The medium-term results of a cemented Freeman femoral neck-retaining prosthesis

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We have reviewed 202 consecutive primary hip replacements using a Freeman cemented femoral component after a mean period of follow-up of 64 months (23 to 113). There was only one revision for aseptic loosening. Retention of the femoral neck may act to reduce the torsional and shear forces at the implant-cement interface and may provide a seal against the migration of polyethylene-laden joint fluid in the potential joint space. The cemented Freeman femoral component with retention of the femoral neck was successful for up to nine years.

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Torsional stability of the femoral component in total hip replacement is the most important factor in fixation of an implant.\textsuperscript{1-4} Theoretically, a neck-retaining prosthesis has biomechanical advantages over other hip implants. Two components of the resultant forces acting on the femoral prosthesis are significant in normal activities of daily living and mobility. The vertically directed vector results in either micromovement or migration of the femoral component, particularly into varus. The vector directed horizontally backwards, when a patient stands from a sitting position or climbs stairs, results in a torsional force turning the femoral head and neck in a posterior direction relative to the shaft of the femur. Retention of the femoral neck increases the area of proximal bone available to resist downward migration by a factor of three and reduces the varus turning moment by a factor of four.\textsuperscript{5-7} It also reduces the torsional moment by increasing the amount of bone available to resist this force.\textsuperscript{6} It has been hypothesised that retention of the femoral neck may prolong survival of the prosthesis.\textsuperscript{1,4}

In this study we report the two- to nine-year clinical and radiological results and survival of cemented Freeman neck-retaining prostheses.

Patients and Methods

Between January 1987 and June 1994, 202 primary hybrid total hip arthroplasties using cemented Freeman femoral prostheses (Corin Medical, Cirencester, UK) were carried out on 186 patients (75 men and 111 women). The mean age at operation was 66.6 years (30 to 91) for the men and 70.6 (28 to 92) for the women. The indication for surgery was osteoarthritis in 92%, inflammatory arthritis in 6%, trauma in 1%, and others in 1%. All patients were operated on or had their operations supervised by the senior author (DAFM). A Hardinge approach was used in all.\textsuperscript{8} The Freeman femoral prosthesis is shown in Figure 1. Most

Fig. 1
The cemented Freeman femoral prosthesis.
prostheses (174; 86%) had a fixed head of 32 mm diameter. The remainder (28) were 28 mm modular implants. The acetabular components were either uncemented Freeman (76) or SLF cups (both from Corin Medical) which are shown in Figure 2. The femoral prostheses were implanted using a second-generation cementing technique and low-viscosity polymethylmethacrylate cement containing gentamicin.

Prospective analysis was carried out on all patients with a minimum follow-up of 23 months. Of the 37 patients who had died, this had occurred perioperatively in four, in three because of cardiovascular causes and in one due to a perforated viscus. Four patients (four hips) were lost to follow-up (2%). The remaining 142 patients (158 hips) were subjected to a clinical assessment and radiological review from anteroposterior (AP) views of the pelvis and proximal femur. The radiographs were assessed for the presence of radiolucent lines according to Gruen’s zones, the presence of osteolysis, particularly of the femoral neck, and distal migration, as measured by a single observer. Due to significant interobserver and intraobserver error in the interpretation and reporting of radiolucent lines, only those of 2 mm or greater and occupying at least one-third of a Gruen zone were reported.

For distal migration, we used Orthographics Digitising and Researchmetrics software (Orthographics Inc, Salt Lake City, Utah) with collation of data in a database. Measurements of migration were made on a minimum of three sequential radiographs, the first within six months of surgery and the last obtained at the most recent follow-up. Measurement by this technique is accurate to 0.5 mm.

Survival rates were calculated using life tables and the Kaplan-Meier method. Failure in this study was defined as a hip which had been revised for aseptic loosening of the femoral component.

Results

Only one stem was revised for aseptic loosening (Fig. 3). The mean follow-up was for 64 months (23 to 113). All the patients who died had their original stem in situ at the time of death. There was one superficial infection, five deep infections, four dislocations (three early and one late), five clinically proven deep-vein thromboses and two pulmonary emboli, one of which was fatal. In addition, there was one case of palsy of the common peroneal nerve and one of the lateral cutaneous nerve of the thigh thought to be related to positioning on the operating table. The life-table analysis is shown in Table I. The cemented Freeman stem had a cumulative survival for five years of 100% and for seven
years of 95.65%. There was one radiolucent line in one patient in zone 7. One other patient had endosteal cavitation in zone 4. The one failed stem had radiolucent lines in all seven zones (Fig. 3). In the study group, 16% showed evidence of resorption of the neck, but in all cases this was less than 25% of its original length. The remaining 84% of patients all had complete retention of the entire femoral calcar at the time of review. Of the 202 cemented femoral stems in our study, 111 were available for migration analysis. The mean annual migration was 0.17 mm (so 0.07). It can be inferred that these stems were not subsiding.

Discussion

The cemented Freeman femoral prosthesis has several advantages which may explain the excellent medium-term results in our series. As well as the biomechanical advantages outlined above, it can pressurise the cement within the femur at the time of initial insertion. Leakage of cement is minimal with the Freeman prosthesis since it is contained within the femur by the proximal part of the implant, filling the slot cut in the femoral neck. As a result, the cement is pressurised into the bone throughout its length and not just distal to the lesser trochanter.

An additional advantage of retention of the femoral neck results from the interface between the prosthesis and cement and bone at the neck. Wear debris produced by the implants circulates in synovial fluid potentially giving rise to osteolysis. In our patients an incidence of 16% of osteolysis of the femoral neck occurred, but in none was this greater than 25% of the original length of the neck. All of the calcar and part of the femoral head are preserved during primary joint replacement with this prosthesis. In the event of revision after use of an implant which does not retain the femoral neck the calcar is often eroded, providing little structural support. Although preservation of the neck may not prevent the occurrence of osteolysis it limits it to its proximal part with preservation of the structurally important calcar. Further evidence for this concept of the protective effect of the calcar against the osteolytic effects of wear debris is that there was only one case of radiological osteolysis visible in Gruen zone 4. It should also be noted that this configuration of stem was used with two different types of acetabular implant which had high rates of failure. Despite this the stem performed well.

A theoretical disadvantage of retention of the femoral neck is the risk of impingement between the retained bone and the acetabular cup and/or acetabular rim/osteophytes. In our series, acetabular components which subtend an arc of 140° were used to reduce this risk. Our dislocation rate of 2% is no more than that of other published series using prostheses in which the neck was not retained.11

In 1990, a multicentre study found the survival rate of cemented Stanmore and Charnley prostheses to be 89% and 92%, respectively, after ten years.12 Standard implants currently have a failure rate of about 1% per year.13 Although not quite at ten years, our survival rate is as good or slightly better than rates previously reported for other cemented devices.14

There appears to be little to choose between the results in a variety of other femoral prostheses using modern cementing techniques. Calculations using the finite-element method15 and cadaver experiments16 suggest that, if secure fixation of cement is obtained over the length of the stem, retention of the femoral neck would make little difference to the expected outcome. It is probable that a neck-retaining stem does reduce the torsional forces4 and may, in the long term, reduce the incidence of aseptic loosening if compared with Charnley prostheses.

The rate of migration of the stem in our patients compared favourably with that of a similar-sized group of cemented Freeman stems with a reported survivorship of 96.8% at ten years.17 This is encouraging for long-term survivorship, as it has been suggested that vertical migration of more than 1.2 mm/year over the first two years is a useful predictor of late aseptic loosening.18

There does not appear to be any drawback to retention of the neck and partial retention of the head in primary cemented hip replacement. The two- to nine-year results using the Freeman cemented stem in our patients lead us to ask the question again; “Why resect the neck at primary total hip replacement?”1

We would like to thank Ms M. Jones MSc for her help with statistical analysis.

Table I. Survivorship table of 202 cemented Freeman femoral stems using revision as the definition of failure

<table>
<thead>
<tr>
<th>Year after surgery</th>
<th>Number at start</th>
<th>Number at risk</th>
<th>Cumulative success rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
<td>202</td>
<td>194</td>
<td>100.00</td>
</tr>
<tr>
<td>1 to 2</td>
<td>186</td>
<td>179</td>
<td>100.00</td>
</tr>
<tr>
<td>2 to 3</td>
<td>172</td>
<td>154</td>
<td>100.00</td>
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<tr>
<td>3 to 4</td>
<td>135</td>
<td>116</td>
<td>100.00</td>
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<tr>
<td>4 to 5</td>
<td>96</td>
<td>81</td>
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<tr>
<td>5 to 6</td>
<td>66</td>
<td>57</td>
<td>100.00</td>
</tr>
<tr>
<td>6 to 7</td>
<td>47</td>
<td>40</td>
<td>100.00</td>
</tr>
<tr>
<td>7 to 8</td>
<td>32</td>
<td>23</td>
<td>95.65 ± 0.45</td>
</tr>
<tr>
<td>8 to 9</td>
<td>13</td>
<td>10</td>
<td>95.65 ± 0.45</td>
</tr>
<tr>
<td>9 to 10</td>
<td>6</td>
<td>3</td>
<td>95.65 ± 0.45</td>
</tr>
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References