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Outcome of Porous Tantalum Acetabular Components for Paprosky Type 3 and 4 Acetabular Defects

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ABSTRACT

Porous tantalum acetabular implants provide a potential solution for dealing with significant acetabular bone loss. This study reviews 24 acetabular revisions using tantalum implants for Paprosky type 3 and 4 defects. The mean Harris Hip Score improved from 35 ± 19 (range, 4–71) to 88 ± 14 (range, 41–100), $p < 0.0001$. Postoperative radiographs showed radiolucent lines in 14 hips with a mean width of 1.3 ± 1.0 mm (range, 0.27–4.37 mm). No gaps enlarged and 71% of them disappeared at a mean of 13 ± 10 months (range, 3–29 months). At a mean follow-up of 37 ± 14 months (range, 24–66 months), 22 reconstructions showed radiograpic evidence of osseointegration (92%). The two failures were secondary to septic loosening. When dealing with severe acetabular bone loss, porous tantalum acetabular components show promising short-term results.

Over 40,000 revision hip arthroplasties are performed each year in the United States and are projected to increase by 137% by the year 2030 [1]. Over 50% of these revisions involve the acetabular component [2]. Broadening indications for primary total hip arthroplasty (THA) along with increasing numbers of acetabular revisions and re-revisions have caused surgeons to encounter cases with increasing surgical complexity. One of the most difficult challenges in hip revision surgery is treating large acetabular defects [3]. Traditional solutions include the use of structural allograft/cage constructs, the long term results of which could be improved [4]. Porous tantalum metal provides an alternative solution with promising preliminary results [1–11].

Osseointegration is important for long-term survival of cementless acetabular components and has led to the development of three dimensional surfaces to permit bone in-growth. Porous tantalum is one such surface that has a porosity of 80%, an average pore size of 550 microns, and an elastic modulus of 185 gigapascals (GPa), giving it a structure similar to trabecular bone [12–14]. These characteristics allowed excellent osseointegration to occur in canine studies [14,15]. Porous tantalum also has a coefficient of friction of 0.88 against cancellous bone, providing it with good initial stability in cases where bone stock is compromised [8]. Not only has porous tantalum been shown to osseointegrate successfully, radiographic studies have shown that periacetabular gaps up to 5 mm in size fill in with new bone over time [16,17].

At our institution, porous tantalum components have been used in the majority of complex revision THA cases that have involved suboptimal conditions for bone ingrowth. We report our short-term radiographic and clinical results of porous tantalum components with a minimum of two-year follow-up.

Materials and Methods

Between 2005 and 2010, 96 acetabular revisions using tantalum components were performed at our institution. A retrospective review of these cases showed 36 hips in 36 patients had acetabula with Paprosky type 3 or 4 defects [18]. Twenty-six hips were classified with Paprosky type 3a defects, 8 hips were classified with Paprosky type 3b defects, and two hips as Paprosky type 4 defects. We excluded minor bone defects classified as Paprosky types 1 and 2, as well as patients with less than 2 years follow-up. Approval for this study was obtained from our institutional review board.

Twenty-four hips classified as Paprosky type 3 or 4 with a minimum of two years follow-up or with failure requiring further surgery are included in this study. Of the included hips, 19 were classified as Paprosky type 3a, 3 as Paprosky type 3b, and 2 as Paprosky type 4. All operations were performed by one of the three senior authors (S.G., J.H., or W.M.) through either a posterolateral or anterolateral approach. Acetabula were reamed line-to-line and elliptical sockets were inserted using press-fit technique and secured with screws. Impaction grafting using allograft bone chips and demineralized bone

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matrix was used at the discretion of the surgeon. Augments and cages were used when the surgeon felt that there was insufficient host bone to securely support the cup in the presence of physiologic loads. Plates were used in the setting of associated transverse acetabulum fractures.

Patients were seen in the clinic at 6 weeks, 3 months, 6 months, one year, two years, and 5 years subsequent to their operation. An anteroposterior pelvic radiograph and cross table lateral radiograph of the hip were taken and a questionnaire inquiring into the patient's level of pain and function was filled out at selected visits. Patients who had not returned for their 2 year exam were invited by phone for a follow-up consultation or asked to send in a questionnaire and have local radiographs taken and sent via mail. Clinical examination was performed by the surgeon and independently by a single, experienced physical therapist. A Harris Hip Score (HHS) was calculated at each clinic visit [19,20].

Radiographs were analyzed by two orthopedic arthroplasty fellows who were not involved in the surgical procedures. Acetabular defects were classified according to the Paprosky system based on the preoperative anteroposterior (AP) pelvis radiograph [18]. The presence of a pelvic discontinuity was recorded at the time of surgery.

Analysis of radiolucent lines was carried out for each patient using postoperative AP pelvis radiographs and measured within each of the three DeLee and Charnley zones modified by Gruen (Fig. 1) [16,21]. Radiolucent lines were considered to be present if they occupied at least 50% of the zone and measured at the widest distance between the edge of the prosthesis and the bone. Measurements were multiplied by a conversion factor (0.87) based on the magnification of our computerized radiographs. Gap sizes were compared between the initial postoperative radiographs and subsequent postoperative radiographs taken at each follow-up visit. Failure of cup osseointegration was defined as the presence of a continuous, circumferential radiolucent lines present at the component-bone interface at the most recent radiograph or evidence of gross migration on serial radiographs.

Intraoperative and postoperative complications were recorded based on chart review. Complications were defined as any adverse medical or surgical event that required treatment and/or prolonged hospitalization.

Survivorship of the cup was calculated based on the number of acetabular components that had to be revised. Osseointegration rate was determined using the number of cups that failed to osseointegrate. Statistical analysis of HHS was carried out using the paired *t*-test.

Results

A total of 36 revision THAs classified as having a Paprosky type 3 or 4 defects were performed using porous tantalum acetabular implants between 2005 and 2010. Of these revision cases, 24 hips had a minimum of two years of follow-up or needed revision and are reported in this study. Of the 12 patients that did not have a minimum of 2 years of follow-up, 6 patients had 12 month postoperative radiographs which showed radiographic evidence of osseointegration of the acetabular component. The other 6 were lost to follow-up. There were no deaths. The average age of the included patients was 67 ± 16 years (range, 16–85 years) and the average follow-up was 37 ± 14 months (range, 24–66 months). Sixty-three percent of the patients were female.

The most common diagnosis for revision was aseptic loosening (75%, Table 1). Nineteen patients had Paprosky type 3a defects, 3 patients had Paprosky type 3b defects, and 2 patients has Paprosky type 4 defects. The average number of preceeding surgeries for the revision THAs was 2 ± 1 (range, 1–7). Tantalum acetabular modular augments were used in five cases and a cup/cage construct in one case to address concerns regarding immediate stability. Two cases had associated transverse acetabular fractures (pelvic discontinuity) requiring plate fixation.

The mean HHS improved from 35 ± 19 (range, 4–71) to 88 ± 14 (range 41–100) ($P < 0.0001$) with 83% of patients in the "excellent" or "good" categories. Of the remaining 4 patients that had a "fair" or "poor" outcome, 2 patients experienced persistent abductor dysfunction with associated pain, 1 patient developed instability and a chronic infection treated with resection arthroplasty, and 1 patient had a persistent infection requiring a two-stage revision.

Allograft was used for bony deficiences in 23 of 24 cases. Of the bone-grafted cases, 15 cases utilized corticocancellous allograft mixed with demineralized bone matrix, 6 cases used corticocancellous allograft alone, 1 case used structural femoral head allograft as well as corticocancellous allograft mixed with dimineralized bone matrix and 1 case used structural femoral head allograft alone.

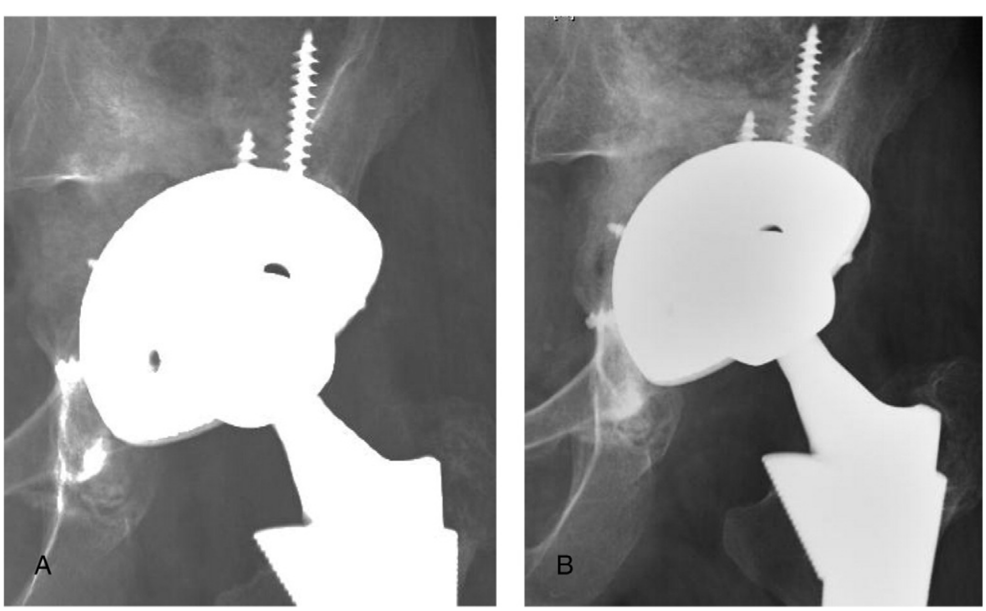

Fig. 1. Radiolucent gap in Zone 2 at 1.5 months postop (A) and 15 months postop (B). Corticocancellous allograft bone chips with demineralized bone matrix was used in this case.