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Tantalum Acetabular Augments in One-stage Exchange of Infected Total Hip Arthroplasty: A Case–control Study

Till Orla Klatte, MD [b], Daniel Kendoff, PhD [a], Reza Sabihi [a], Atul F. Kamath, MD [c,1], Johannes M. Rueger, PhD [b], Thorsten Gehrke, MD [a]

[a] Department of Orthopaedic Surgery, Helios ENDO-Klinik Hamburg, Holstenstrasse 2, 22767 Hamburg, Germany
[b] Department of Trauma, Hand, and Reconstructive Surgery, University Medical Center Hamburg-Eppendorf, Martinistrasse 52, 20246 Hamburg, Germany
[c] Department of Orthopaedic Surgery, Mayo Clinic, Rochester, Minnesota

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ABSTRACT

During the one-stage exchange procedure for periprosthetic joint infection (PJI) after total hip arthroplasty (THA), acetabular defects challenge reconstructive options. Porous tantalum augments are an established tool for addressing acetabular destruction in aseptic cases, but their utility in septic exchange is unknown. This retrospective case–control study presents the initial results of tantalum augmentation during one-stage exchange for PJI. Primary endpoints were rates of re-infection and short-term complications associated with this technique. Study patients had no higher risk of re-infection with equivalent durability at early follow-up with a re-infection rate in both groups of 4%. In conclusion, tantalum augments are a viable option for addressing acetabular defects in one-stage exchange for septic THA. Further study is necessary to assess long-term durability when compared to traditional techniques for acetabular reconstruction.

Periprosthetic infection remains a major burden in total joint replacement. Although progress has been made to reduce the periprosthetic infection rate in the field of total hip arthroplasty (THA), infection rates remain between 0.2-2.2% after primary THA and up to 9% in the revision THA setting [1–4].

The most common treatment method for infected THA is the two-stage exchange, while the one-stage exchange technique has not seen widespread use over the last few decades. However, controversy exists whether two- or one-stage exchange is the most effective treatment, although the two-stage procedure is often considered the gold-standard worldwide [5–7]. The two-stage procedure does have certain disadvantages, however, when compared to a one-stage exchange. These include prolonged hospitalization, need for a second surgery, and extended antibiotic administration, which might not be justified in all patients and may lead to higher mortality [8].

Our referral arthroplasty center has particular experience with the one-stage technique. In acetabular reconstruction, the one-stage exchange has its special intra-operative ramifications. One of these is the challenging situation of periprosthetic infection with severe acetabular defects, including Paprosky IIA and higher [9]. In the setting of THA infection, the use of bone allografts is controversial, and there is concern for a higher re-infection rate [10]. Consequently, in our institution, acetabular bone allograft is not generally used in the treatment of PJI.

Methods to address acetabular defects have included the use of a greater amount of bone cement to fill up voids, or, in cases of higher grades of bone destruction, reinforcement rings have been used. However, particular reinforcement rings are known for a high rate of loosening and possible re-infection [4,11–13]. More recently, porous metal acetabular augments have been used in aseptic cases with good results [14]. Due to their high porosity and low modulus of elasticity, porous metal augments appear to have promising potential for bony integration and biologic fixation [15–17]. Furthermore, some studies have shown a superiority of tantalum implants compared to stainless steel implants with regard to infection [18,19].

Consequently, at the authors' institution, porous metal augments have been used in the single-stage reconstruction in patients with infected THA and acetabular destruction. The aim of this study is to report on the early use of these augments in the setting of one-stage exchange of infected THA. Results from this group of patients, including re-infection rates, are compared to those of a cohort whose one-stage reconstruction for infection did not involve the use of porous metal augmentation.

Patients and Methods

This case–control study was initiated after obtaining approval from the institutional review board. Patients treated for a periprosthetic THA infection, either after primary implantation or after revision for aseptic or septic causes of failure, were included. Patients

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Reprint requests: D. Kendoff, MD, HELIOS ENDO-Klinik Hamburg, Holstenstrasse 2, 22767 Hamburg, Germany.

[1] Maurice E. Müller Hip Reconstruction Fellow.

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were identified by querying the electronic database at the authors' institution from January 2009 through December 2011. All patients underwent a one-stage exchange revision with trabecular metal (porous tantalum) acetabular augments (Zimmer, Inc., Warsaw, Indiana, USA) and a cemented acetabular cup system. This study group (SG) included 50 consecutive patients. From the same database, a control group (CG) was randomly selected from the same time period to afford a 1:1 match. This CG included those patients who were treated with one-stage exchange for periprosthetic THA infection without the use of trabecular augments.

All patients in the SG and CG were operated by three surgeons who each perform 100 single-stage revisions per year with the same operative techniques.

Twenty-eight women (mean age 72.2 years, range 41 to 87) and 22 men (mean age 70.3 years, range 62 to 86) comprised the SG. In the CG, there were 30 men (mean age 68.3 years, range 49 to 77) and 17 women (mean age 69 years, range 42 to 87). There was no significant difference regarding the age of SG and CG ($p > 0.2$). There were eight patients lost follow-up in the SG, and five patients lost to follow-up in the CG; there were two unrelated deaths, and eleven patients were not available. All demographic information with relevant patient risk factors for PJI is presented in Table 1.

All infection diagnoses were made in accordance with the Musculoskeletal Infection Society algorithm [20], including a pre-operative joint aspiration to isolate infecting organism. Patients treated with implantation of a porous metal augment had acetabular defects of Type IIA up to IIC, according to the Paprosky Classification [9]. There were 6 patients with a IIA defect, 26 patients with a IIB defect, and 18 patients with a IIC defect. The patients of CG did not show signs of acetabular destructions. A standardized telephone interview was conducted to establish whether any postoperative complications or re-operations occurred, including those performed at any other institution. Primary endpoints were rates of re-infection and short-term complications associated with this technique.

Descriptive statistics are presented for both groups in the form of number of occurrences and percentage or mean, standard deviation, and range. Two-by-two tables were used to calculate the odds ratio for developing complications for each dichotomous predictive variable. Statistical significance for these analyses was set to $p < 0.05$. Fisher`s exact test was used. Statistical analysis was carried out by means of a statistical software package (GraphPad Prism Version 5.02, GraphPad Software Inc., La Jolla, CA, USA).

Table 1
Baseline Characteristics of the Patient Cohort.

	Study Group		Control Group		
PJI	(n)	(%)	(n)	(%)	P value
Risk factors					
Diabetes	6	12	11	23	0.2
Cancer	5	10	7	15	0.6
COPD	7	14	6	13	1.0
Rheumatism	2	4	2	4	1.0
Cirrhosis	1	2	0	0	1.0
Psoriasis	0	0	2	4	0.2
1 Risk factor	19	38	18	38	1.0
2 Risk factors	1	2	4	9	0.2
Charlson Index					
0	22	44	19	40	0.7
1	8	16	7	15	1.0
2	14	28	11	23	0.6
3	4	8	4	9	1.0
4	1	2	1	2	1.0
5	0	0	4	9	0.1
6	1	2	1	2	1.0

Charlson Co-morbidity Index was evaluated accordingly to Charlson et al. (33). There was no significant relation ($p > 1.0$) between the two groups in regard of risk for re-infection and risk factors or Charlson Co-morbidity Index.

Surgical Technique

The surgical technique is explained via an illustrative case of a 72-year-old male with a periprosthetic infection two years after primary THA, performed at an outside institution, who presented with new-onset pain and loss of function of the right hip. Clearly evident is the loosening of the cemented stem and as well of the cementless cup (Paprosky IIA) (Fig. 1). Pre-operatively, Proprionibacterium acnes (P. acnes) was detected via hip aspiration as the affecting organism. Fig. 1B shows the opened joint of the patient in Fig. 1 and highlights the infected tissue with the glossy membrane typical of P. acnes infection.

A posterior-lateral approach was used in all cases. An aggressive debridement was performed as previously described [21]. A minimum of three local biopsies were taken around the joint. In Fig. 1C, the cup has been removed and reaming of the bone and a radical debridement inclusive of the femur had been performed. Before re-implantation of the THA starts, the wound has been thoroughly irrigated using pulsatile lavage with polyhexanide, and the specific systemic intravenous antibiotic therapy had begun. Fig. 1D demonstrates the tantalum wedge and cup in the correct position. The original wedge itself is fixed provisionally with K-wires, and then definitively with three 6.5-mm cannulated screws. The correct position of the new polyethylene cup is depicted (Fig. 1E), and has been cemented inferior to the tantalum wedge. The cement contains the specific antibiotic based on the susceptibilities of the pre-operatively identified Propionibacterium acnes. The stem has been treated in the same way. Fig. 1F shows the x-ray 10 days post-operative.

In the SG and the CG, all prostheses were cemented with polymethylmethacrylate (PMMA) impregnated with culture-specific antibiotics. Antibiotics were chosen based on pre-operative aspirate culture and sensitivity results, in conjunction with input by a microbiologist. Prostheses in the SG were an all-polyethylene cup (Mark III, Waldemar Link Co, Hamburg, Germany) combined with a cemented stem (SPII Stem, Waldemar Link Co, Hamburg, Germany) in 31 cases; a dual mobility cup (Avantage® cup, Biomet, Valence Cedex, France) in 14 cases; and the Avantage® cup combined with a MP® Reconstruction Stem (Waldemar Link Co, Hamburg, Germany) in 8 cases. In the CG, an all-polyethylene cup (Mark III, Waldemar Link Co, Hamburg, Germany) combined with a cemented stem (SPII Stem, Waldemar Link Co, Hamburg, Germany) was used in 43 cases; and, in four patients, an Avantage® cup (Biomet, Valence Cedex, France) was used.

In both groups, 32-mm ceramic heads (Biolox® delta, CeramTec, Plochingen, Germany) were used. In cases in which the Avantage® cup was implanted, a cobalt-chrome metal alloy head was used.

Based on the cultures and individual antibiograms, intravenous antibiotics were administered during surgery.

Drains were removed two days post-operatively. All patients were allowed immediate full weight-bearing. All patients underwent a conventional postoperative course of physiotherapy and rehabilitation, including standardized restriction of movements of the affected hip joint.

Post-operative intravenous antibiotic therapy was continued based upon the patients' clinical signs and monitoring of inflammatory markers. The intravenous antibiotic therapy was administered an average of 18 days (range, 5 to 168 days) in the SG, and for an average of 16 days (range, 8 to 168 days) in the CG.

Results

The average follow-up for the SG was 3 years (range, 1.5 to 4.5 years), and the average follow-up for the CG was 3 years (range, 1.6 to 4.1 years). The mean time from the last surgery (i.e. the surgery prior to one-stage exchange) and the onset of PJI-related symptoms (i.e. the approximate onset of clinically overt infection), was 3.2 years (range, 5 days to 18 years) in the SG. From the time of preceding