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Uncemented Porous Tantalum Acetabular Components: Early Follow-Up and Failures in 613 Primary Total Hip Arthroplasties

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ABSTRACT

Uncemented tantalum acetabular components were introduced in 1997. The purpose was to determine the 2- to 10-year results with this implant material in primary total hip arthroplasty. Our registry identified all primary total hip cases with porous tantalum cups implanted from 1997 to 2004. Clinical outcomes and radiographs were studied. 613 cases were identified. Seventeen percent of patients were lost to follow-up. Twenty-five reoperations were performed (4.4%). Acetabular cup removal occurred in 6 cases (1.2%). No cups were revised for aseptic loosening. Incomplete radiolucent lines were found on 9.3% of initial postoperative radiographs. At 2 years, 67% had resolved. Zero new radiolucent lines were detected. Two- to 10-year results of porous tantalum acetabular components for primary total hip arthroplasty demonstrate high rates of initial stability and apparent ingrowth.

Total hip arthroplasty has proved to be a very effective procedure at improving pain and restoring function in patients with arthritic hip joints [1]. Many modern cementless acetabular cup designs have shown excellent rates of ingrowth and longevity, with low levels of loosening at mid- and long-term follow-up [2–4]. Nevertheless, certain groups, such as younger more active patients, have had more disappointing survivorship [5,6]. As the use of primary THA increases in such a demographic, the desire to improve fixation, ingrowth and survivorship continues.

To this end, acetabular components made from the highly porous metal tantalum were introduced in 1997. This material has shown remarkable ingrowth properties both experimentally [7–9] and in short-term radiographic follow-up studies [10–13]. Its features include a high degree of porosity (80%) with fully interconnecting pores, which not only appears optimal for ingrowth, but also gives it the potential to act as a conduit for local delivery of substrates such as antibiotics or bone growth factors [14]; and a roughened surface microtexture that provides a scratch fit for better initial stability upon implantation [15]. Furthermore, it has a lower modulus of elasticity than previously used metals, closer to that of bone, allowing a more physiologic transfer of forces to the pelvis and decreasing the potential for acetabular stress shielding [10,15,16].

The hypothesis with porous metal components of this type is that the percentage surface of ingrowth will be greater, the bony attachments themselves will be deeper and stronger, and durability will be improved in all patient populations. This study was undertaken to present the clinical and radiographic results of the first 613 consecutive primary THAs using a porous tantalum acetabular component with 2 to 10 years of follow-up.

Materials and Methods

Between July 1997 and January 2004, 613 primary total hip arthroplasties in 558 patients were performed at the Mayo Clinic, Rochester, MN, using a tantalum acetabular component. Using the Mayo Total Joint Registry, data on all patients were prospectively collected for a minimum of 2 years or until death or failure, and then reviewed for this study. Mayo Clinic IRB approval was obtained.

Fifteen patients (15 hips) died (3%) and 98 patients (106 hips) were lost to follow-up (17%). None of the deaths were related to the patients' hip surgery and, to our knowledge, none of the hips in either group had been revised. The study group consisted of 289 women and 269 men with an average age of 62 ± 14 years (range, 15–94 years) at the time of surgery. There were 321 right hips and 292 left. The preoperative diagnosis was osteoarthritis in 466 cases, avascular necrosis in 59, inflammatory arthritis in 30 (24 rheumatoid, 3 ankylosing spondylitis, 2 psoriatic, 1 JRA), posttraumatic arthritis in

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27, acutely failed ORIF (for femoral neck or intertrochanteric fracture) in 13, developmental hip dysplasia in 8, malunion or nonunion of a femoral neck fracture in 5, pathologic femoral neck fracture in 3, and remote septic arthritis in 2.

All the acetabular cups in this study were uncemented trabecular metal (TM) components (Implex/Zimmer, Warsaw, IN) made from highly porous tantalum. 383 (62%) of the components were monoblock acetabular cups with direct compression-molded ultra-high-molecular-weight polyethylene liners, 30 (5%) were the same monoblock cups with peripheral screw holes, and 200 (33%) were revision-type modular tantalum shells with multiple dome screw holes. All monoblock cups had a 28-mm inner diameter liner, matched with 28-mm heads. One hundred fifty-five of the 200 modular shells were full-thickness tantalum and had polyethylene liners cemented into them. The other 45 had a titanium inner surface with a ring locking mechanism that engages a circumferential slot in the equator of the liner (similar to the Trilogy shell, Zimmer, Warsaw, IN) to allow for an uncemented modular liner to be inserted. All the TM cups used had a hemi-ellipsoid geometry with an equatorial diameter 2 mm larger than the polar diameter, allowing for an initial 2-mm press-fit with line-to-line reaming. All the cups were implanted with this line-to-line reaming, press-fit technique.

Clinical information on all patients was obtained from the total joint registry and consisted of intraoperative and postoperative complications, failures of any component, reoperations of the index hip for any reason, and most importantly revisions of the index THA with removal of the tantalum acetabular component. In the cases with cup removal, the operative reports for both the index THA and the revision were completely reviewed. Standard clinical follow-up was at 3 months postoperatively, at 1 year and yearly thereafter. The mean follow-up was 3.5 years (range: 2–10 years).

Excluding patients who died, 493 (82%) of 598 hips had radiographic follow-up of 2 years or more. For these hips, all preoperative, immediate postoperative and sequential follow-up films were reviewed for the study. Radiographs consisted of an AP pelvis view, an AP hip view, and a true lateral (cross-table, Danelius–Miller) view of the hip. The immediate postoperative films were examined for radiolucent lines, often consistent with incomplete seating of monoblock acetabular component. If present, these were followed on future films to determine whether they had resolved (filled-in), persisted or expanded. The presence of new radiolucent lines at the bone–prosthesis interface was evaluated on all follow-up films using the zone system of DeLee and Charnley [17]. Signs of cup migration and the appearance of osteolysis were evaluated on all follow-up films, in comparison to the immediate postoperative images.

Results

Six (1.2%) of 493 hips followed for a minimum of 2 years or more had a revision surgery with removal of the acetabular component; none were for aseptic loosening. A total of 22 hips (4.4%) in 22 patients had any reoperation (25 total reoperations).

In the subgroup of 320 patients that were 5 to 10 years since THA, 53 (16.6%) were lost to follow-up. Three (1.1%) of the remaining 267 hips had a revision with cup removal (2 for psoas impingement, 1 for infection). Two other patients had a revision of the femoral component (one for periprosthetic fracture, one for aseptic loosening), and one patient had a posterior acetabular wall plating for pelvic discontinuity. At an average of 6.2 years, this 5- to 10-year subgroup had 97.8% survivorship free of any revision, 98.9% survivorship of the acetabular component, free of revision for any reason, and 100% survivorship of the acetabular component, free of revision for aseptic loosening.

Revisions With Tantalum Cup Removal

As of June 2007, 6 of the original 613 tantalum acetabular components had been revised. Three hips developed a deep infection at 1, 12 and 14 months. All three were monoblock cups, one of which had peripheral screws. The first patient suffered a periprosthetic femur fracture at 2 weeks postoperatively and had their femoral component revised. Wound drainage persisted after this revision and at 1 month after the index procedure, the patient presented with a deep infection that was treated with component resection and two-stage revision. The tantalum cup in this case was well fixed and required removal with the Explant system. The second patient also suffered a periprosthetic femur fracture at 1 month postoperatively and had their femoral component revised. The patient went on to dislocate on three occasions and have a revision to insert a constrained liner. The patient subsequently dislocated again and at the time of open reduction was found to have obvious signs of infection and was treated with component resection and two-stage revision. The tantalum cup in this case was also well fixed and required the Explant system for removal. The third patient had their initial THA after a resection arthroplasty for an infected native hip, following remote (21 years prior) open reduction and internal fixation of an acetabular fracture that became infected subsequent to a groin abscess. The hip arthroplasty was staged 6 months after acetabular hardware removal and hip resection. The patient received a full course of antibiotic therapy and had negative inflammatory markers and intraoperative pathology at the time of THA. Intraoperative cultures at the time of THA grew *Pseudomonas* and the patient was treated with IV antibiotics for 6 weeks, then PO suppression indefinitely. At 14 months, the patient presented with evidence of infection. Surgery revealed gross purulence deep into the hip and component resection was performed. Cultures grew the same species of *Pseudomonas* as the previous cultures. In this case, the tantalum acetabular component was easily removed with the Explant system and showed only a few patchy areas of tissue adherence with mostly fibrous adhesions over the cup surface.

Three other cups were revised for psoas impingement and tendinitis refractory to conservative treatment, at 8 months, 1.5 years and 5.5 years. All three were monoblock cups, with one having peripheral screws. All three of these patients had persistent groin pain after their THA despite excellent relief of pain and return to function from all other points of view. After extensive investigation, they all had full relief of their symptoms with a psoas injection of local anesthetic and elected to undergo revision surgery. None of their radiographs showed signs of loosening at any time, but anterior overhang of the tantalum cup was noted in all cases on the cross-table lateral x-ray. Intraoperatively, signs of psoas irritation and a complimentary area of exposed tantalum surface were found in each case. All three cups were well fixed and required the Explant system for removal.

In this cohort, there has not been any revision of an acetabular component for aseptic loosening.

Reoperations

Nineteen other reoperations were performed in 18 patients, including the 2 femoral revisions for periprosthetic fracture and the revision to a constrained liner described above. There were five other surgeries for periprosthetic fracture (three femoral revisions and two ORIFs) and one femoral revision for aseptic loosening. There were three other revisions to constrained liners for multiple dislocations, including one monoblock liner removed by sequential reaming of the polyethylene followed by cementing in a constrained device. There were five hematoma evacuations, one I + D for infection at 2 weeks postoperatively (last seen at 3 years and infection-free), and one plating of a transverse pelvic fracture/pelvic discontinuity with the