ABSTRACT

Purpose. To report the mid-term outcome of a modular, cementless, proximally hydroxyapatite-coated, anatomic femoral stem in total hip arthroplasty (THA).

Methods. 160 consecutive patients aged 42 to 92 (mean, 70) years underwent 185 cementless THAs for primary osteoarthritis or femoral neck fractures. All procedures were performed by a single surgeon using the same modular, cementless, proximally hydroxyapatite-coated, anatomic femoral stem, regardless of age and bone quality. Clinical evaluation (pain, range of movement, and ability to walk) was based on the Merle d’Aubigne and Postel scores. Radiological assessment was based on criteria by Engh et al. in the 7 Gruen zones with regard to the presence of radiolucent lines, osteolysis, cancellous condensation, cortical hypertrophy or atrophy, reactive lines, and pedestal formation. Failure of the stem was defined as revision or impending revision because of aseptic loosening or pain.

Results. Of the 160 patients, 21 died and none were lost to follow-up. In 3 of the 21 patients, the femoral stems were revised for periprosthetic fractures after a fall at 6 weeks, 10 months, and 3.8 years. 138 patients (162 THAs) completed a mean follow-up of 7.8 (range, 5.5–10.4) years. Their overall mean Merle d’Aubigne and Postel scores increased from 7.09 preoperatively to 16.36 postoperatively. The mean Engh score was 24.9 out of 27, with the mean score for femoral stem fixation 10 out of 10 and 14.9 out of 17 for femoral stem stability. No reactive lines at the bone-stem interfaces and no subsidence or osteolysis were evident in any of the radiographs. There were 5 periprosthetic femoral fractures, 2 deep infections, 3 dislocations, and 2 aseptic loosening (one each for the femoral stem and acetabular socket). Survivorship of the femoral stem at 10 years was 99% when revision secondary to only aseptic loosening of the stem was the endpoint. It was 96% when failures due to all causes (infection, periprosthetic fracture, and aseptic loosening) were the endpoints.

Conclusion. The MBA femoral prosthesis provides a predictably stable fixation, with excellent mid-term outcome.

Key words: arthroplasty, replacement, hip; hip prosthesis; prosthesis design
INTRODUCTION

Cementless total hip arthroplasty (THA) has evolved significantly since 1979.1 Various femoral stem geometries are currently in use. The implant shape determines cortical contact and initial stability. Porous surfaces enable fixation. We report the midterm outcome of a modular, cementless, proximally hydroxyapatite-coated, anatomic femoral stem (MBA; Groupe Lepine) in THA.

MATERIALS AND METHODS

160 consecutive patients aged 42 to 92 (mean, 70) years underwent 185 cementless THAs between April 2000 and December 2004 for primary osteoarthritis (n=159), femoral neck fractures (n=22), avascular necrosis of the femoral head (n=2), non-union of femoral neck fractures (n=1), and secondary osteoarthritis after fracture (n=1). 15 of the patients underwent bilateral THA consecutively, not simultaneously under one anesthetic episode. Of the 96 left and 89 right hips (in 93 men and 92 women), 137 had unilateral and 48 had bilateral diseases, according to the Charnley functional categories. All procedures were performed by a single surgeon using the same modular, cementless, proximally hydroxyapatite-coated, anatomic femoral stem (MBA Groupe Lepine), regardless of age and bone quality. There are 5 modular options of the neck available with this prosthesis: a standard neck with a neck shaft angle of 130°, a varus neck, a valgus neck, an antverted neck, and a retroverted neck, with 15° variance from the standard neck angle in the respective planes. The neck-stem junction is a hexagonal type Morse taper fit.

The proximal portion of the femoral stem is biconical in shape and expands to fill the proximal femur and has a metaphysio-diaphyseal curve of 4°. The distal end is asymmetric and tapered anterolaterally to eliminate cortical stress (Fig. 1). The femoral stem is made of titanium alloy. The proximal portion has a double layer of coating. The under layer is of pure titanium, which is projected using a plasma torch under vacuum at very high temperature. It is 100 µm in thickness and produces micro roughness without altering the alloy surface. The top layer is a hydroxyapatite coating of 50 to 100 µm in thickness, which is projected in powder form by a plasma torch under vacuum (Fig. 2). There are 8 different sizes. The modular neck has a double Morse taper design and is machined from cobalt chrome alloy. The femoral heads used were either a 28-mm diameter high-nitrogen stainless steel metal head or a 32-mm...
diameter alumina head. They were either of a metal-on-polyethylene or alumina-on-alumina articulation. All the acetabular components had a hydroxyapatite coating. The types of acetabular socket implanted were MBA (n=18), Tetras (n=86), Pavi (n=75), Duraloc (n=2), and Hedrocel (n=4).

Under cover of prophylactic antibiotics, surgery was carried out in a lateral decubitus position through a posterior capsular-sparing mini-invasive approach. Both femoral and acetabular components were press fitted without use of cement. The femoral stems implanted were sizes 1 (n=1), 2 (n=24), 3 (n=33), 4 (n=54), 5 (n=52), 6 (n=13), and 7 (n=8). In 2 hips the proximal femur was reinforced with a Dall-Miles cable as a preventive measure against periprosthetic fractures owing to severe osteoporosis. Additional screw fixation was used in 7 hips to secure the acetabular socket. Acetabular deficiency was augmented in one hip using morsellised autografts. Additional procedures to remove osteosynthesis screws were performed in 2 hips. Early weight bearing and early hydrotherapy were allowed unless contraindicated.

Patients were evaluated pre- and post-operatively (at 6 weeks, 3 months, one year, 2 years, 5 years, 10 years). Clinical evaluation (pain, range of movement, and ability to walk) was based on Merle d’Aubigne and Postel scores. Patients were asked specifically whether they had thigh pain or discomfort, the type of pain (start-up hesitancy or delayed onset of thigh discomfort), and the activity causing the pain. Anteroposterior and lateral weight-bearing radiographs were standardised using a magnification marker. The femoral component was analysed according to the 7 zones of Gruen et al. with regard to the presence of radiolucent lines, osteolysis, cancellous condensation, cortical hypertrophy or atrophy, reactive lines, and pedestal formation according to the criteria by Engh et al. Failure of the stem was defined as revision or impending revision because of aseptic loosening or pain. Considering the very small sample size, the Wilcoxon signed rank test was used to compare various categories of scores pre- and post-operatively. The Kaplan-Meier survival curve was used to demonstrate the rate of the prosthesis survival.

RESULTS

Of the 160 patients, 21 died from causes unrelated to the surgery and none were lost to follow-up. In 3 of the 21 patients (22 THAs), the femoral stems were revised for periprosthetic fractures after a fall at 6 weeks, 10 months, and 3.8 years. One patient with a resection arthroplasty was excluded from the analysis because of infection secondary to a groin abscess from coronary stenting 5.3 years postoperatively. 138 patients (162 THAs) completed a mean follow-up of 7.8 (range, 5.5–10.4) years. Their overall mean Merle d’Aubigne and Postel scores increased from 7.09 (SD, 3.02) preoperatively to 16.36 (SD, 0.68) postoperatively. The scores of all the sub-categories also increased (p<0.001, Wilcoxon signed rank test, Table 1).

<table>
<thead>
<tr>
<th>Category (full score)</th>
<th>Mean (SD) score</th>
<th>Change</th>
<th>p Value (Wilcoxon signed rank test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain (6)</td>
<td>2.23 (0.92)</td>
<td>5.47 (0.51)</td>
<td>3.24 (0.56)</td>
</tr>
<tr>
<td>Ability to walk (6)</td>
<td>2.18 (0.90)</td>
<td>5.89 (0.31)</td>
<td>3.71 (0.87)</td>
</tr>
<tr>
<td>Range of motion (6)</td>
<td>2.68 (1.25)</td>
<td>5 (0)</td>
<td>2.32 (0.87)</td>
</tr>
<tr>
<td>Overall (18)</td>
<td>7.09 (3.02)</td>
<td>16.36 (0.68)</td>
<td>9.3 (2.54)</td>
</tr>
</tbody>
</table>

Of the 160 patients, 21 died from causes unrelated to the surgery and none were lost to follow-up. In 3 of the 21 patients (22 THAs), the femoral stems were revised for periprosthetic fractures after a fall at 6 weeks, 10 months, and 3.8 years. One patient with a resection arthroplasty was excluded from the analysis because of infection secondary to a groin abscess from coronary stenting 5.3 years postoperatively. 138 patients (162 THAs) completed a mean follow-up of 7.8 (range, 5.5–10.4) years. Their overall mean Merle d’Aubigne and Postel scores increased from 7.09 (standard deviation [SD], 3.02) preoperatively to 16.36 (SD, 0.68) postoperatively. The scores of all the sub-categories also postoperatively (p<0.001, Wilcoxon Signed rank test, Table 1).

There were no instances of intra-operative proximal femoral fractures or postoperative sciatic nerve paralysis. Two hips sustained periprosthetic proximal femoral fractures following falls at 3.8 and 6.8 years, for which the femoral stems were revised (Table 2). Two hip joints developed deep infections at 3.8 years and 3 weeks secondary to infection of venous leg ulcers and skin colonisation, respectively. Both patients were treated with early open arthrotomy washout, debridement, exchange.

<table>
<thead>
<tr>
<th>Complications</th>
<th>No. of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic loosening femoral stem</td>
<td>1</td>
</tr>
<tr>
<td>Aseptic loosening acetabular socket</td>
<td>1</td>
</tr>
<tr>
<td>Periprosthetic femoral fracture</td>
<td>5</td>
</tr>
<tr>
<td>Deep infection</td>
<td>2</td>
</tr>
<tr>
<td>Dislocation</td>
<td>3</td>
</tr>
</tbody>
</table>
of modular components (acetabular liner, femoral neck, and femoral head), and long-term antibiotic therapy. In both patients, the femoral stems and acetabular sockets were retained. One patient had recurrent anterior dislocation, for which the version of the modular neck and head were changed at 6 weeks, whereas 2 patients had posterior dislocations, one after a fall at 8.4 years and underwent closed reduction and the other had a traumatic dislocation and underwent reduction. The latter went on to have recurrent instability, for which the femoral head and neck were changed at 3.3 years. All 3 patients went on to have a stable hip. All patients except one had stable and well-integrated femoral stems. Similarly, all patients except one had stable acetabular socket. Both patients had thigh pain and groin pain, respectively, and revision surgery (change of implant) with bone grafting was performed and aseptic loosening was confirmed. Both patients were symptom free after their revision surgery.

No reactive lines at the bone-stem interfaces and no subsidence or osteolysis were evident in any of the radiographs (Fig. 2). Bone remodelling in the form of cortical atrophy in zones 1 and 7 owing to stress shielding, and slight cortical thickening in zones 2 and 6 were noted, especially in patients with larger stem sizes. The mean Engh score for fixation and stability was 24.9 out of 27. The mean score for femoral stem fixation was 10 out of 10 and 14.9 out of 17 for femoral stem stability.

Survivorship of the femoral stem at 10 years was 99% (95% confidence interval, 97%–100%) when revision secondary to aseptic loosening of the femoral stem was the endpoint (Fig. 3). It was 96% (95% confidence interval, 92%–98%) when failures due to all causes (infection, periprosthetic fracture, and aseptic loosening) were the endpoints.

**DISCUSSION**

In our study, the survival rate was equal to or better than that in other series of hydroxyapatite-coated femoral components.\(^6\)–\(^10\) Cementless THA is increasingly popular. The high rate of osteolysis, aseptic loosening, and revision associated with earlier uncemented femoral components has been greatly reduced with better-designed implants incorporating circumferential porous coating to impede particle migration and osteolysis. Moreover, proximal femoral fixation prevented stress shielding, and a tapered distal tip reduced thigh pain.

In our series, 5 (3%) of the patients had periprosthetic femoral fractures after a fall. The mean age of these 5 patients at the time of fracture was 80 (range, 73–83) years. During revision surgery, the femoral stems were noted to be well fixed and difficult to extract in all of them except the one who underwent revision 6 weeks after THA. Rates of periprosthetic fractures have been reported to range...
from 0.1 to 2.1% for postoperative fractures and from 0.3 to 5.4% for intra-operative fractures. Such rates have increased owing to ageing of the patient population. None of our patients complained of anterior thigh pain when asked specifically. This is comparable to other series involving hydroxyapatite-coated femoral stems.

The modularity of the neck of this femoral component is helpful in both primary and revision settings. In primary procedures after implantation of the stem, correction can still be made in leg length and offset. In revision procedures, modularity of the neck facilitates adjustments in leg length, offset and neck version without needing to extract a well-fixed femoral component, and also aids access to the acetabular component by way of removal of the modular neck and head. In our study, in both types of dislocation, changing the modular neck and head avoided more extensive revision requiring removal of a well-fixed femoral stem.

Contrary to the increased rate of revision in modular hip systems based on the Australian Orthopaedic Association National Joint Replacement Registry, the modular, cementless, proximally hydroxyapatite-coated, anatomic femoral stem provided predictably stable fixation, with excellent mid-term outcome.

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REFERENCES