Excellent Results of Primary THA Using a Highly Porous Titanium Cup

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abstract

Cementless acetabular cups for primary total hip arthroplasty have had excellent results, with failure rates typically less than 5% at up to 10-year follow-up. Tritanium is a 3-dimensional metal interface that has been used for porous biological fixation. The purpose of this study was to review the clinical and radiographic results of the use of Tritanium cups (Stryker Orthopaedics, Mahwah, New Jersey) for primary total hip arthroplasty. Two hundred eighty-eight total hip arthroplasties performed using a porous titanium acetabular cup in 252 patients between 2008 and 2010 were reviewed. One hundred thirty-three men and 119 women with a mean age of 58 years (range, 18-88 years) were included. Mean follow-up was 36 months (range, 24-56 months). Outcomes evaluated were implant survivorship, Harris Hip Score, complications, and radiographic outcomes. At final follow-up, no cup failures had occurred. Mean Harris Hip Score improved from 53 points (range, 33-82 points) preoperatively to 91 points (range, 64-100 points) postoperatively. One complication occurred; a 64-year-old woman with recurrent postoperative effusions underwent hip exploration and required abductor mechanism repair. On radiologic evaluation, no signs existed of progressive radiolucencies or changes in cup position. The survivorship of the Tritanium cup and the low complication rate is comparable with previous studies using other porous-metal prostheses. Longer follow-up study is needed and assessment of the results of using this implant in the revision setting is important.
Over the past 2 decades, cementless acetabular cups for primary total hip arthroplasty (THA) have had excellent results, with failure rates typically less than 5% and with many designs showing less than 1% failure at up to 10-year follow-up.1-8 Three senior authors (S.F.H., R.E.D., M.A.M.) noted an approximate 1% failure rate at less than 5-year follow-up using various hydroxyapatite, sintered, porous foam-coated acetabular prostheses. Although the failure rate is low, newer interface materials must be sought for cementless acetabular fixation to further reduce cases of loosening and to ensure long-term durability. In addition, similar outcomes have to be evaluated in revision settings.9,11

Highly porous titanium is a 3-dimensional metal interface that has been used for porous biological fixation. It is similar in structure to porous tantalum acetabular cups.3,5,12-14 The Tritanium acetabular cup (Stryker Orthopaedics, Mahwah, New Jersey) is expected to have similar excellent results when compared with other porous metal components. The 3 senior authors began using these cups in 2008 for all primary THAs.

The authors reviewed the clinical and radiographic results of the use of titanium cups for primary THA. In specific, outcomes evaluated included failure rates, Harris Hip Scores, complication rates, and radiographic findings.

**Materials and Methods**

The authors evaluated 288 THAs performed in 252 patients by 3 experienced adult reconstructive surgeons (S.F.H., R.E.D., M.A.M.) at 2 high-volume institutions using a porous titanium acetabular cup between 2008 and 2010. One hundred thirty-three men and 119 women with a mean age of 58 years (range, 18-88 years) were included. Mean follow-up was 36 months (range, 24-56 months). Indications for THA were primary osteoarthritis (n=250), osteonecrosis (n=27), rheumatoid arthritis (n=7), and femoral neck fracture (n=4). Institutional review board approval was obtained from both institutions.

The Tritanium primary acetabular cup has a hemispherical shell with a repeating lattice design, 72% porosity, a coefficient of friction of 1.01, and an average pore size of 546 microns (Figure 1).15 The component is available in a solid back shell (a solid design) and hemispherical cluster hole shell (with clustered screw holes). The solid and the cluster hole designs range in size from 44 to 66 mm. The Tritanium multi-hole shell has multiple screw holes and is available in sizes 48 to 80 mm. The multi-hole shell is produced by a different manufacturing process, but the pore structure and size are similar. In the current study, 218, 57, and 13 hips received solid back shells, hemispherical cluster holes, and cluster hole shells, respectively, and the sizes of the acetabular components used ranged from 48 to 64 mm.

Clinical evaluation was based on Harris Hip Score results.16 All patients returned for follow-up at approximately 6 weeks, 6 and 12 months, and yearly thereafter. At initial follow-up, patients were examined and assessed for surgical complications, such as prolonged wound drainage, hematoma formation, superficial or deep infection, deep venous thrombosis, dislocation, intractable pain, nerve palsy, and cup failure.

Standard anteroposterior and frog-leg lateral radiographs were obtained at each follow-up for all patients and were reviewed by the senior authors. The acetabular zones described by DeLee and Charnley17 were used to assess bone fixation using the Anderson Orthopaedic Research Institute radiographic Criteria.18 Aseptic loosening was defined as 2 mm or more of progressive radiolucencies on serial radiographs.

Collected data were entered into an Excel spreadsheet (Microsoft Corp, Redmond, Washington) and were analyzed using GraphPad Prism (GraphPad Software, San Diego, California). Failure was defined as removal or exchange of the acetabular component due to an aseptic cause.

**Results**

At final follow-up, aseptic acetabular component survivorship was 100%, and no titanium cup failure had occurred. Mean Harris Hip Score improved from 53 points (range, 33-82 points) preoperatively to 91 points (range, 64-100 points) postoperatively, a mean improvement of 37 points (range, 20-58 points).

One major complication occurred, making the complication rate approximately 0.4%. A 64-year-old woman had recurrent postoperative effusions and un-

![Figure 1: Tritanium acetabular cup (Stryker Orthopaedics, Mahwah, New Jersey). Solid back shell design (A). Hemispherical cluster-hole shell design (Stryker Orthopaedics) (B). Hemispherical multi-hole shell design (Stryker Orthopaedics) (C).](image-url)
underwent hip exploration with abductor mechanism repair 3 months postoperatively. At last follow-up 25 months postoperatively, her Harris Hip Score was 90 points.

On radiographic analysis, no components showed changes in alignment or inclination angles. Zonal radiographic analysis revealed no signs of progressive radiolucencies or cup migration (Figure 2).

**DISCUSSION**

The use of porous metals in cementless THA has had successful results at mid- to long-term follow-up in multiple studies. In the current study, the authors assessed the short-term survivorship of a new highly porous titanium metal acetabular component in primary THA for the treatment of various hip arthritis etiologies. The clinical outcomes (ie, Harris Hip Score and complication rate) were assessed and compared with previously reported data on other highly porous metal prostheses.

The current excellent results are comparable with those reported for other highly porous metal acetabular components.\(^1\)\(^-\)\(^3\),\(^19\),\(^20\) Gruen et al\(^3\) reported the outcomes of 414 porous tantalum cups (Trabecular Metal; Zimmer, Inc, Warsaw, Indiana) with a pore size of approximately 550 microns that had a 100% survivorship rate at 2-year follow-up. Macheras et al\(^5\) reported survivorships of up to 99% at 8- to 10-year follow-up in 151 hips that had received a porous tantalum Trabecular Metal monoblock acetabular component (Zimmer, Inc) with an approximate mean

<table>
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<tr>
<th>Author</th>
<th>No. of Patients (Hips)</th>
<th>Approx FU (range), y</th>
<th>Highly Porous Metal Type</th>
<th>Mean HHS (Range), Points</th>
<th>Survivorship (%)</th>
<th>Notes</th>
</tr>
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<tr>
<td>Gruen et al(^3)</td>
<td>(414)</td>
<td>3 (2-5)</td>
<td>Tantulum</td>
<td>49 (2-88)</td>
<td>90 (38-100)</td>
<td>100 HHS of 82% of patients</td>
</tr>
<tr>
<td>Komarasamy et al(^4)</td>
<td>104 (112)</td>
<td>3 (1.5-4)</td>
<td>Tantulum</td>
<td>45 (NR)(^a)</td>
<td>14 (12-60)(^a)</td>
<td>100 99% of patients were very satisfied or satisfied with procedure</td>
</tr>
<tr>
<td>Macheras et al(^5)</td>
<td>138 (151)</td>
<td>9 (8-10)</td>
<td>Tantulum</td>
<td>44 (4-87)</td>
<td>97 (59-100)</td>
<td>100 99 at 8 y for aseptic loosening or mechanical failure</td>
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<td>Malizos et al(^6)</td>
<td>218 (240)</td>
<td>5 (3-9.5)</td>
<td>Tantulum</td>
<td>48 (24-58)</td>
<td>94 (69-97)</td>
<td>98.75 4.5% complication rate</td>
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<td>Kostakos et al(^7)</td>
<td>44 (51)</td>
<td>2 y</td>
<td>Tantulum</td>
<td>41</td>
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<td>100 Radiographic analysis</td>
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<td>Moen et al(^7)</td>
<td>51 (51)</td>
<td>10.3 (9.6-10.8)</td>
<td>Tantulum</td>
<td>NR</td>
<td>NR</td>
<td>100</td>
</tr>
<tr>
<td>Current study</td>
<td>288 (252)</td>
<td>3 (2-5)</td>
<td>Titanium</td>
<td>53 (33-82)</td>
<td>91 (64-100)</td>
<td>100</td>
</tr>
</tbody>
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Abbreviations: Approx FU, approximate follow-up; HHS, Harris Hip Score; NR, not reported.

\(^a\)Oxford Hip Score.
pore size of 550 microns. The Table shows studies using porous metal acetabular cups.

Previous studies have reported similar outcomes using porous-coated titanium acetabular components. Chen et al.\(^1\) reported a study of 145 THAs using a hemispheric titanium fully porous coated Duraloc 100 and 1200 acetabular cups (DePuy, Warsaw, Indiana) with a mean pore size of 250 microns. They reported an overall Kaplan-Meier survivorship of 97.2% and no acetabular cup failure at 8-year follow-up and a 4.1% dislocation rate at a minimum of 3 years postoperatively.\(^3\) No dislocations occurred in the current study. Grobler et al.\(^2\) reported outcomes of 100 consecutive patients undergoing THA who had received a porous-coated titanium cup (Duraloc 300 cup; DePuy) with a mean pore size of 250 microns. They reported a 10-year survivorship for cup loosening of 100%; however, 4 patients underwent liner revision (1 due to dislocation and 3 due to periacetabular osteolysis).\(^5\)

The results of the highly porous titanium metal acetabular cup used in the current study differ from the results of some of the previously reported studies on older-generation titanium shells. Cheung et al.\(^10\) reported the outcomes of 66 THAs using a smooth hydroxyapatite-coated press-fit acetabular cup (Omnifit PSL HA; Osteonics, Allendale, New Jersey) with a pore size of approximately 250 microns. They reported cup survivals of 95.4% and 83% at 5- and 9-year follow-up, respectively.\(^6\) Jafari et al.\(^13\) evaluated the outcomes of revision THA in 207 patients (214 hips) receiving hydroxyapatite-coated titanium acetabular cups (Stryker Orthopaedics) compared with 79 patients (81 hips) who had received porous tantalum acetabular cups (TM; Zimmer) and mean pore size of 550 microns. The failure rate (both mechanical or radiographic) was 8% at a mean follow-up of approximately 52 months (range, 24-98 months) for the titanium cups and 6% at approximately 35 months (range, 24-63 months) for the tantalum cups, respectively. Because 80% of the failures in the titanium group occurred after 6 months postoperatively, Jafari et al.\(^13\) reported that the older hydroxyapatite-coated titanium acetabular cups only had the potential for bone ongrowth, unlike the porous tantalum cup that had successful bone ingrowth. Due to a pore size and porosity that is comparable with the porous tantalum cup, the titanium shell used in the current study should allow for similar osseointegration.

Several limitations existed in the current study. It was not a prospective study, and no comparison or matching groups were used. All procedures were performed by 3 high-volume, fellowship-trained adult reconstructive surgeons; therefore, the current results may not be easily reproducible by less-experienced or low-volume surgeons. However, the results are valuable because few reports have been published on the outcomes of the Tritanium acetabular cups. More long-term follow-up studies are needed to evaluate the outcomes.

**CONCLUSION**

The excellent short-term clinical and radiographic survivorship results for the use of a porous titanium acetabular cup are encouraging. The Tritanium acetabular cup may be an improvement over other porous-coated titanium implants, and the authors expect results comparable with those of other successful prostheses. Although further follow-up is recommended, the authors will continue to use this acetabular cup for primary cases and will study its use in the revision setting.

**REFERENCES**

16. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result


