Small stem Exeter total hip replacement: clinical and radiological follow-up over a minimum of 2.5 years

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ABSTRACT

Purpose. To evaluate the clinical and radiological outcome in patients undergoing small stem Exeter total hip replacement.

Methods. A total of 46 small stem Exeter total hip replacements were performed on 44 consecutive patients (18 men and 26 women) attending the University of Malaya Medical Centre. The mean age at the time of operation was 58 years (range, 24–81 years). Of the 46 procedures performed, 35 were primary total hip replacements and 11 were revision operations, with aseptic loosening of the original implant being the main indication for revision. The main indications for surgery in primary cases were avascular necrosis and rheumatoid arthritis. Clinical and radiographic outcomes were assessed at 6 weeks’, 12 weeks’, 6 months’ follow-up, and annually thereafter. Postoperative cementing technique was also assessed.

Results. The mean follow-up period was 4 years. The mean Oxford Hip Score improved from 46 points preoperatively to 17 points at the final follow-up examination. There were no revision operations, no implant breakages, and no excessive migration of the implants. The potential complications of implant failure due to smaller implant size and increased patient activity were not observed.

Conclusion. Due to the smaller size of Asian femora, the small stem Exeter implant is a very useful development. This study suggests that it will perform as well as its larger counterparts.

Key words: prosthesis implantation; total hip replacement; treatment outcome

INTRODUCTION

The Exeter total hip replacement prosthesis was first implanted in the autumn of 1970. In 1976, design modifications were made whereby the anteroposterior (AP) section of the stem was increased slightly, and 5 sizes were introduced with a 44 mm offset, together with 4 having a 37.5 mm offset. Three sizes were made with a 22 mm head for cases of congenital dislocation of the hip (CDH). At the same time, the original polished surface was changed to a matt finish, a step later found to be retrograde and this was reversed at the beginning of 1986. Until 1986, all stems were made of 316L stainless steel. At the beginning of 1986,
Orthinox, a high strength, low corrosion stainless steel was introduced.\(^3\) Throughout these design modifications, the fundamental stem geometry remained unchanged. The double-tapered, collarless design allows distal subsidence of the stem within the cement mantle and therefore, more uniform transmission of load into the cement, and dynamic ongoing pressurisation. The Exeter implant has had 30-year follow-up with good results. We report our experience with the small stem Exeter total hip implant, which has been used in Malaysia since 1995.

These smaller implants were introduced to the East Asian market in the mid-90’s to cater for the smaller build of the Asian population. Initially, the small CDH stem with a 35.5 mm offset was used. For some patients, this was still too large. Later the newly manufactured small stem Exeter total hip replacement implant was used. This implant is shorter and therefore, the angle of taper is altered. It is available with offsets of 30 mm, 33 mm and 35.5 mm (Fig. 1).

**PATIENTS AND METHODS**

From 1995 through 1999, 46 consecutive total hip arthroplasty (THA) procedures were performed on 44 consecutive patients at the University of Malaya Medical Centre, using the small stem Exeter total hip replacement implant (Stryker Inc, Warsaw, US). Stems with offsets of 30 mm, 33 mm and 35.5 mm were used (Table 1). The head size was 26 mm in all cases. Preoperative templating was performed in all cases. The last author carried out all the procedures, using the anterolateral approach to the hip in all cases. Second generation cementing techniques were used, including cement restrictor, pressurised lavage, retrograde introduction of cement with a cement gun, and a proximal femoral cement pressuriser. Simplex P radiopaque bone cement (Stryker Inc, Warsaw, US) was used in all cases. Patients were mobilised and fully weightbearing as soon after the operation as possible. There were 18 male and 26 female patients. The mean age at surgery was 58 years (range, 24–81 years). The mean weight was 58 kg (range, 38–82 kg) and the mean height was 157 cm (range, 143–175 cm). There was a range of indications for surgery (Table 2), with a broad spread across the 3 Charnley categories\(^4\) (Table 3).

Clinical outcomes were assessed using the Oxford Hip Score\(^5\) and radiological outcomes were assessed from AP radiographs of the pelvis, and lateral views of the affected hips. Stem failure was classified according to the criteria described by Gruen et al.,\(^6\) and the classification of cup failure by DeLee and Charnley\(^7\) was used for the acetabular component. Cementing technique was assessed using the criteria described by Barrack et al.\(^8\) Subsidence was measured using a modification of the method described by Fowler et al.\(^3\) All immediate postoperative and latest follow-up radiographs were digitised in black and white and stored in jpeg (DSC-F55V; Sony

**Table 1**

<table>
<thead>
<tr>
<th>Offset size (mm)</th>
<th>Number</th>
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<tbody>
<tr>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>33</td>
<td>14</td>
</tr>
<tr>
<td>35.5</td>
<td>8</td>
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**Table 2**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of patients</th>
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<tr>
<td>Revision</td>
<td>11</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>16 (17)*</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>7</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>6</td>
</tr>
<tr>
<td>Post-trauma</td>
<td>2</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>1</td>
</tr>
<tr>
<td>Developmental dysplasia of hip</td>
<td>1 (2)*</td>
</tr>
</tbody>
</table>

* Number of THA in parentheses

**Figure 1** Small stem implant with 30 mm offset, compared to size-1 implant with 37.5 mm offset.
Corporation, Tokyo, Japan), using a 3.3-megapixel Sony Cybershot camera. Osiris Imaging Software (version 4; University Hospital of Geneva, Geneva, Switzerland) was then used to measure alignment and subsidence of the implant.9

RESULTS

At a mean follow-up of 4 years, 2 patients had died. The cause of death in both cases was not related to the THA. One patient was lost to follow-up. All the remaining patients had a surviving THA.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Unilateral hip disease, no additional limitations</td>
<td>12</td>
</tr>
<tr>
<td>B</td>
<td>Bilateral hip disease, no additional limitations</td>
<td>24</td>
</tr>
<tr>
<td>C</td>
<td>Multiple joint disease, other disease limiting mobility</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 3

Distribution of Charnley category

Clinical results
The mean preoperative Oxford Hip Score was 46 (range, 36–51). The mean Oxford Hip Score at review was 17 (range, 12–24). The Oxford Hip Scores did not correlate with the radiological appearance or the age of the patient. There was some correlation with the preoperative diagnosis, however. Patients in Charnley category C had higher Oxford Hip Scores at follow-up than patients in Charnley categories A and B. There were no cases of deep infection. There were 2 dislocations. One patient dislocated twice, within one month of surgery. The other patient sustained dislocation of her left revision total hip replacement.
and a crack fracture of the left femoral shaft while undergoing a total hip replacement, on the right side. She was treated with traction for 6 weeks and made a good recovery.

**Cementing technique**

Radiological assessment of the cement mantle in the postoperative radiographs showed that in 38 (83%) hips there was complete filling of the medullary cavity with cement (grade A) [Fig. 2]. In 8 hips there was slight radiolucency at the cement bone interface (grade B) [Fig. 3].

**Alignment**

At the last follow-up visit, 25 stems were 1° to 3° in valgus and 5 stems were 3° to 6° in valgus. A further 15 stems were in neutral alignment, and one stem was 3° in varus.

**Subsidence and radiolucent lines**

There was no migration at the cement-bone interface, measured from the greater trochanter to the proximal cement mantle. At the stem-cement interface there were 3 (7%) cases of vertical subsidence of the femoral stems of more than 2 mm but less than 5 mm. In the remaining cases (93%) the femoral stem had subsided by less than 2 mm. There were 7 (15%) cases in which radiolucent lines were present at the cement bone interface in Gruen zones 1, 2, 3, 6 and 7 on the AP radiograph. On the lateral radiographs, there were 3 (4.6%) cases of radiolucency at zone 8, at the level of the lesser trochanter. One case had a continuous radiolucent line at the cement-bone interface on the AP radiograph. The cases with radiolucent lines were revision cases and in the case with the continuous radiolucent line at the cement-bone interface, this was seen on the immediate postoperative radiograph as well. Thus it appeared that the radiolucent line was non-progressive in nature.
There were 2 cases with radiolucency in zones 2 and 3 of the acetabulum. Both were revision cases. There was one case of cup migration (tilting). This patient had no clinical symptoms and was a case of primary THA (Fig. 4). There were no other radiolucent lines and no cement fractures seen in the acetabular component at follow-up.

DISCUSSION

To the authors’ knowledge, this is the first report of early outcomes following THA with the small stem Exeter implant. Prior to the introduction of this implant in 1995, there had been a size mismatch between the standard Exeter stem and the majority of femora operated on in our institution. This finding was supported by morphometric studies in Hong Kong and Singapore. Data from these studies were used to design implants for the Asia Pacific region.

Cemented THA has been extremely successful in restoring hip function and eliminating hip pain. This study corroborates the excellent early results seen with standard-sized cemented Exeter THA. Finite element analyses, in vitro studies, and in vivo radiostereometric analyses of the Exeter stem have shown that it is a force-closed fixation design, utilising the taper slip principle, which is reliant on subsidence under load to obtain and maintain a tight fit. Loading causes the taper to fit more snugly and when the load is reduced, during sleep for example, stress relaxation can take place, while the taper maintains the strain. It is expected that for satisfactory Exeter implants, the migration at the stem cement interface is initially rapid and then slows. Early subsidence in this context is not synonymous with loosening, and this must be taken into account when interpreting the subsidence of the stems and the lucent zones reported in this series. Therefore, previously published conclusions predicting femoral stem failure on the basis of subsidence of the stem relative to the femur cannot be used to predict failure in polished double-tapered designs such as the Exeter. Moreover, the patients with stems that have subsided are functioning well and clinical studies have shown that distal migration of the Exeter stem does not cause poor long-term results. It has also been shown that the distal migration of the Exeter stem occurs at the stem-cement interface and not at the bone-cement interface, thus protecting the bone-cement interface from osteolysis and aseptic loosening. In addition, distal migration of the stem, and cement creep expand the cement mantle and reinforce the cement-bone interface.

In the authors’ view, a factor contributing to the favourable outcome seen over this follow-up period, is the smaller size of the implant, both in length and coronal width, that allows for a uniform cement mantle in the smaller femur. The initial concerns regarding a smaller, shorter-stemmed implant, such as angulation, aseptic loosening and implant breakage have not occurred at a mean follow-up of 4 years. Therefore, the implant is clinically safe and can be used in the target population. The acetabular cup size was also smaller in this series (Table 4) and one case of cup migration was observed in this series, with tilting of the socket occurring after a period of 4 years. The initial operation in this case was for avascular necrosis and this patient is currently able to work as a nurse at our institution and is asymptomatic.

Measurements of patient activity are important for proper understanding and evaluation of the results of any long-term study of THA. However, patient activity was not objectively evaluated over time in this series. A significant percentage of the patients in this series were young and very active, and this would undoubtedly impact on the survivorship of the prosthesis in this group.

Osteoarthritis of the hip is relatively rare in Asia. In this series, the 3 most common indications for THA were avascular necrosis, rheumatoid arthritis, and revision surgery. This will also influence the long-term outcome in this series as these indications inherently have a higher prevalence of morbidity compared to primary osteoarthritis, which is the principal indication for THA in Europe and North America.

CONCLUSION

Early results of THA with the small stem Exeter prosthesis appear promising. The potential complications of implant failure due to smaller implant size and increased patient activity have not materialised. The current evidence suggests that the small stem Exeter THA implant will perform as well as its larger counterparts.

<table>
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<tr>
<th>Cup size (mm)</th>
<th>Number (%)</th>
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<tbody>
<tr>
<td>44</td>
<td>24 (52)</td>
</tr>
<tr>
<td>48</td>
<td>19 (41)</td>
</tr>
<tr>
<td>52</td>
<td>3 (7)</td>
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REFERENCES