Cementless Acetabular Reconstruction for Arthropathy in Old Acetabular Fractures

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abstract

This study was conducted to identify the factors influencing mechanical failure of cementless acetabular reconstruction for arthropathy after operative treatment of acetabular fractures. Fifty-six patients (56 hips) undergoing cementless total hip arthroplasty were enrolled and followed for a mean of 120 months (range, 60-180 months). The 10-year survival rate, with mechanical failure (radiographic loosening or revision due to aseptic loosening) as the endpoint, was analyzed with respect to sex, age, body mass index (BMI), acetabular bone deficiency, sclerotic changes to the acetabulum, and use of the Trabecular Metal (TM) cup (Zimmer, Inc, Warsaw, Indiana). Mean 10-year survival rates of the acetabular component were as follows: 80% (range, 65%-96%) in males and 100% in females ($P=.032$); 77% (range, 60%-95%) in patients younger than 50 years and 91% (range, 82%-100%) in older patients ($P=.027$); 88% (range, 78%-98%) in patients with a BMI less than 30 kg/m$^2$ and 81% (range, 74%-89%) in patients with a BMI of 30 kg/m$^2$ or higher ($P=.068$); 54% (range, 32%-76%) in patients manifesting large acetabular deficiency and 90% (range, 78%-100%) in the remaining patients ($P<.001$); 78% (range, 65%-91%) in patients with the presence of sclerotic acetabulum and 92% (range, 86%-100%) in patients with the absence of sclerotic acetabulum ($P=.022$); and 82% (range, 73%-100%) in patients who received a conventional shell and 100% in patients who received the TM cup ($P=.039$). Male sex, age younger than 50 years, large acetabular deficiency, and sclerotic changes of the acetabulum were significant factors contributing to the mechanical failure of cementless acetabular reconstruction performed for old acetabular fractures treated with open reduction and internal fixation. Use of the TM cup seemed able to prolong the endurance of the acetabular component in the subsequent reconstruction. [Orthopedics. 2015; 38(10):e934-e939.]
Cemented THA is although THA remains a good alternative for the treatment of posttraumatic arthritis, osteonecrosis of the femoral head, and chondrolysis have been described after both nonoperative and operative treatment of acetabular fractures.\(^1\)\(^-\)\(^4\) Once progressing into symptomatic posttraumatic arthritis, treatment options are generally limited to total hip arthroplasty (THA) and arthrodesis. However, the latter has lost popularity and has been mainly superseded by the former because of its sequelae.\(^1\)\(^-\)\(^5\) Although THA remains a good reconstructive alternative for old acetabular fractures, it is technically more difficult than a routine THA.\(^5\)\(^-\)\(^11\) Cemented THA is not currently recommended because long-term follow-up has found a high incidence of revision, as well as symptomatic and radiographic loosening of the acetabular component.\(^12\) Uncemented sockets have been reported to result in a lower rate of loosening than cemented components in this challenging group of patients.\(^6\)\(^-\)\(^9\) Several factors such as younger age, higher body weight, and large acetabular deficiencies have also been reported to be associated with the need for revision because of aseptic loosening in subsequent THA.\(^10\)\(^-\)\(^14\)

The development of the Trabecular Metal (TM) cup (Zimmer, Inc, Warsaw, Indiana), with its high porosity similar to subchondral bone and porous geometry favoring osteoconduction or osteoinduction, has desirable characteristics for bone ongrowth\(^15\) and has already had some encouraging results for both primary and revision THA.\(^16\)\(^,\)\(^17\)

The current authors conducted a retrospective study to explore whether mechanical failure of the acetabular component was associated with patient sex, age, body mass index (BMI), acetabular deficiency, sclerotic changes to the acetabulum, and use of the TM cup.

**Materials and Methods**

Between 1996 and 2010, 56 patients (56 hips: 27 right and 29 left) were treated at the authors’ institution with cementless THA after sequelae from previous open reduction and internal fixation (ORIF) of an acetabular fracture. The indications for THA included pain and limited function, accompanied by radiological signs of advanced arthritis, articular incongruity, or osteonecrosis of the femoral head. Mean patient BMI was 24.3 kg/m\(^2\) (range, 19.2-33.4 kg/m\(^2\)). Patients sustained the acetabular fractures at a mean age of 51.8 years (range, 18-81 years) and underwent THA at a mean age of 54.1 years (range, 19-86 years). Mean time from initial fracture surgery to THA was 27 months (range, 6-114 months). Mean clinical and radiographic follow-up was 120 months (range, 60-180 months).

**Procedure and Implant**

The operative approach for THA was determined by factors such as the previous ORIF exposure site, the need to remove hardware or excise heterotopic bone, the location of any acetabular deficiency, and the presence of soft tissue contracture. The approach was posterior in 35 hips and anterolateral in 21 hips. No transtrochanteric approach or trochanteric osteotomy was used.\(^18\)\(^,\)\(^19\) No fracture nonunion was noted in this series. Hardware left from previous surgeries was not routinely removed unless its presence compromised the appropriate positioning or fixation of the acetabular component. It was completely removed in 5 patients, partially removed in 33 patients, and completely retained in 18 patients.

Acetabular bone deficiency was classified based on the Paprosky classification for THA.\(^20\) Five patients had a Paprosky III deficiency, and they received morcelized cancellous graft from the femoral head, which was impacted into the contained cavitary defect both manually and by reverse reaming. No structural graft was used. All acetabular reconstructions were performed with a cementless, hemispheric component having multiple optional holes for supplemental screw fixation. The conventional Trilogy cup (Zimmer, Inc) was used in 48 patients and the TM cup was used in 8 patients; the latter was suggested to all patients with Paprosky III acetabular deficiency or with the presence of sclerotic changes to the acetabulum. However, the decision to use the TM cup was influenced by patient choice because it was not covered by the national health insurance.

The outer diameter of the acetabular component was determined by patient anatomy and was underreamed by 2 mm to achieve an initial press-fit. Sharp reamers were used for acetabulum with sclerotic changes. Reaming was done aggressively and as deep and large as possible until a bleeding acetabular bed was formed but without breaking through the wall of the acetabulum to damage the stability of the cup. The initial fixation was augmented with 6.5-mm cancellous screws. All bearing surfaces were ultra-high-molecular-weight polyethylene (UHMWPE) liners modularly inserted and articulated to a cobalt-chromium femoral head.

**Postoperative Protocol**

Full weight bearing as tolerated with crutch assistance was allowed for 6 weeks postoperatively. Each patient was evaluated clinically and radiographically at 6 weeks and 3, 6, and 12 months postoperatively, and then yearly afterward. At each follow-up visit, an anteroposterior radiograph of the pelvis and a lateral radiograph of the hip were taken. If infection was clinically or radiographically suspected, laboratory data, including complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP), were checked.

**Radiographic Analysis**

All preoperative and serial postoperative radiographs were evaluated by an independent observer (Y.-P.S.). Evaluation of preoperative radiographs was focused on the presence of sclerotic changes to the acetabulum. Sclerosis was determined if the acetabulum was more radiopaque than its surrounding bony contexture. On serial postoperative radiographs, the implant-bone interfaces were evaluated for the presence and extent of radiolucent lines according to...
An acetabular component was considered to be loose if a complete radiolucent line was observed at the implant-bone interface on anteroposterior or lateral radiographs or if the acetabular component had migrated, as assessed with the method of Massin et al. Statistical Analysis

The 10-year survival rate of the acetabular component, with mechanical failure (radiographic loosening or revision due to aseptic loosening) as the negative endpoint, was analyzed with respect to the variables of patient sex, age at THA (younger than 50 years vs 50 years and older), BMI (less than 30 kg/m² vs 30 kg/m² and higher), acetabular bone deficiency noted at THA (large vs other), presence or absence of sclerotic changes to the acetabulum, and type of acetabular component (conventional vs TM cup). Survival of the TM cup was further compared with that of the conventional cup by taking into account the status of acetabular bone deficiency and sclerotic changes to the acetabulum. The Kaplan-Meier method was used to calculate the probabilities of implant survival. Differences in the survival of subgroups were tested by the log-rank test, with a P value of .05 considered significant.

RESULTS

Fifty-six patients were enrolled in the study, including 39 males and 17 females. Complications after THA included acute myocardial infarction in 1 patient, pneumonia in 2 patients, urinary tract infection in 2 patients, and superficial wound infection in 3 patients. Thirty-six patients were younger than 50 years at THA (mean, 42.3 years; range, 19-49 years), and 20 were 50 years or older (mean, 61.2 years; range, 50-86 years). Forty-four patients had a BMI lower than 30 kg/m² (mean, 22.9 kg/m²; range, 19.2-29.8 kg/m²), and 12 patients had a BMI of 30 kg/m² or lower (mean, 31.4 kg/m²; range, 30.2-33.4 kg/m²). During THA, 5 patients were found to have Paprosky III acetabular deficiency, 7 had Paprosky II, 8 had Paprosky I, and 36 had no or slight deficiency. Five patients with Paprosky III deficiency received autologous femoral head grafting, whereas the other 51 patients did not receive bone grafting. Fracture-related sclerotic changes to the acetabulum were noted in 30 patients by preoperative radiographic evaluation, whereas the other 26 patients manifested no sclerotic changes.

A radiolucent line adjacent to the acetabular component was seen in DeLee and Charnley’s zone 1 in 10 patients, zone 2 in 4 patients, and both zones in 6 patients. Scalloping expansile-type osteolysis was not detected around any cup. Complete radiolucency over 3 zones was seen in 6 patients. All of them had conventional cups but had normal CBC, ESR, and CPR laboratory data. Three patients did not undergo revision due to no or mild pain, 2 underwent revision due to moderate or severe pain, and 1 underwent revision due to severe pain and cup migration. The 3 patients who did not undergo revision showed no progressive radiolucency throughout their 1-year follow-up after THA. The revisions were performed an average of 47 months (range, 13-92 months) after index surgery.

All 6 patients with mechanical failure were male; 5 of them were younger than 50 years, and 4 had a BMI lower than 30 kg/m². Two patients had Paprosky III deficiency, 1 had Paprosky II, and 3 had no or slight deficiency. Five patients had sclerotic changes of the acetabulum found at THA, and 1 patient had no sclerotic changes. All mechanical failures occurred with the conventional shell (Figure 1).
No stem loosening or infection developed in the 56 patients studied. Mean overall 10-year survival rate, with the presence or absence of mechanical failure as the endpoint, was 87% (95% confidence interval, 81%-93%) (Figure 2). Evaluation revealed that male sex ($P = .032$), age younger than 50 years ($P = .027$), large acetabular defects with Paprosky III deficiency ($P < .001$), the presence of sclerotic changes to the acetabulum ($P = .012$), and use of a conventional shell rather than the TM cup ($P = .039$) were significantly associated with a poorer endurance of the acetabular component. However, BMI seemed to make little difference in the survival rate ($P = .068$) (Table 1). For patients with a large acetabular deficiency ($P < .001$) or sclerotic changes to the acetabulum ($P = .008$), the TM cup was more durable than the conventional cup (Table 2).

**DISCUSSION**

Total hip arthroplasty in the treatment of old acetabular fractures is technically more challenging than routine THA because of repeated exposure, bone deficiency, implant fixation, and perioperative parameters such as operative time, blood loss, and transfusion.6-11 Although Bellabarba et al7 reported a 10-year survival rate of 97% in subsequent THA, which compared favorably with that of routine THA, their follow-up duration was relatively short. A 12% rate of cup revision were reported by Huo et al25 and Berry and Halasy,6 respectively. The current study reported a modest mechanical failure rate of 10.7%, ranging between the values reported by Bellabarba et al2 and Huo et al.25

The current study results indicated that male sex, age younger than 50 years, and large acetabular deficiency were significant risk factors for mechanical failure of the cup in subsequent THA. In primary THA, male sex, younger age, and high activity level contributed to the development of acetabular prosthesis loosening.26,27 The occurrence of wear-related loosening in subsequent THA was reasonable. Large acetabular defects provided poor bony support for cups, poor quality of cup fixation, and less contact for bony ingrowth and were thus more likely to cause cup loosening. Weber et al8 also reported younger age and large residual deficiency in the acetabular bone as risk factors for revision in subsequent THA. Although their investigation found no statistical differences between the sexes, males in their series tended to have poorer cup survival than females.

Another risk factor reported by Weber et al8 was heavier weight (larger than 80 kg). However, in the current study, BMI did not appear to be a significant risk factor. Historically, obesity was considered a risk factor for prosthesis failure because the joint reaction force experienced at the hip is directly proportional to body weight.28 Despite the increased joint load.

**Figure 2:** Kaplan-Meier survival curve. Mechanical failure was set as the negative endpoint. The error bars indicate 95% confidence intervals.

**Table 1**

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of Mechanical Failures</th>
<th>Mean 10-year Survival Rate (95% CI)</th>
<th>$P^a$</th>
</tr>
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<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39</td>
<td>6</td>
<td>80% (65%-96%)</td>
</tr>
<tr>
<td>Female</td>
<td>17</td>
<td>0</td>
<td>100% (100%-100%)</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50</td>
<td>36</td>
<td>5</td>
<td>77% (60%-95%)</td>
</tr>
<tr>
<td>≥50</td>
<td>20</td>
<td>1</td>
<td>91% (82%-100%)</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>44</td>
<td>4</td>
<td>88% (78%-98%)</td>
</tr>
<tr>
<td>≥30</td>
<td>12</td>
<td>2</td>
<td>81% (74%-89%)</td>
</tr>
<tr>
<td>Acetabular deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paprosky III</td>
<td>5</td>
<td>2</td>
<td>54% (32%-76%)</td>
</tr>
<tr>
<td>None, Paprosky I or II</td>
<td>51</td>
<td>4</td>
<td>90% (78%-100%)</td>
</tr>
<tr>
<td>Sclerotic changes to the acetabulum</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Presence</td>
<td>30</td>
<td>5</td>
<td>78% (65%-91%)</td>
</tr>
<tr>
<td>Absence</td>
<td>26</td>
<td>1</td>
<td>92% (86%-100%)</td>
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<tr>
<td>Acetabular component</td>
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<td></td>
<td></td>
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<tr>
<td>Conventional</td>
<td>48</td>
<td>6</td>
<td>82% (73%-100%)</td>
</tr>
<tr>
<td>TM cup§</td>
<td>8</td>
<td>0</td>
<td>100% (100%-100%)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; CI, confidence interval; TM, Trabecular Metal.

$^a$Log-rank test; $P < .05$ is statistically significant.

in obese patients, the absence of consistent increases in bearing wear seems to exclude obesity from being a conclusive risk factor for component loosening.\textsuperscript{29} The decreased walking activity accompanied by overweight and obesity may also counterbalance the increased stresses on the prosthetic components and interfaces.\textsuperscript{30} This may explain why obesity has had no consistent effect on implant loosening and wear in clinical studies,\textsuperscript{31} although it is usually associated with a higher incidence of comorbidities, including cardiovascular and respiratory events and deep venous thrombosis.\textsuperscript{32,33}

The current study indicated that sclerotic changes to the acetabular bed after acetabular fracture were a risk factor for cup failure. The reasons may be multifold. First, the stiff sclerotic bone bed constrained the expendable potential of acetabulum, which was adverse to the press-fit technique in cementless reconstruction. Second, it was difficult to get a bleeding acetabular bed during THA in the sclerotic bone. Third, the avascular and nonviable sclerotic bed made a poor environment for osseointegration of the implant. All these risks compounded to raise the cup failure rate.

The TM cup has high porosity, coefficient friction, and intrinsic strength to provide greater stability and an environment conducive for bone ongrowth and vascularization,\textsuperscript{15,34} allowing for potential benefits in major bone loss during revision THA.\textsuperscript{35-37} There are few reports on its promising clinical and radiological results for both complex primary and revision THA.\textsuperscript{35,38} In the current study, 8 hips were reconstructed with TM cups, and none of them experienced mechanical failure during follow-up. Regarding the relationship between the TM cup and large acetabular bone deficiency, the authors found that 3 patients with Paprosky III deficiency who received the TM cup achieved a 100% survival rate. However, the 2 patients with Paprosky III deficiency who received the conventional cup sustained mechanical loosening (Table 2). The TM cup also alleviated sclerotic changes to the acetabulum. Among the 30 patients with sclerotic changes to the acetabulum, 6 patients receiving the TM cup achieved 100% survival. In contrast, the remaining 24 patients receiving the conventional cup achieved 70% survival (Table 2). Survival was significantly improved by the use of the TM cup in cases with large acetabular bone deficiency or sclerotic changes to the acetabulum. More cases and further evaluations are warranted to make more concrete conclusions.

This study identified some risk factors for mechanical failure of the acetabular component in THA for arthropathy of old acetabular fractures, which has rarely been explored in previous literature. To the authors’ knowledge, this is also the first series to investigate whether the use of the TM cup affects the longevity of the acetabular component in the subsequent THA. The study has some limitations. First, this is a retrospective case series study, and the design is subject to biases related to the confounding factors and the lack of a comparison group. Second, the duration of follow-up is relatively short. It may be more beneficial if all patients had been followed for at least 10 years. Third, the identification of sclerotic changes to the acetabulum on radiographs is subjective. However, an objective method to quantify the degree of sclerosis is impractical because radiological evaluation has not yet been taken as a standard procedure.

**Conclusion**

Total hip arthroplasty is a favorable procedure for advanced hip arthropathy...
that develops after ORIF of acetalubar fractures. This study demonstrates that several risk factors, including male sex, age younger than 50 years, large acetalubar deficiency, and the presence of sclerotic changes to the acetalum, affect the endurance of the cementless acetalubar component for reconstruction. This finding reminds surgeons that the cup may have an inferior longevity in patients carrying the aforementioned risk factors. However, if patients undergoing THA are found to have large acetalubar deficiencies or sclerotic changes to the acetalum, use of the TM cup is recommended.

REFERENCES