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Complications - Infection

The Use of Tantalum Metaphyseal Cones for the Management of Severe Bone Defects in Septic Knee Revision

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ABSTRACT

Background: Femoral and tibial massive bone defects are common findings in septic total knee revision and pose considerable challenges for the orthopedic surgeon. The aim of this study was to report the midterm clinical and radiographic outcomes with the use of tantalum cones for the management of massive bone defects after 2-stage knee revision.

Methods: We retrospectively reviewed the medical records of 60 patients (mean age, 67.9 ± 8.8 years) treated with 94 tantalum cones associated with constrained or semiconstrained knee for massive bone loss (mean follow-up, 43.5 ± 17.4 months). In all cases, the indication was a staged revision for periprosthetic knee infection. Functional scores, radiographic outcomes, and implant survivorship were analyzed.

Results: The mean Knee Society Score and Oxford Knee Score improved from 44.1 ± 7.4 and 19.2 ± 4.1 to 85.4 ± 5.6 and 38.4 ± 3.9 ($P < .01$), respectively. The mean flexion increased from 60.6° ± 15.5° to 96.8° ± 10.9° at the last evaluation ($P < .01$). The mean improvement in flexion contracture was 6.2 ± 8.0 ($P < .01$). Two failures (3.3%) due to periprosthetic knee infection recurrence were observed, but no cone-related mechanical failures were reported. The cone-related survival rate was 97.8%.

Conclusion: Excellent clinical and radiographic midterm outcomes were achieved with a low complication rate. Tantalum cones may be considered a safe and effective option in the management of massive bone defects also in septic knee revision surgery.

Total knee arthroplasty (TKA) is one of the most successful procedures in orthopedic surgery. In the United States, 523,000 TKAs were performed in 2005. The number of primary procedures is projected to increase to 3.48 million [1] and the number of revisions to 268,200 by 2030. Although aseptic loosening remains the most common indication for revision of total knee arthroplasty (rTKA) [2], periprosthetic joint infection (PJI) is a leading cause of devastating complications and socioeconomic burden [3].

Massive bone loss during rTKA is a complex problem that poses a challenge for orthopedic surgeons, particularly if the patient has already undergone multiple surgical procedures. There are several possible reconstructive strategies to treat such bone defects [4]. The bone defects classification of the Anderson Orthopedic Research Institute (AORI) [5] is a useful system to guide surgeons through different management strategies. AORI type I-IIA bone defects are effectively managed with primary TKA (type I) or revision implant (type II) with cement to fill a bone defect and reinforce it with screws or cancellous bone graft or augmentation to restore the joint line and knee stability [4]. Severe bone defects require more complex fixation strategies. The surgical options for bone loss management of type IIB-III defects are structural allografts, trabecular metal cones or sleeves, custom prosthetic components, or wide bone resection with megaprosthesis implantation [6–12]. Moreover, optimal stem fixation strategy is a source of concern. Cemented stems allow optimal fixation and local antibiotic distribution when antibiotic-loaded bone cement is used. Nevertheless, cementless stems achieve comparable results providing long-term osseointegration.

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Debate surrounds the optimal strategy to treat severe bone defects [13]; however, porous metaphyseal cones are a promising solution in the reconstruction of large contained or uncontained bone defects in rTKA [14–21]. While there is a growing literature on porous metaphyseal cones, no definite conclusions can be drawn because standardization is lacking, especially with regard to preoperative diagnosis and surgical technique. Furthermore, no clear evidence has been published about the effectiveness of porous metal cones in septic knee revision surgery.

The purpose of this study is to analyze the safety and efficacy in terms of functional outcome, complication rate, reoperations, rerevisions, and survivorship of tantalum metaphyseal cones in the management of complex bone defects in staged septic knee revision at short-term to midterm follow-up.

Materials and Methods

This retrospective, single-center study was approved by the institutional review board, and written, informed consent was obtained from all patients before the revision procedure. The data were collected from the prospective institutional arthroplasty registry. Between July 2010 and January 2016, 94 porous metal cones were implanted in 60 patients with knee PJI. Inclusion criteria were treatment with femoral and/or tibial metaphyseal porous tantalum cones (Trabecular Metal; Zimmer, Warsaw, IN) implanted during septic 2-stage rTKA, and completion of a follow-up period of at least 2 years. All the included prostheses were classified as septic according to the modified Musculoskeletal Infection Society criteria [22]. The indication for the use of metal cones was complex metadiaphyseal bone loss.

Bone defects were graded by the AORI classification system. Intraoperative evaluation and staging of residual bone stock was performed. Type II and III defects were defined as complex bone loss on either the femoral or tibial side.

Of the total of 60 patients, 34 (56.7%) were women and 26 (43.3%) were men. The mean age at the time of surgery was 67.9 ± 8.8 years. The mean body mass index (weight in kg divided by the height in meters squared) was 27.7 ± 5.2 kg/m^2; 16 patients were classified as obese (body mass index > 30). Relevant comorbidities included diabetes in 15 patients (25%), rheumatoid arthritis in 4 (6.7%), and heart failure in 3. Forty-two (70%) were nonsmokers, 9 (15%) were smokers, and 9 (15%) were former smokers [23]. The mean follow-up was 43.5 ± 17.4 months (Table 1). The indication for rTKA was chronic PJI in all cases. PJI were classified as chronic infections according to the Zimmerli classification [5,24,25].

Globally, the mean number of previous surgical procedures, excluding the index staged revision, was 3.0 ± 1.5 including arthroscopic procedures, ligament and tendon reconstructions, knee arthroplasty, and subsequent revisions. Eleven (11.3%) patients had undergone 1 previous operation, 19 (31.7%) had 2 operations, 14 (23.3%) had 3 operations, 5 (8.3%) had 4 operations, 9 (15.0%) had 5 operations, and 2 had 6 and 7 operations each (1.7%).

A posterior-stabilized prosthesis was removed in about half of the patients (58.3%); the prostheses in the other patients were hinged (11.7%) or constrained nonhinged (23.3%) designs and unicompartmental (6.7%; Table 1). The patellar component was present in 16 (26.7%) patients and was always removed at time of the first stage.

All surgical procedures in a 2-stage surgical strategy were performed by a single senior surgeon (GB) experienced in complex revision arthroplasty. At the time of explantation, deep surgical debridement and mobile antibiotic-loaded spacer implantation were performed [26]. Three to 6 intraoperative biopsies for microbiological analysis were obtained by default. In order to improve the diagnostic sensitivity of simple preoperative and intraoperative culture analyses, sonication of the infected implant was routinely performed. Table 2 shows the results of preoperative or intraoperative cultures.

Table 1
Main Demographic and Surgical Data.

Parameter	Value
Sex	
Female	34 (56.7)
Male	26 (43.3)
Body mass index (kg/m^2)	
Female	28.9 ± 5.5
Male	26.1 ± 4.3
Age at time of surgery (y)	67.9 ± 8.8
Side of procedure	
Right	37 (61.7)
Left	23 (38.3)
Indication for revision surgery	
Second-stage reimplantation for PJI	60 (100)
Level of constraint at time of explant	
Hinged	7 (11.7)
Constrained	14 (23.3)
Posterior stabilized	35 (58.3)
Unicompartmental	4 (6.7)
Comorbidity	28 (46.7)
Diabetes	15 (25)
Rheumatoid arthritis	4 (6.7)
Cardiopathy	3 (5)
Smoking status	
Nonsmoker	42 (70)
Current	9 (15)
Former	9 (15)
Previous surgeries	3 ± 1.5

Values are given as N (%) and plus or minus values are the mean ± standard deviation.
PJI, periprosthetic joint infection.

An intra-articular surgical drain was kept in place until the second postoperative day. A specific intravenous antibiotic course of at least 4 weeks was routinely followed by oral administration for at least 2 weeks. When the intraoperative cultures were negative, intravenous glycopeptides and fluoroquinolones were protracted for 3 weeks, followed by oral fluoroquinolones for 4 more weeks.

At the time of reimplantation, new surgical debridement and spacer sonication were performed, and 3 to 6 samples were taken for cultural analysis and 1 specimen for definitive histologic examination and frozen section. The mean interstage interval was 14.1 ± 6.2 weeks. Complications arising during the first stage and the interstage interval were intraoperative femoral supracondylar fracture managed with stemmed articulating spacer and femoropodalic cast for 2 months in 1 patient, spacer dislocation in 1

Table 2
Microbiological Data.

Microbiological Cultures	No. of Patients
CoNS	12
MSSA	10
MRSE	7
Polymicrobial flora	6
Streptococcus spp.	6
Gram negative	5
MRSA	2
MSSE	1
Candida spp.	1
Negative culture	10
Total	60

CoNS, coagulase-negative *Staphylococci*; MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSE, methicillin-resistant *Staphylococcus epidermidis*; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSE, methicillin-sensitive *Staphylococcus epidermidis*.

patient, wound dehiscence in 1 patient, and spacer exchange at 3 months after explantation due to persistent infection in 1 patient.

All reimplantations were performed through a medial parapatellar approach. Osteotomy of the tibial tuberosity was performed in 2 patients and a medial gastrocnemius flap for wound closure was used in 1 patient. The lodging for femoral and/or tibial cone implant was prepared with dedicated rasps. After selection of size and shape, the cone was press-fitted with a specific impactor into the metadiaphyseal bone to ensure excellent metaphyseal stability. The level of constraint of final implant was selected according to ligament stability and bone defect size. Type of fixation and stem length, diameter, and shape were decided intraoperatively based on the surgeon's preference. A surgical drain was maintained in place until the second postoperative day. Patients started ambulation with either partial (50%) or toe-touch weightbearing and walker or crutches starting from the second postoperative day. Supervised physical therapy and passive motion were started the day after surgery and continued for 6 to 8 weeks.

All patients were assessed clinically and radiographically for a mean of 43.5 ± 17.4 months; no patients were lost to follow-up. Patients without a recent follow-up visit were recalled for the purposes of the present study.

The Knee Society Score, Oxford Knee Score, and range of motion were determined routinely before surgery (pre-first stage), at 3, 6, 12 months after the procedure, and annually thereafter. Radiographs (anteroposterior [AP], lateral [LL], and axial patellar view) were performed by default on the first postoperative day, at 3, 6, 12 months, and annually thereafter. Radiographic evidence of osseointegration, migration, stem loosening, osteolysis, cortical hypertrophy, or malposition was reviewed by 2 trained orthopedic fellows (LC, FC) according to the Knee Society TKA radiographic evaluation for long-stemmed revision prostheses in order to fully evaluate the entire length of the prostheses [27,28]. Doubtful cases (2 patients) were solved by consensus.

Implant axial alignment was evaluated with neutral, defined as between 3° and 9° of valgus [18]. Minor (wound dehiscence, superficial wound defects) and major complications (deep infection, aseptic loosening, intraoperative or postoperative fractures, revision, reoperation) were investigated and fully reported. We defined as revision any surgical procedure after the index revision surgery that required cone removal. Reoperation was defined as any kind of surgery that involved the specific knee joint after the indexed procedure with or without implant component removal (other than cones). The primary outcome of interest was defined as the clinical and radiologic evaluation, along with complications of tantalum cones in staged septic knee revision surgery. The secondary outcome measures were defined as revision rate for septic recurrence and eradication rate.

Trabecular metal cones were implanted in 10 type IIa defects (6 femurs and 4 tibias), 50 type IIb defects (19 femurs and 31 tibias), and 30 type III defects (14 femurs and 16 tibias). Table 3 presents the distribution of bone defects and the respective number of cones. A standard cone frame was used in 86 cases. Three tibias and 1 femur required a double cone frame for bone defect management. These cases were classified as type III defects. The mean duration of surgery was 124.9 ± 26.6 minutes.

A rotating-hinged total knee prosthesis (Nexgen RHK; Zimmer, Warsaw, IN) was used in 18 cases (30%) and a condylar constrained total knee prosthesis (Nexgen LCCK, Zimmer) in 42 (70%). Hybrid cementation and uncemented stems with bone cement at the cone-implant interface were used in all cases but one (1.7%). This case required cementation of the tibial stem because the proximal tibia of this female patient was small and hindered cone implantation.

The most frequently used stem length was 75 mm (60.0% on the femoral and 75.0% on the tibial side). Stem length was 100 mm in 19 femora (31.5%) and 13 tibias (22.0%), 150 mm in 6, and 200 mm in 1 (Table 4). Straight stems were implanted in 56 patients; an offset stem was implanted in 4 (3 tibias and 1 femur). Ten-mm and 12-mm polyethylene inserts were placed in 20 patients each, a 14-mm polyethylene insert in 15, a 17-mm insert in 5. Porous metal augments were implanted to restore optimal joint line, rotation, and implant stability with a mean number of 1.9 ± 1.1 (range, 0-5).

Statistical Analysis

Continuous variables are reported as mean ± standard deviation and relative confidence intervals. Categorical variables are expressed as the number of cases and/or percentage. The Shapiro-Wilk test was used to identify normally distributed variables. Differences between means were tested with the *t*-test for continuous variables or with the Mann-Whitney *U* test if not normally distributed. The nonparametric Wilcoxon signed-rank test was used to compare continuous paired data collected preoperatively and at the last follow-up visit. Categorical variables were tested with the chi-square test or Fisher exact test. Interobserver reliability for radiologic analysis was evaluated with Cohen's kappa coefficient. Kaplan-Meier survival curves were created using parameters to analyze survivorship free of revision for any reason for total implants and for femoral and tibial cones. A *P* value of <.05 was considered statistically significant.

Results

Clinical Evaluation

The mean Knee Society Score and Oxford Knee Score of the entire population improved significantly from 44.1 ± 7.4 and 19.2 ± 4.1 before the operation to 85.4 ± 5.6 and 38.3 ± 3.9, respectively, at the last follow-up evaluation ($P < .01$). The range of motion improved from 60.6° ± 15.5° of mean preoperative flexion and 8.1° ± 9.2° of mean preoperative flexion contracture to 96.8° ± 10.9° and 1.8° ± 2.3°, respectively ($P < .01$; Table 5). Comparing clinical outcomes derived from different groups of patients, the presence of an infected constrained or hinged prosthesis showed that a type III defect and a hinged final implant were significantly associated with a worse functional outcome at final follow-up (Table 6).

Table 3
Bone Defects by Femoral and Tibial Side According to the AORI Classification and Number of Cones for Each Type of Defect.

Defect	Femoral		Tibial	
	No. of Patients	Cones—N (%)	No. of Patients	Cones—N (%)
Type I	1	0 (0)	3	0 (0)
Type IIa	16	6 (6.4)	10	4 (4.2)
Type IIb	27	19 (20.2)	30	31 (33)
Type III	14	15 (16)	17	19 (20.2)
Total	60	40 (42.5)	60	54 (57.5)

AORI, Anderson Orthopedic Research Institute.

Table 4
Femoral and Tibial Stem Length.

Stem Length (mm)	Femoral Stems—N (%)	Tibial Stems—N (%)
75	36 (60.0)	45 (75.0)
100	19 (31.5)	13 (22.0)
155	4 (7.0)	2 (3.5)
200	1 (1.5)	—
Total	60 (100.0)	60 (100.0)

Table 5
Clinical Outcomes.

Score	Before Surgery (N = 60)	Last Visit (N = 60)	Mean Improvement (*P* Value)	95% CI
KSS	44.1 ± 7.4	85.4 ± 5.6	41.3 (*P* < .01)	39.9 to 42.7
OKS	19.2 ± 4.1	38.3 ± 3.8	19.1 (*P* < .01)	18.1 to 20.1
Flexion (°)	60.6 ± 15.5	96.8 ± 10.9	36.2 (*P* < .01)	32.6 to 39.8
Flexion contracture (°)	8.1 ± 9.2	1.9 ± 2.3	6.2 (*P* < .01)	4.0 to 8.4

Plus or minus values are the mean ± standard deviation.
CI, confidence interval; KSS, Knee Society Score; OKS, Oxford Knee Score.

Radiographic Evaluation

Postoperative radiographs demonstrated good AP and LL position at the bone-porous cone interface in all cases. Subsequent follow-up imaging showed osseointegration of the implant (reactive osseous trabeculation). We observed 2 cases of femoral diaphyseal cortical hypertrophy, without pain or functional limitation. Radiolucent lines of less than 1 mm after implantation without progression over time were noted in 8 cases, 5 of which on the femoral side (zones 3-7a and 7b on the AP view and zones 1-2-5-7 on the LL view), 2 on the tibial side (zone 1 on the LL view), and 1 case with tibial and femoral nonprogressive radiolucencies (femoral zone 1 on the LL view and tibial zone 1 on the AP view).

At the latest follow-up evaluation, all cones were well fixed with no evidence of loosening or migration. Fifty-seven implants (95%) were in a neutral position and 3 (5%) were considered in valgus alignment. Comparison of radiolucencies between constrained condylar implants and hinged prosthesis at final follow-up showed no statistically significant association between type of final implant and radiolucency development ($P = .23$). Interobserver reliability values for radiographic parameters (osseointegration, migration, loosening, osteolysis, cortical hypertrophy, and malposition) were 0.93, 0.84, 0.91, 0.95, 0.90, and 0.85, respectively, with nearly unanimous agreement between surgeons.

Complications

During the second-stage surgery, 1 intraoperative tibial metadiaphyseal fracture was managed with a femoropodalic cast and protected weight bearing for 6 weeks. At the final follow-up visit, the cone was well fixed and the patient reported good clinical outcomes.

After reimplantation, 6 (10.0%) reoperations were recorded, 2 of which were re-revisions for septic failure with cone removal. The first involved a 64-year-old woman with history of substance abuse. Polymicrobial flora was isolated from the preoperative and intraoperative analyses during the first stage. Fourteen days after the second stage, 4 of 6 microbiological samples tested positive for polymicrobial flora and a multidrug antibiotic therapy was started. Owing to the poor clinical response to the antibiotic therapy and to the fair degree of compliance, the patient underwent knee arthrodesis with circular external fixation 5 months after reimplantation. At the time of the final explantation, the trabecular metal cone appeared well osseointegrated and hard to remove.

In the second patient, a 60-year-old diabetic, obese woman with 5 previous surgeries before the 2-stage revision, another 2-stage revision attempted 2 months after the index procedure with a custom-made final implant resulted in good outcome. In this case, the cone was intraoperatively loose. Three (5.0%) patients required reoperation for aseptic loosening of the prosthetic component. In all 3 cases, the loose component had no metaphyseal cone (2 tibial and 1 femoral prosthetic components). A full cone was implanted to stabilize the revised component, resulting in a good midterm outcome. Another patient underwent reoperation with polyethylene exchange 2 months after surgery for knee instability. Finally, a good final outcome was achieved in 1 patient with positive intraoperative microbial cultures managed with specific suppressive therapy for 3 months.

Outcome Evaluation

The cone-related revision rate for any cause at the final follow-up was 2.2%, and the cone survival rate considering aseptic loosening as primary end point was 100%. There were 2 septic failures, with a cone-related septic failure rate of 2.2%. The two-stage eradication rate was 95.0%. The Kaplan-Meier survival rate for the observation period considering implant failure for any reason was 90% (Fig. 1) and the survivorship free of revision for any cause of femoral and tibial cones was 97.8% at the final follow-up visit (Fig. 2).

Discussion

The main findings of the present study are that tantalum metaphyseal cones for the management of metaphyseal bone defects in 2-stage revision of infected TKAs demonstrated a high midterm survival rate and few complications.

Debate surrounds the management of large bone deficiencies in the setting of rTKA. Metaphyseal defects pose a considerable challenge for the surgeon to restore the joint line and achieve implant stability. Recently published series, although with heterogeneous patient cohorts, have reported good short-term to midterm results with trabecular metal cones for the management of major metaphyseal bone defects in rTKA [29,30]. To our knowledge, however, no prior studies have reported the results in a large population with infected TKA treated with 2-stage revision. Potter

Table 6
Comparison of Clinical Outcomes. Scores Measured at Last Follow-Up Visit.

Score	UKA/PS Removed Implant (Mean ± SD)	Non-UKA/PS Removed Implant (Mean ± SD)	*P* Value (95% CI)	Type 3 Defect (Mean ± SD)	Non-Type 3 Defects (Mean ± SD)	*P* Value (95% CI)	CC Final Implant (Mean ± SD)	Hinged Final Implant (Mean ± SD)	*P* Value (95% CI)
KSS	86.6 ± 4.6	83.0 ± 6.5	**.02** (0.7 to 6.6)	82.6 ± 6.0	87.3 ± 4.6	**.01** (1.9 to 7.4)	86.5 ± 5.2	82.8 ± 5.7	**.02** (0.7 to 6.7)
OKS	39.1 ± 3.7	36.6 ± 3.6	**.01** (0.5 to 4.5)	36.5 ± 3.4	39.6 ± 3.7	**.02** (1.2 to 5.0)	39.1 ± 3.8	36.7 ± 3.7	**.03** (0.2 to 4.4)
Flexion	99.3 ± 10.5	90.0 ± 7.7	**<.01** (4.1 to 14.6)	90.1 ± 8.1	101.1 ± 10.6	**<.01** (5.8 to 16.2)	98.6 ± 11.7	92.5 ± 7.7	.05 (0.1 to 12.4)
Flexion contracture	1.4 ± 2.1	2.8 ± 2.5	**.03** (0.2 to 2.6)	3.1 ± 2.4	1.0 ± 1.8	**<.01** (1.0 to 3.2)	1.5 ± 2.1	2.6 ± 2.6	.12 (0.3 to 2.3)

P values in bold indicate significant differences between outcome measures.
CC, constrained condylar; CI, confidence interval; Non-PS, constrained condylar or hinged; PS, posterior stabilized; SD, standard deviation; UKA, unicompartmental knee arthroplasty.

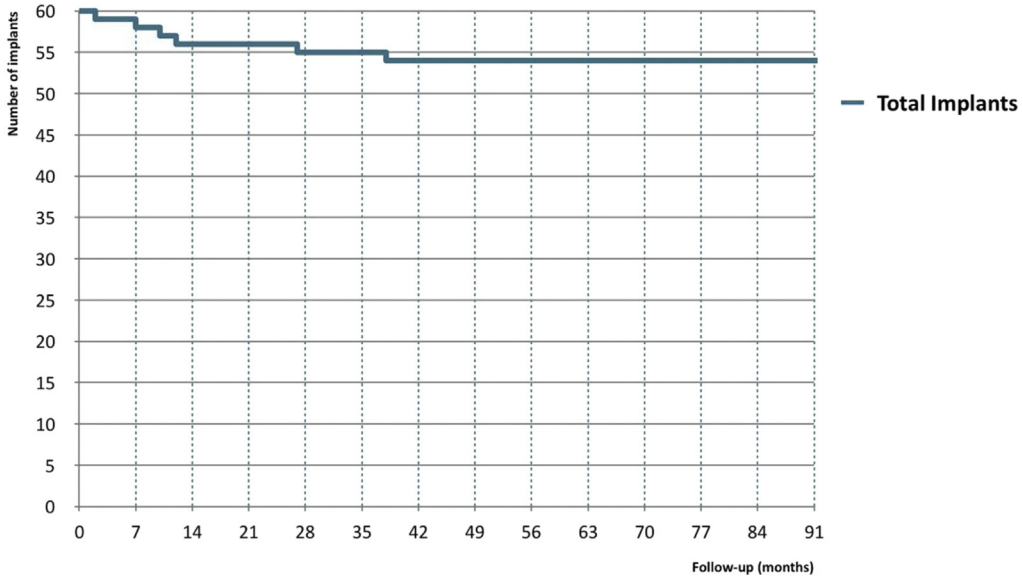

Fig. 1. Kaplan-Meier survival function for failure for any reason of revision of total implants (n = 60) in patients treated with 2-stage revision managed with metaphyseal porous tantalum cones.

et al [31] performed 159 rTKA with the implant of femoral cones and cemented stems and minimum 2-year follow-up. The 5-year revision rate for any cause of failure was 14.4% (8.8% for infection). Kamath et al [30] reported the results of 63 knee revisions with 66 tibial metaphyseal cones and 94% of cemented stems. The survivorship of the tibial implant at a mean follow-up of 70 months was >95%.

Metaphyseal-diaphyseal junction stability provides the mechanical support to compressive loads, creating a stable base for the femoral and tibial components [4,32]. Once metaphyseal stability is provided, cemented or cementless stems are possible solutions for the final implant construct with good results in rTKA and comparable long-term failure rate [33,34]. Nevertheless, there is no consensus on whether cementless or cemented stems are better in the setting of septic knee revision. Fully cemented stems and hybrid uncemented stems were reported to have similar reinfection rates from 8% to 24% after 2-stage revision TKA [34–36].

In the present series, the hybrid fixation technique [37] with diaphyseal cementless stems and cement only in the epiphyseal-metaphyseal region was used in all cases except one (1.7%). In our experience, particular attention should be paid to minimize the risk of iatrogenic fractures during preparation of the metaphyseal seating of the cone, especially in small patients. In such patients, in order to prepare the cone lodging avoiding intraoperative fractures, we routinely combine the use of the specific impactor with Volkmann-like bone curettes of different shapes and a hip stem reamer. Villanueva-Martinez et al [16] reported a 24% rate of intraoperative fractures related to cone implantation. In our series, 1 case of intraoperative tibia fracture occurred during preparation of the tibial cone seating.

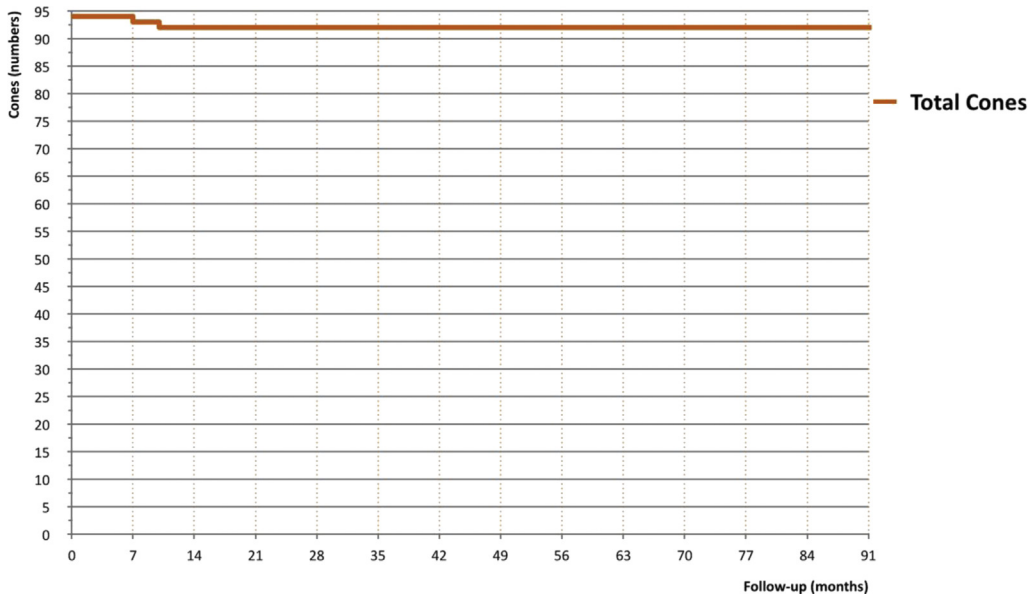

Fig. 2. Kaplan-Meier survival with time and probability of survivorship of tantalum cones for any reason of revision.

Optimal metaphyseal fixation achieved with tantalum cones allowed the use of 75-mm stems in the majority of our patients (67.5%). Longer stems were mainly reserved for osteoporotic patients in whom the loading distribution should be delivered over a wider bone-implant interface [34]. No cases of end stem pain were recorded in this series.

Tantalum cones are widely accepted for the management of complex metaphyseal bone defects (AORI type IIb and III bone defects). While 98.4% of the cones were used in such clinical settings, 10 were implanted in type IIa defects. All these patients had a grossly unstable component on the intraoperative tests and required metaphyseal fixation because of the extremely poor bone quality.

The aseptic loosening rate of the implant at the end of follow-up was 5% and the failure was always detected at the prosthetic component without a metaphyseal cone. We hypothesize that the difference in primary metaphyseal stability between the prosthetic component with and without tantalum cone could influence the secondary biomechanical stability of the side without a cone. Jensen et al [38] demonstrated by radiostereometric analysis that tibial revision implants with tantalum cones provided early stable condition and less migration patterns than prosthetic components without a metaphyseal cone. The cone survival rate, when aseptic loosening is considered the primary end point at the end of follow-up, was 100%. This result is shared by previous studies [6,15–21,29].

According to our data, unfavorable prognostic factors are the presence of a type III defect, the removal of a constrained or hinged prosthesis and the need of a hinged prosthesis during the second stage. Clinical outcomes were significantly better in patients with posterior-stabilized or unicompartmental implants at the explant phase of the 2-stage procedure, patients with bone defects less than type III, and patients with final constrained condylar implants. These results contrast with the data of a study by Villanueva-Martinez et al [16] that showed better results for a rotating hinged knee than for condylar-constrained designs. But because their patients had fewer previous knee surgeries with primary implants before revision surgery, this difference should be considered a bias that potentially influences the clinical outcome. Potter et al [31] reported that aseptic failure of the femoral cone is associated with hinged implants and type III bone defect at a mean 5 years of follow-up. Our data contrast with this observation, although our study had a shorter follow-up and a different population makeup.

Studies published to date have reported excellent radiographic outcomes [6,15–21,29], with osseointegration of the implants and reactive osseous trabeculation at the interface because tantalum metal increases osteoblast proliferations and bony ingrowth [39]. In the present study, the eradication rate after a 2-stage revision was high (95%), as compared with other studies [15–21,35,36], and septic failures led to a cone-related septic revision rate of 2.2%.

This study has several limitations: the bias related to its retrospective design and relatively short mean follow-up compared to previous studies on rTKA. These limitations notwithstanding, its major strength is the homogeneity of the selected patient cohort from which appropriate conclusions can be drawn regarding tantalum cones in septic knee revisions.

Conclusions

Metaphyseal cones, in septic knee revision, have high survivorship free of revision for any cause at short-term to midterm follow-up. The data indicate that trabecular metal cones are reliable options for the management of metaphyseal bone loss during 2-stage knee revisions. Long-term follow-up studies are needed to define the reliability of metaphyseal cones.

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