Modular prosthetic replacement of the proximal femur after resection of a bone tumour

A LONG-TERM FOLLOW-UP

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We describe 25 patients who were treated for a tumour of the proximal femur by resection and replacement with an uncemented, bipolar, modular prosthesis. When followed up after more than ten years four prostheses (16%) had required revision. Two joints showed wear and another necrosis of the acetabulum. One patient with loosening of the stem had been treated by radiotherapy to the femur. Articular cartilage seemed to be a reliable barrier to acetabular wear. Very few signs of the formation of particulate debris were observed. The most obvious feature in the bone-stem relationship was stress shielding, seen as osteoporosis of the proximal part of the femur around the stem in 68%. Functional activity was satisfactory in 68% of the patients. A better system of reattachment of the soft tissues is needed to avoid pain and a persistent limp.

Received 12 February 2001; Accepted after revision 24 April 2001

Limb-salvage surgery developed in the late 1970s after the introduction of chemotherapy and improved imaging techniques. Custom-made implants were used before the development of modular prostheses for replacement of the proximal femur. Their use has been extended to include the whole femur, the distal femur and proximal tibia. Many of the patients were in their second or third decade and an uncemented stem was chosen as it was thought that the use of cement may lead to failure and bone loss, with little opportunity for revision. Patients with tumours in the proximal femur were older than those with lesions in the distal femur.

A cemented prosthesis was used for patients with metastases and a short life expectancy. Very few failures have been reported. Soft-tissue reattachment and early dislocation were the main problems. The problem of reattachment has been addressed by the use of new devices or, when indicated, by an allograft prosthetic composite. The use of a bipolar prosthesis has lessened the risk of dislocation. Good results in the medium term have been reported with as regards wear. It is difficult, however, to correlate the acetabular behaviour with the changes in the femoral shaft. After three to four years, in most joints, the main feature is stress shielding, seen as the development of osteoporosis or resorption of the cortical bone. We have reviewed the long-term results of replacement of the proximal femur with an uncemented modular prosthesis.

Patients and Methods

Between August 1983 and December 1991, 34 patients with a tumour in the proximal femur were treated by resection and reconstruction using the KMFTR (Howmedica, Kiel, Germany) uncemented modular prosthesis and bipolar cup. Reattachment of gluteus medius was performed using a polyethylene plate fixed by two screws in the prothetic trochanter and clamping of the tendon of gluteus medius. Patients treated by extra-articular resection and other types of reconstruction, including acetabular replacement and cemented stems, were excluded. In all, 25 patients have been followed up for more than ten years; seven have died and two have been lost to follow-up. The mean follow-up was for 12.25 years (10 to 16.5). There were 19 men and six women with a median age of 34 years (11 to 71). The diagnosis was chondrosarcoma in ten, Ewing’s sarcoma in five, osteosarcoma in four, recurrent giant-cell tumour in two and haemangioendothelioma, osteoblastoma, fibrosarcoma and malignant fibrous histiocytoma in one each. In 11 patients chemotherapy was administered after surgery and in one other a course of radiotherapy (55 Gy) was given to the femur. The mean length of resection was 18.5 cm (12 to 25). In two patients skeletal maturity had not been reached at the time of surgery. All the patients were reviewed clinically and radiographically. In 13, special views were taken including three anteroposterior (AP) views of the pelvis, one supine and the...
others standing in the anatomical position and in maximum abduction, with a high-definition film of the stem. These radiographs were compared with the postoperative films paying particular attention to the stem and sites of insertion of screws, the acetabulum, the relationship between the stem and the femur, for evidence of stress shielding, stem halo, bone sclerosis at the tip of the prosthesis, and the formation of a pedicle. Depending on the diagnosis, the patients were closely followed for the first five years and then seen yearly. The functional evaluation was based on the method of the Musculoskeletal Tumor Society.

Results

There were four complications which required reoperation. One was a deep infection which healed after debridement and local irrigation. A postoperative dislocation was treated by immobilisation in a cast after reduction. One stiff knee
was managed by manipulation and intradural analgesia, and a local recurrence of a parosteal osteosarcoma required further excision on two occasions; at the second operation, 40 months after the primary surgery the bipolar cup was replaced because of wear. Other complications which did not require operation were five broken screws associated with loosening of the stem, one fracture adjacent to the implant, loosening of the stem in a patient who had had radiotherapy to the femoral shaft, one case of aseptic necrosis of the acetabular roof and two of acetabular wear. In two patients, one with acetabular wear and the other with necrosis of the acetabulum, acetabular replacement has been planned because of persistent pain.

**Radiological outcome.** Acetabular wear was found superolaterally in two joints, in one case of more than 2 cm. In seven patients the outer surface of the cup was in direct contact with subchondral bone without erosion. In the remaining 16 (64%) articular cartilage was present (Fig. 1). Enhanced density of subchondral bone was seen whether articular cartilage was present or not. Marginal osteophytes were found in both groups and there were no cases of protrusio acetabuli, or bone cysts (Table I). In relation to the stem, the most important radiological feature was stress shielding, which was noted in 17 patients (68%) as osteoporosis or resorption. Osteoporosis was defined as a decrease of cortical bone density with preservation of the diameter of the femur, while resorption was present when the diameter was decreased with or without osteoporosis. A

### Table I. Radiological analysis of the acetabular area according to whether the cartilage space was present or absent

<table>
<thead>
<tr>
<th></th>
<th>Present (n = 16)</th>
<th>Absent (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcification of cartilage</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Subchondral bone density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Marked</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Acetabular wear</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Osteophytes</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table II. Radiological features in the shaft of the bone (the patient with loosening of the stem was excluded)

<table>
<thead>
<tr>
<th></th>
<th>Present (n = 17)</th>
<th>Absent (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoporosis</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Resorption</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Bone-tip sclerosis</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Resorption at the collar</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Halo</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Breakage of a screw</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Formation of a pedicle</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>
good initial press-fit was more often associated with stress shielding (15 joints). It never impaired the stability of the implant. As expected, sclerosis at the tip of the prosthesis and resorption around the neck were more marked in association with stress shielding (Fig. 2). A halo in relation to broken screws was noted when there was no stress shielding. The formation of a pedicle did not correlate with the mechanical behaviour of the implant (Table II). Loosening of the stem was observed in the only patient treated by radiotherapy of the femur.

**Functional outcome.** The functional results were judged to be satisfactory in 17 patients (68%: 7 excellent and 10 good), fair in seven and poor in one. Pain was reported by 15 patients (60%). In 12 it was mild and required no medication. In three regular medication was necessary. A leg-length discrepancy was present in 19 patients. In 16 the difference was not more than 2 cm, in one the treated leg was 4 cm longer than the contralateral limb, and in two it was 3 cm shorter. A mild Trendelenburg limp was present in 14 patients. In four it was marked and in five severe. There were only two patients who walked normally. Eight used one walking stick and one, the oldest in the series, required two.

**Discussion**

The concept of bipolar reconstruction has not yet been uniformly accepted.\(^\text{14-18}\) It is used to reduce the rate of postoperative dislocation and to maintain bone of good quality until the hip becomes painful enough to require resurfacing.\(^\text{19,20}\) Only 16% of our patients required further operations. The progression of the bone changes around the implant was not perceptible after the first five years. At present, two patients have persistent referred pain, which is well tolerated with the help of non-steroidal anti-inflammatory drugs and revision has been refused. In young and active patients the preservation of the acetabulum was surprising. The cartilage space was still present in most cases (64%), but both the articular cartilage and good subchondral bone prevent wear.\(^\text{21-25}\)

We are satisfied with the design of the prosthetic stem; the one failure was in bone treated by radiotherapy. Stress shielding represented only a minor problem as after a mean follow-up of 12.25 years no failure can be related to this. The other signs reported are related to the type of fixation of the stem. With primary fixed stems, stress shielding appears in a few years but does not seem to progress, whereas, when the primary fixation is not perfect, more stress is distributed directly to the surrounding cortex.

We expected more bone-collar resorption to be caused by particulate debris.\(^\text{26-29}\) The presence of a collar with good contact on cortical bone, and an uncemented stem, may reduce the formation of a fibrous layer around the prosthesis.\(^\text{15,30,31}\) The movement of the hip was less than with bipolar replacement for fractures because of the excision of muscle and ineffective tendon reattachment.\(^\text{14,32}\)

The patient does not maintain an active lifestyle, limping and pain may persist. A better system of reattachment is expected to solve this problem.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**


