We reviewed the results of 84 total hip replacements performed with a short metaphyseal-fitting anatomical cementless femoral component in 84 unselected consecutive patients with a mean age of 78.9 years (70 to 88). The mean follow-up was 4.6 years (4 to 5). The mean pre-operative Harris hip score was 26 points (0 to 56), which improved to 89 (61 to 100) at the final follow-up. No patient had thigh pain. The mean pre-operative Western Ontario and McMaster Universities osteoarthritis index score was 61 points (48 to 75), which improved to 21 (6 to 46). The mean University of California, Los Angeles activity score was 5.5 points (3 to 7) at the final follow-up. Osseointegration was seen in all femoral and acetabular components. All hips had grade 1 stress shielding of the proximal femur. No acetabular or femoral osteolysis was identified.

These results demonstrate that a short metaphyseal-fitting femoral component achieves optimal fixation without diaphyseal anchorage in elderly patients.
84 patients (84 hips) in the final clinical and radiological analysis. Of these, 51 (61%) were between 70 and 79 years of age and 33 (39%) were between 80 and 88 years of age. The indication for THR was osteoarthritis in 55 patients (65.5%), osteonecrosis in 17 (20.2%), and fracture of the femoral neck in 12 (14.3%) (Table I).

All patients received a Proxima femoral component with a 36 mm Biolox delta ceramic modular head (DePuy, Warsaw, Indiana). A fully porous-coated Pinnacle acetabular component (DePuy) with a ceramic liner was used in all hips. The acetabular components were press-fitted after under-reaming by 1 mm, and in 37 hips (44%) one or two screws were used for additional fixation. The acetabular component sizes ranged from 52 mm to 58 mm. The cost of this combination (US$ 2429.98) was less than for an Exeter cemented femoral component with a contemporary acetabular component and cobalt-chrome head and conventional polyethylene bearing (US$ 2501.78). This includes the actual cost of implanting using a modern cementing technique, including two batches of cement, a distal medullary plug, the cement gun and syringe, the cement compactor and the proximal rubber seal. These costs may be different in other healthcare systems.

All the operations were performed by the senior author (YHK) using a posterolateral approach. The femoral neck was cut horizontally at the cervicocapital juncture, because preservation of the femoral neck is required for axial and torsional stability of the stem.18,19 A ‘round-the-corner’ technique20 was used for femoral broaching and insertion of the implant. The broaches and implants were inserted in a slight varus position and then rotated into the correct axial alignment (Fig. 2). Adequate cancellous bone (2 mm to 3 mm) for osseointegration was left in the lateral part of the proximal femur. The size of the femoral component which was selected matched the size of the largest broach used. The dimension of the real component was 0.5 mm larger than that of the prepared metaphysis.

Patients were allowed to stand on the second postoperative day and progressed to full-weight-bearing with crutches as tolerated. They were advised to use crutches for six weeks and to use a cane thereafter if needed.

The patients were reviewed at three months, one year, and yearly thereafter. Radiographs were taken one week after surgery and at each follow-up evaluation. The Harris hip score (HHS)21 was determined before surgery and at each follow-up, as was the Western Ontario and McMaster Universities osteoarthritis index (WOMAC) score.22 Thigh pain was scored on a 10-point visual analogue scale23 where 0 = no pain and 10 = severe pain, and activity was assessed using the University of California, Los Angeles (UCLA) score.24 All the data were obtained by one observer (SML), who was not part of the surgical team. Any clicking or squeaking from the ceramic-on-ceramic bearing was recorded.

A supine anteroposterior (AP) radiograph of the pelvis with both hips in 15° internal rotation and no abduction, and a cross-table lateral radiograph of each, were obtained immediately after operation and at follow-up visits.

**Table 1. Patient demographics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of hips</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Number of patients</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Mean age (range) (yrs)</td>
<td>78.9</td>
<td>(70 to 88)</td>
</tr>
<tr>
<td>Mean weight (range) (kg)</td>
<td>88.5</td>
<td>(49 to 98)</td>
</tr>
<tr>
<td>Mean height (range) (cm)</td>
<td>168.1</td>
<td>(151 to 189)</td>
</tr>
<tr>
<td>Mean follow-up (range) (yrs)</td>
<td>4.6</td>
<td>(4 to 5)</td>
</tr>
</tbody>
</table>

**Fig. 1**

Photograph of the Proxima femoral component.

**Fig. 2**

Diagram illustrating the ‘round-the-corner’ technique which is used for femoral broaching and insertion of the implant. Broaches and implants are inserted in a slight varus position and rotated into the correct alignment.

The position of the femoral component in the AP and lateral planes was assessed as shown in Figure 3.

The radiographs were analysed by a research associate (SML) for stability of the components. They were classified as osseointegrated, fibrous stable or unstable. Components that showed spot welds were considered osseointegrated. Those that lacked definite ingrowth but had no progressive lucency or change in position were designated as fibrous stable, and those with clear signs of loosening, including axial or angular migration, were classified as unstable. Subsidence of the femoral component was evaluated by measuring the distance between the tip of the greater trochanter and the upper margin of the lateral flare of the stem, and the distance between the most proximomedial part of the porous-coated surface of the stem and the upper border of the lesser trochanter. These values in the AP radiographs taken one week after operation were compared with those taken at the final follow-up to define the subsidence. The intra-observer error for this measurement was determined by the intraclass correlation coefficient after the measurements were repeated three times at intervals of three days. This was 0.96 (0.95 to 1.0), indicating excellent reproducibility. A linear change of 2 mm or an angular change of 5°, bead-shedding and increased circumferential lucency were considered to be signs of loosening of the acetabular component. The vertical change in its position was measured between its inferior margin and the inferior margin of the ipsilateral teardrop, and horizontal change was measured between the Köhler line and the centre of the outer shell. The intraclass correlation coefficient was 0.97 (0.95 to 1.0).

Stress shielding was graded on the radiographs at the final follow-up according to the classification of Engh and Bobyn. Measurement of linear wear of the ceramic liner was attempted, but was below the level detectable by the method used.

The size and location of osteolytic lesions were assessed using the technique described by Zicat, Engh and Gokcen. The prevalence of heterotopic ossification was determined, and lesions were classified according to the criteria of Brooker et al.

Statistical analysis. The changes in HHS were evaluated with two-tailed Student’s t-tests. The chi-squared test with Yates’ correction was used to analyse complication rates and the radiological data. All statistical analyses were performed using the Statistical Package for the Social Sciences, version 14.0 (SPSS Inc., Chicago, Illinois) and statistical significance was set at p < 0.05.

Results
The mean follow-up was 4.6 years (4 to 5). The mean HSS, WOMAC score, patient activity level and level of thigh pain improved significantly (p ≤ 0.001). The mean HHS was 26 points (0 to 56) before surgery and 89 points (61 to 100) at final follow-up. The mean WOMAC score was 61 points (48 to 75) before surgery and 21 points (6 to 46) at the final follow-up, at which time 68 patients (81%) had no pain, 11 (13%) had mild pain that did not limit activity, and five (6%) had discomfort around the greater trochanter. No patient had thigh pain. The mean UCLA activity score at the final follow-up was 5.5 points (3 to 7). Even though the mean age was 83 years at the most recent follow-up, all but seven patients were active, with the
assessments. The radiographs showed heterotopic ossification in 15% of the total hip replacements, which occasionally required revision and was the main cause of patient complaints. However, radiographic changes in the proximal femoral region were generally not apparent, suggesting that the femoral component was stable and well-fixed. In addition, there were no significant changes in the radiolucent lines around the periprosthetic bone, indicating no discernible bone resorption. Therefore, osseointegration was confirmed in all the femoral and acetabular components. There were no discrepancies in the mean length of the femoral component or the acetabular component, and the differences in the radiolucent line were less than 5 mm longer or shorter. The femoral component was slightly longer (3.1 mm) in the total hip replacement group, but this was not statistically significant (p = 0.19).

**Table II. Comparison of patients with normal hips and with total hip replacements (mean, range)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Normal hip (n = 84)</th>
<th>Total hip replacement (n = 84)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre of rotation of hip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal (mm)</td>
<td>40.1 (35 to 48)</td>
<td>39.2 (36 to 49)</td>
<td>0.26</td>
</tr>
<tr>
<td>Vertical (mm)</td>
<td>15.1 (13 to 21)</td>
<td>16.5 (11 to 24)</td>
<td>0.19</td>
</tr>
<tr>
<td>Femoral offset (mm)</td>
<td>41.9 (35 to 48)</td>
<td>41.3 (36 to 50)</td>
<td>0.82</td>
</tr>
<tr>
<td>Limb length discrepancy (mm)</td>
<td>-</td>
<td>3.1 (± 1.0) longer</td>
<td>-</td>
</tr>
</tbody>
</table>

* Student’s paired t-test

Discussion

This study showed gratifying results after cementless THR using a Proxima femoral component in elderly patients. We found that poor bone quality was not a contraindication and stable fixation of the femoral component was achievable in osteoporotic bones, as was observed by McAuley et al. 11 with their extensively porous-coated diaphyseal femoral component. We believe that the satisfactory results using this femoral component in this group of patients can be attributed to optimal preparation of the proximal femur with preservation of the femoral neck, the lateral flare of the femoral component, a reduced load transfer to the component due to reduced daily activities, the potential for osseointegration even in this age group, and the improved quality of the ceramic-on-ceramic bearing.

There are only two reports describing the results in a similar unselected consecutive series of patients who were aged ≥ 65 years. 11, 30 It is useful to compare their results with ours. In one study, the rate of revision or radiological loosening was 12% (125 of 1041 hips) for the femoral component and 27% (281 of 1041) for the acetabular component. 30 In another study, 11 the rate of failure of the anatomical, medullary locking prosthesis (AML; DePuy, Warsaw, Indiana) was 2% (3 of 142 hips with radiological follow-up) for the femoral components and 6% (9 of 142 hips) for the acetabular components. We had no failures in our study.

In the study with the AML, 11 five of 152 patients had thigh pain. Oishi, Walker and Colwell 31 found that three of their 88 patients had thigh pain when hybrid fixation...
was used with a third-generation cementing technique. The absence of thigh pain in our study may be attributable to the rigid axial and torsional stability of the femoral component in the proximal femur and an absence of contact between the distal stem and the femoral cortex.

A potential concern with the use of short metaphyseal-fitting anatomical cementless femoral components in elderly patients is loss of stability of the component and failure of osseous ingrowth. Walker et al.16 suggested that extending the femoral component beyond the lesser trochanter would be unnecessary for a cementless anatomical femoral component with a lateral flare, and that a short stemless implant would suffice. Leali and Fetto32 found that a proximally fixed cementless femoral component with a lateral flare provided significant initial stability. Santori et al.33,34 and Santori and Santori35 reported solid fixation of their custom-made short metaphyseal-fitting stem (DePuy, Leeds, United Kingdom). Their findings validated the assumption that torsional loads can be controlled without diaphyseal anchorage by preservation of the femoral neck and the lateral flare of the femoral component. In our study, the fixation was successful in all hips and stability of the femoral component did not deteriorate at mid-term follow-up and the performance of the Proxima femoral component in this consecutive series of elderly patients was comparable to that of other conventional cementless femoral components.26,27,35-37

Santori et al.33 observed mild stress shielding with rounding off of the calcar in 70 of 131 femora after using their custom-made short femoral component. This did not progress after one year. Leali and Fetto32 also demonstrated that the bone content was preserved after one year. All hips in our series had mild stress shielding at the final follow-up, which we think is due to physiological loading of the proximal femur.

McAuley et al.11 noted in a series of older lower-demand patients, that 13 of 142 hips showed evidence of at least 2 mm of wear of the polyethylene liner. They suggested that the generation of debris and the resulting osteolysis remain unresolved issues. They considered using a 32 mm head in older, lower-demand patients if the larger diameter head improves stability of the hip and the thickness of the polyethylene liner is adequate. In our series, we used a 36 mm Biolox delta liner and a Biolox delta femoral head to improve stability and to potentially reduce wear and osteolysis.

Several studies38-40 have shown that the perceived cost differential between cemented and cementless systems is not necessarily an issue. Barrack et al.39 also found that the actual cost of implanting a modern cemented femoral component was greater than for a corresponding cementless one. In our series, the Proxima stem with a Biolox delta ceramic head and liner was cheaper than a modern cemented femoral component with a contemporary acetabular component and cobalt-chrome head and polyethylene liner. The Proxima femoral component was 4% cheaper than other conventional cementless components.

It has been suggested that the use of conventional cementless components may increase the prevalence of intra-operative peri-prosthetic fracture and heterotopic ossification. None of these problems were of concern in our series.

Our study has some limitations. Although we collected all the data prospectively, the study was not randomised and we had no control group in which we used a different component or a different surgical technique to compare outcomes. For analysis of femoral component migration we did not use the more precise methods of radiostereophotogrammetric analysis. The duration of follow-up was short and hence insufficient to allow us to draw significant conclusions. However, there is strong evidence that the early stability of the cementless femoral component produces good clinical results.41,42

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The authors would like to thank S.-M. Lee for her assistance with the collection and analysis of data.

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References


