensure an optimal fit of the femoral TM cone.

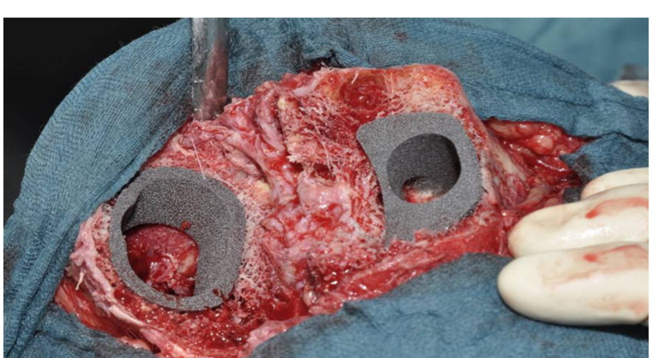

Fig. 1. Optimized sizing and in situ fixation of femoral and tibial cone.

Generally, the cones are available in different shapes and sizes, some are side specific.

Based on the general osseous size of the knee, the present localization and shape of the defect, adequate trialing with plastic probe cones can be performed. However, relative exact rotational orientation has to be done, in order to insert a long stemmed, cemented implant. This includes consideration of the depth of the femoral implant box, in order to be able to still achieve enough depth and prevent overstuffing. In addition, we recommend strict trialing with probes and even original cones in place with the original revision TKA implant in every case. Especially in the use of any kind of hinged implant, hyperextension needs to be strictly prevented, with this technique. Although not using implants of the producing tantalum company in our series, all rotational and pure hinged implants could be inserted without further “cutting to fit” of the tantalum cones in any cases.

The TM cones were impacted into a stable position guided by the shape and location of the bone defects (Table 1). The prosthetic components were subsequently cemented into the TM cones whilst maintaining rotation and the longitudinal axis (Fig. 3). Gentamicin-loaded bone cement (Refobacin Bone Cement R, Biomet, Warsaw, Indiana) was used in all cases. Impaction bone grafting with morselized cancellous bone graft was used to fill defects between the host bone and the Trabecular metal cone in three cases; this was performed to enlarge the overall area of contact. The indication for this procedure is to fill small remaining cancellous defects between the TM cone and the host bone, if the shape of the TM cone is not symmetric to the cavitary bone defect after contouring the host bone.

Tibial and femoral bone loss was categorized according to the Anderson Orthopaedic Research Institute (AORI)-Classification [8]. Knee function was assessed preoperatively, and at latest follow up according to the Knee Society clinical rating system (KSS) [25].

Anteroposterior, lateral knee, long leg standing and axial patellar view radiographs were performed preoperatively and at final follow up (Fig 4). Radiographs were analysed according to a previously reported modification [16,26] of the Knee Society total knee

Table 1
Overview of the Used Implants and Cones.

	TM-Cone Femoral	TM-Cone Tibial	1 + 1 TM-Cones Femoral + Tibial	Total
Rotational Knee Prosthesis, Endo-Model	8	3	2	13
Hinge Knee System, Endo-Model	5	6	14	25
Total	13	9	16	38