Tantalum Components in Difficult Acetabular Revisions Have Good Survival at 5 to 10 Years: Longer Term Followup of a Previous Report

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Abstract

Background The best method for acetabular revisions in patients with severe bone loss remains controversial; typical approaches include jumbo cups, cages, cup-cages, and custom components. Tantalum (TM) components have good results at midterm followup, but the longer term survival and complications are not available. We previously reported on a series of such reconstructions; here we provide additional followup on that group along with a larger study cohort.

Questions/purposes (1) What is the survival at a minimum followup of 5 years of these components implanted in difficult revisions and what is the mechanism of failure? (2) What is the most common complication of these reconstructions, and what hip scores did these patients achieve?

Methods Between 2001 and 2010, one surgeon performed 150 acetabular revisions, of which 74 (49%) were done using TM components. The general indication for use of these devices was the surgeon’s perception that there was sufficient bone loss to place the reconstruction at a high risk of mechanical failure (generally Paprosky Type 3 or 4 or lower Paprosky type with < 50% host bone coverage or morbid obesity). No cages were used during this time. Fifteen patients died and 11 were lost or did not return, leaving 48 hips (46 patients) with a mean followup of 8 years (range, 5-14 years). Of these, 39 were reported on in our previous series, and nine are new in the present series; the overall group here has an additional median of 5 years followup (range, 3-7 years). Five hips had six augments placed to obtain stability. Patients were evaluated by the Harris hip score and standard radiographs; survivorship was estimated using the cumulative incidence competing risks survival analysis. The primary outcome was fixation and survival of the TM component and the secondary outcome was complications.

Results Cumulative incidence competing risks estimate survival free from aseptic loosening was 92% at 10 years (95% confidence interval [CI], 0.81-0.98). Dislocation, the most common complication, occurred in seven of 48 (15%) patients, and five of 48 (10%) had a reoperation for it. Survival free from any reoperation was 84% at 10 years (95% CI, 0.72-0.92). The Harris hip score improved from a mean of 50 points (SD 10; p < 0.001) at latest followup.
Conclusions  Given the findings of this study, TM components appear to provide durable fixation at midterm followup in complex acetabular revisions. Steps to minimize dislocation, the most frequent complication of these revisions, may include the routine use of larger femoral heads. Future studies likely will need to be multi-surgeon or multicenter and should evaluate different techniques and components for long-term fixation and the prevention of dislocation.

Level of Evidence: Level IV, therapeutic study.

Introduction

Controversy persists on the best method for acetabular reconstruction in “difficult revisions,” specifically those patients with large defects, < 50% living host bone, pelvic discontinuity, and other comorbidities [1, 7, 12, 13, 17]. Several studies have suggested short-term success with tantalum (TM) components with or without augments [3, 14, 20], whereas other studies have recommended a “cup-cage” construct [2], a custom porous-coated cage, or a distraction technique with an extralarge acetabular component as better reconstructive options [8, 13, 18, 19].

We previously reported the results of 39 TM acetabular components, implanted only in patients we judged at high risk of failure, at a mean followup of 3 years (range, 2-7 years) and found excellent fixation and one early loosening [14]. Thus, we continued to use this component exclusively, without any cages, for acetabular revisions with bone loss considered at higher risk for failure to determine the limits of this approach. However, there are few long-term data available for the TM component in difficult acetabular revisions and, to our knowledge, only one study with a mean followup > 5 years [22]. We therefore enlarged our study series and extended the followup on the earlier patients on whom we have previously reported [14].

Here, we asked the following questions: (1) What is the survival at a minimum followup of 5 years of these components implanted in difficult revisions and what is the mechanism of failure? (2) What is the most common complication of these reconstructions, and what hip scores did these patients achieve?

Patients and Methods

This is a retrospective study, using longitudinally maintained data, of 72 patients (74 hips) who had an acetabular revision using a TM acetabular component (Trabecular Metal™; ZimmerBiomet, Warsaw, IN, USA) between August 2001 and February 2010 by one surgeon (PFL). These components were implanted only in hips we judged to be at high risk for failure; we generally defined this as Paprosky Type 3 or 4 or a less severe defect on the Paprosky classification with < 50% host bone coverage or morbid obesity. These 74 revisions (49%) were a subset of 150 uncemented acetabular revisions performed during this time. No acetabular cages were used. This study includes 39 revisions for which the results at a mean of 3 years followup had been previously reported [14]. We added nine additional patients, and the followup on the original group was extended a median 5 years (range, 3-7 years).

The methods with respect to surgical techniques, patient followup, clinical hip score, acetabular bone loss classification, postoperative treatment, and radiographic analyses were similar to our earlier paper on a similar group of patients [14]. Radiographic loosening was defined as a change in cup position of greater than 5° on the AP pelvic radiograph or a change in the vertical or horizontal position of the cup of > 2 mm, as read by the operating surgeon (PFL) [16].

We attempted to recall all patients for this study. Fifteen patients (15 hips) had died, and 11 patients (11 hips) could not attend followup or could not be contacted for a minimum 5-year followup, but the component was well fixed at the last clinic visit. These hips were included in the survival analysis. There were complete clinical and radiographic data, at a minimum 5 years followup (mean, 8 years; range, 5-14 years), for 48 TM acetabular components. Twelve patients had followup of ≥ 10 years. There were 23 men and 23 women in this group with a mean age of 64 years (range, 39-85 years). Thirty-four hips had acetabular component loosening, four had recurrent dislocation, five had osteolysis resulting from polyethylene wear, four had two-stage revisions for infection, and one had a bipolar endoprosthesis with protrusion. The mean patient weight was 82 kg (range, 53-120 kg), the mean height was 168 cm (range, 150-188 cm), and the mean body mass index was 30 kg/m² (range, 21-45 kg/m²).

The acetabular revision was the first revision in 28 hips, the second in 12 hips, the third in six hips, and the fourth in two hips. The component revised was uncemented in 37, cemented in nine, resurfacing in one, and a protruded bipolar in one hip. There were 26 Paprosky Type 3 (16 Type 3B [including one pelvic dissociation], 10...
Type 3A), 20 Type 2 (but judged to have < 50% living host bone), and two Type 1 defects (both in patients with morbid obesity) [17].

Eighteen of the 48 hips had a concomitant femoral component revision. The TM acetabular component implanted was the nonmodular shell with a cemented polyethylene liner in 16 hips and the modular shell in 32 hips. Six trabecular metal augments were used in five patients. Generally, we used these augments if stability of the trial component with a rim fit was inadequate. Seven screws were used in one hip, five screws in three hips, four screws in 13 hips, three screws in 22 hips, and two screws in nine hips. The acetabular liner implanted had an inner diameter of 28 mm in three hips, 32 mm in 17 hips, 36 mm in 24 hips, and 40 mm in four hips. Only three hips had a constrained liner placed in the index procedure [5]. The mean size of the acetabular component was 62 mm (range, 54-74 mm).

Computerized axial tomography of the hips was not performed. Metal artifact reduction sequence MRI was performed in one patient with an acetabular osteolytic lesion suspected to have trunnion corrosion.

Cumulative incidence competing risks survival analysis with 95% confidence intervals was performed for the endpoint of revision for aseptic loosening or any radiographic loosening of the acetabular component and for the endpoint of reoperation for any reason. The nonsurgeon author (JAO) compiled the Harris hip scores and surgical complications of these patients using the longitudinal database. The differences in hip scores were evaluated using Student’s t-test.

Results

Cumulative incidence competing risks survival, with the definition of failure as aseptic loosening of the acetabular component, was 92% at 10 years (95% confidence interval [CI], 0.81-0.98) (Fig. 1). With the definition of failure as reoperation for any reason, the survival was 84% at 10 years (95% CI, 0.72-0.92) (Fig. 2). Forty-three hips had stable fixation of the TM component. There were three early and two late failures. The three early failures were: one patient with infection treated by removal of the component and two-stage reimplantation; one patient with recurrent dislocation with a shift of the component into abduction after closed reduction, treated by cup revision and placement of a constrained liner; and one patient with a total femur component with a hinged knee arthroplasty had asymptomatic medial migration of the cup [16]. Both late failures were aseptic loosening of the acetabular component. One patient, with rheumatoid arthritis and pelvic discontinuity, had symptomatic aseptic loosening of the augment and shell at 5 years after

![Graph](image_url)  
**Fig. 1** This is the cumulative incidence competing risks estimate survival for the entire cohort (n = 74) with failure defined as revision for aseptic loosening or radiographic evidence of loosening.
a fall, but she was medically unfit for rerevision. One patient had trunnion corrosion with elevated serum cobalt (7.5 μg/mL) and an acetabular osteolytic lesion and, after a fall, had a sudden shift of the cup at 7 years and was revised.

Dislocation was the most common complication and occurred in seven of 48 patients (15%) at 2 to 8 weeks postoperatively. Two patients had a single dislocation. Five of 48 patients (10%) had recurrent dislocations, four posterior and one anterior. Four patients had reoperations with a constrained liner [4] cemented into the revision shell and one (previously mentioned) had rerevision of the shifted component and cementation of a constrained liner. One other reoperation was plate fixation of a supracondylar fracture of the ipsilateral femur. The mean preoperative Harris hip score [11] was 50 points (SD 17) and improved to a mean postoperative score of 85 points (SD 10; p < 0.001).

**Discussion**

We previously reported the results of 39 TM acetabular components, implanted only in patients we judged at high risk of failure, and reported only one loosening at a mean followup of 3 years [14]. Thus, we continued to use this component exclusively, without any cages, for acetabular revisions considered at higher risk for failure [7, 12, 15]. However, the best approach for reconstruction in these patients is now controversial, because several studies recommend a “cup-cage” construct, a custom porous-coated cage, or distraction technique as better reconstructive options [8, 13, 18, 19]. Because there were little long-term followup data available for the TM component in difficult acetabular revisions, we asked the following questions: (1) What is the survival at a minimum followup of 5 years of these components implanted in difficult revisions and what is the mechanism of failure? (2) What is the most common complication of these reconstructions, and what hip scores do these patients achieve?

This study has several limitations. First, this was a retrospective study of one technique for acetabular reconstruction and there was no control group with a surface coating other than TM in these difficult revisions. This component was used in less than half of the acetabular revisions during this time, but we did not compare these revisions with the others because of several confounding variables, especially acetabular bone loss. Second, this was a relatively small group of revisions and the followup of 5 to 14 years (mean, 8 years) may not be sufficient to determine the late success of this method of acetabular revision. Third, there were 15 patients who died, and 11 were lost or refused to return for examination and radiographs. However, the implants in these patients were well fixed at last followup, and
the difficulty in getting older and asymptomatic patients to return for routine long-term followup is well known [22]; even so, it is possible that those missing may have had more failures than those who had more complete followup. Fourth, the radiographic analysis was not blinded, but we used parameters to define loosening that have been validated [16]. We did not have the capability for roentgen stereophotogrammetric analysis in our office [10] and did not believe it was ethical to perform computerized axial tomography in asymptomatic patients.

Compared with our initial study of these components, there were two late failures after 5 years, one in a patient with rheumatoid arthritis and pelvic discontinuity and one in a patient who developed an acetabular osteolytic lesion and had trunnion corrosion. Both patients developed symptomatic loosening after a serious fall, although it is possible that the implant-bone interface was already compromised before the injury. Thus, the reevaluation of new “second-generation” porous-coated components (such as TM) and other techniques for acetabular revision at longer term followup, with survival analysis, remains necessary and important. To our knowledge, there are only five published studies [1, 4, 6, 9, 22] of TM components, with or without augments, with a followup ≥ 5 years (Table 1). Three studies have shown good fixation of these TM components, even with severe bone loss [1, 9, 22]. Del Gaizo et al. [9] reported only one aseptic loosening, resulting in revision after 6 years, in a group of 37 revisions (36 patients) at a mean followup of 5 years. Abolghasemian et al. [1] reported three aseptic loosenings (two with pelvic discontinuity) resulting in revision in 34 revisions with a mean followup of 64.5 months. In the study most similar to the present one, Whitehouse et al. [22] reported the 10-year survival of 53 revisions and three primaries (56 patients) at a median followup of 110 months. Sixteen (29%) of the patients had died during followup. There were three revisions for aseptic cup loosening, and the survival at 10 years was 92% (95% CI, 81%-97%). These authors continued to recommend these components in the reconstruction of complex acetabular defects [22]. The other major method used for these types of revisions was the custom triflange acetabular component, but, to our knowledge, there are only two studies with mean followup > 5 years [8, 19]. DeBoer et al. [8] reported no loose custom triflange components in 20 revisions (18 patients) followed for a mean of 10 years. Taunton et al. [19] reported only one revision for aseptic loosening in 57 revisions (57 patients) performed at four centers and followed for a mean of 65 months. To our knowledge, there is no study comparing the clinical results of the custom triflange component with a TM component with or without augments. To our knowledge, there is only one study of this TM component with cage reinforcement (“cup-cage construct”) with a mean followup > 5 years. Abolghasemian et al. [2] reported three

Table 1. Studies of tantalum components in acetabular revisions with ≥ 5 years mean followup

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Number of hip revisions</th>
<th>Mean followup (years; range)</th>
<th>Survival (defined as aseptic loosening)</th>
<th>Number of aseptic loosenings</th>
<th>Number of dislocations (number reoperated for recurrent dislocation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borland et al. [4] (2012)</td>
<td>24</td>
<td>5 (3-7)</td>
<td>NS</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Del Gaizo et al. [9] (2012)</td>
<td>37</td>
<td>5 (2-9)</td>
<td>NS</td>
<td>1</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Abolghasemian et al. [1] (2013)</td>
<td>34</td>
<td>5 (2-9)</td>
<td>91% at 5 years (95% CI, 75%-97%)</td>
<td>3</td>
<td>NS (0)</td>
</tr>
<tr>
<td>Whitehouse et al. [22] (2015)</td>
<td>53</td>
<td>9 (7-11)</td>
<td>92% at 10 years (95% CI, 81%-97%)</td>
<td>3</td>
<td>NS (2)</td>
</tr>
<tr>
<td>Clement et al. [6] (2016)</td>
<td>55</td>
<td>5 (3-9)</td>
<td>92% at 5 years (95% CI, 80%-97%)</td>
<td>0</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Present study</td>
<td>74 (entire cohort)</td>
<td>8 (5-14)</td>
<td>91% at 10 years (95% CI, 74%-96%)</td>
<td>4</td>
<td>7 (5)</td>
</tr>
</tbody>
</table>

NS = not stated; CI = confidence interval.
loosenings in 26 revisions with this technique at a mean followup of 82 months.

In this study, dislocation was the most frequent complication of acetabular revision using TM components. We had seven patients with dislocations overall, and five underwent revision for recurrent dislocation, one of whom had concurrent shell revision for early loosening. This risk of dislocation (15% [seven of 48 patients]) was comparable to that reported in other studies of acetabular revision with standard or extra-large porous-coated components and custom triflange components [8, 14, 15, 19, 21]. At the time of these revisions, we generally did not implant a constrained liner at the same time as the initial TM cup insertion, because we believed this would contribute to a greater chance of early cup loosening. Large heads with highly crosslinked polyethylene were not routinely available for all procedures, and dual-mobility components were not available during the study period. Patients who have these acetabular revisions should be informed preoperatively of the high risk of dislocation and the possibility of subsequent reoperation for this complication after bone ingrowth into the component.

In conclusion, this study has demonstrated continued good fixation and 91% survival free from aseptic loosening at 10 years of TM acetabular components, with or without augments, in difficult acetabular revisions. Because there were two late revisions after 5 years followup that were not seen in our initial report of this component and technique, there should be continued emphasis on long-term followup of newer, second-generation porous-coated acetabular components and other custom-manufactured components for difficult acetabular revisions with bone loss. Given the findings of this study, the senior author (PFL) continues to use this component alone for most difficult acetabular revisions with bone loss. Future studies, likely multisurgeon or multicenter, should evaluate alternatives to minimize dislocation, which was the most common complication after these reconstructions. Possible approaches include large ceramic heads, dual-mobility components, and constrained liners, each of which has important strengths and weaknesses. Additional followup will be necessary to determine the longer term success of this component.

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References