Unipolar proximal femoral endoprosthesis replacement for tumour

THE RISK OF REVISION IN YOUNG PATIENTS

C. R. Chandrasekar,
R. J. Grimer,
S. R. Carter,
R. M. Tillman,
A. Abudu,
L. M. Jeys

*From the Royal
Orthopaedic
Hospital,
Birmingham,
England*

We undertook a cemental unipolar proximal femoral endoprosthesis replacement in 131 patients with a mean age of 50 years (2 to 84). Primary malignant tumours were present in 54 patients and 67 had metastatic disease. In addition, eight patients had either lymphoma or myeloma and two had non-oncological disorders. The mean follow-up was 27 months (0 to 180). An acetabular revision was required later in 14 patients, 12 of whom had been under the age of 21 years at the time of insertion of their original prosthesis. The risk of acetabular revision in patients over 21 years of age was 8% at five years compared with 36% in those aged under 21 years. All the unipolar hips in this younger age group required revision within 11 years of the initial operation.

We conclude that unipolar replacement should not be used in younger patients and should be avoided in patients with a life expectancy of more than five years.

The proximal femur is a common site for primary bone tumours and the most common long bone to be affected by secondary malignant deposits.^{1,2} The use of endoprostheses for the treatment of malignant tumours of the proximal femur is well recognised and their use in metastatic disease is also becoming more common. Proximal femoral endoprosthesis replacement can be performed with or without acetabular resurfacing. Although the latter procedure is undertaken in total hip replacement (THR) performed for osteoarthritis, the acetabulum is intact in most patients who require a proximal femoral replacement. The main benefit of a unipolar replacement is the lower risk of dislocation of the prosthesis which is a major problem after proximal femoral replacement, but there remains the risk of subsequent damage to the articular cartilage leading to pain and the possibility of subluxation of the hip, especially in younger patients.³⁻¹²

Because of the high incidence of dislocation in adult patients with a proximal femoral endoprosthesis and an acetabular replacement, and the desire not to use these in younger patients, in 1990 we began to employ unipolar prostheses in most patients who needed proximal femoral replacement. We have now assessed the outcome of these cases with particular reference to the consequence of using a unipolar head.

We have recently reported a high rate of failure after prosthetic replacement of the hip for tumours in children³ and we wished further to review the outcome for those patients who underwent unipolar proximal femoral endoprosthesis replacement.

Patients and Methods

Between 1990 and 2006, 131 patients underwent unipolar endoprosthesis replacement of the proximal femur. There were 65 males and 66 females with a mean age of 50 years (2 to 84); 24 were aged 21 years or less at the time of the operation. The diagnoses are shown in Table I. A total of 56 patients had a pathological fracture before surgery. Fractures had occurred in 13 (24.1%) of the patients with primary malignant bone tumours and in 37 (55.2%) of those with metastases. Of these patients, 19 presented with failed fixation after a previous fracture secondary to metastases.

All the patients had appropriate staging studies including MRI of the pelvis and the proximal femur. The operations were all carried out at a single institution by the oncological surgical team. Adjuvant chemotherapy was administered when appropriate, according to nationally agreed protocols, at the patient's local oncology unit. Details of all the patients were entered prospectively into a database.

All the custom-made and modular prostheses were designed and manufactured at the Department of Biomedical Engineering of the

■ C. R. Chandrasekar, FRCS,
Orthopaedic Surgeon
■ R. J. Grimer, FRCS,
Consultant Orthopaedic
Oncologist
■ S. R. Carter, FRCS,
Consultant Orthopaedic
Oncologist
■ R. M. Tillman, FRCS,
Consultant Orthopaedic
Oncologist
■ A. Abudu, FRCS, Consultant
Orthopaedic Oncologist
■ L. M. Jeys, FRCS, Consultant
Orthopaedic Oncologist
Royal Orthopaedic Hospital,
Bristol Road South,
Birmingham B31 2AP, UK.

Correspondence should be sent
to Mr R. J. Grimer; e-mail:
rob.grimer@roh.nhs.uk

©2009 British Editorial Society
of Bone and Joint Surgery
doi:10.1302/0301-620X.91B3.
21666 \$2.00

J Bone Joint Surg [Br]

2009;91-B:401-4.

Received 13 August 2008;

Accepted after revision 5
November 2008

Table I. Diagnoses in the 131 patients

Diagnosis	Number of patients
Primary tumours (54)	
Ewing's sarcoma	20
Chondrosarcoma	15
Osteosarcoma	9
Spindle-cell sarcoma	8
Giant-cell	2
Secondary malignant tumours (67)	
Breast	20
Kidney	16
Bronchus	9
Prostate	4
Thyroid	2
Others	16
Haematological malignancy (8)	
Lymphoma	6
Myeloma	2
Non-oncological	2

Institute of Orthopaedics of University College, London, United Kingdom, now known as Stanmore Implants Worldwide. The custom-made implants were manufactured based on appropriate radiographs. The modular system provided a choice of a different size of femoral head, trochanteric re-attachment, and size and length of the femoral stem. There was also an option to use a polished or hydroxyapatite-coated collar at the prosthesis-bone junction in the expectation that there might be osseointegration with the prosthesis. The latter has been shown to dramatically decrease the problem of late aseptic loosening in distal femoral and proximal tibial replacements.^{13,14}

Custom-made implants were used in 40 patients (30.5%) and modular prostheses in 91 (69.5%). The mean length of femoral resection was 9.2 cm (4.5 to 21). The mean size of the femoral head used was 46 mm (28 to 56) with the mean size in adults aged over 21 years being 48 mm and in children 40 mm.

All the operations were performed in a clean-air theatre. Antibiotic prophylaxis was given at the time of surgery and for up to 24 hours after. Resection of the tumour was carried out following oncological principles aiming to achieve a wide margin of resection in primary bone tumours. In patients with secondary deposits with pathological fractures and possible involvement of the hip, a palliative reconstruction was carried out avoiding extra-articular resection. The operation was performed in the lateral position using a longitudinal incision which included excision of the biopsy tract. The appropriate segment of the proximal femur was resected. In patients requiring proximal femoral replacement, but whose disease had spared the greater trochanter, the latter was osteotomised and re-attached to the endoprosthesis using

the trochanteric re-attachment plate and screws or cable-grip wires. If it was not possible to preserve the greater trochanter the abductor mechanism was sutured to vastus lateralis and the fascia lata. Trial components were used to select the appropriate size needed to restore limb length and stability. A unipolar head was matched to the size of the resected femoral head. The heads were available in sizes from 32 mm to 56 mm in increments of 2 mm. A cemented acetabular component was used in patients with either degenerative changes in the hip or when there was possible involvement of the acetabulum with tumour. These were not included in this study. The unipolar femoral components were cemented, using antibiotic-containing bone cement, introduced with a gun.

After the operation the patients were mobilised partially weight-bearing and progressed to full weight-bearing by the time of discharge. After six weeks they were re-admitted to hospital for a period of intensive physiotherapy. They were followed up every three months for two years, then at six months until five years after the operation and yearly thereafter. We recorded the survival of the patient and the prosthesis, the risk of revision of the prosthesis because of acetabular symptoms, the incidence of the failure of limb salvage because of amputation and complications such as dislocation and infection. We used Kaplan-Meier survival curves to assess the rates of failure of the prostheses.

Results

The mean follow-up was 27 months (0 to 180). The mean follow-up for patients with metastases was 17 months (0 to 72) and for those with a primary bone tumour 37 months (1 to 180).

There were two peri-operative deaths, both due to pulmonary embolism in elderly patients who had been on prolonged bed rest before the operation. A further three elderly patients had a pulmonary embolus after the operation and all survived after appropriate supportive treatment. Of the 131 patients, 78 (59.5%) survived for more than 12 months. The median survival time was 24 months and the overall patient survival was 50% at five years. At the time of review 83 of 107 patients in the older and seven of 24 in the younger age group had died.

There were three cases of early post-operative dislocation of the hip, all in patients over the age of 80 years, which required open reduction and had a soft-tissue repair which corrected the problem.

Revision of the prosthesis for acetabular problems was needed in 14 patients (10.7%). Of the 24 patients aged under 21 years, 12 (50%) required revision, seven for subluxation in patients aged between 2 and 15 years at the time of implantation, and five for pain in patients aged between 11 and 21 years at the initial procedure. Ten of these patients had Ewing's sarcoma and two osteosarcoma. The median time to failure in this group was 4.8 years (mean 63 months, 18 to 126). The rate of failure in these patients under the age of 21 years was such that none retained their unipolar

Fig. 1a

Fig. 1b

Radiographs showing a) a unipolar femoral head with evidence of superolateral subluxation in a 14-year-old patient, five years after insertion and b) 12 months after revision to a metal-on-metal hip replacement which relieved the symptoms.

reconstruction for more than 10.5 years. One patient, aged 15 years at the time of the initial procedure, is now aged 24 years and is starting to experience pain in the hip which will need acetabular revision in the near future. In the younger children the consistent finding was superolateral subluxation of the hip which was usually painless (Fig. 1), but progressive, while in the older children there was superolateral erosion of the articular cartilage leading to pain.

In the 107 patients over the age of 21 years only two required revision for an acetabular problem. One 59-year-old woman had pain in the acetabulum after 14 months while another 54-year-old woman with type-I neurofibromatosis developed a central erosion of the acetabulum 3.6 years after a proximal femoral replacement.

The survival of the implant with revision for acetabular complications as the endpoint was assessed using Kaplan-Meier analysis comparing the younger patients up to 21 years

Fig. 2

Kaplan-Meier survival curve showing the survivorship of the unipolar head without revision in patients over and under 21 years of age.

of age with those who were older (Fig. 2). The estimated survival at five years was 64% and 92%, respectively. No unipolar replacement lasted for more than 10.5 years without being revised, although none of the older patients has survived for more than ten years after the surgery.

After removal of the unipolar component the type of reconstruction varied with the age of the patient, but in general an attempt was made to use a THR with as large a head size as possible to reduce the risk of dislocation. Of the 12 patients in the younger group who underwent revision, all but two had revision with a large modular head and the acetabular component from a metal-on-metal resurfacing arthroplasty. None of these patients have had pain or dislocation since the revision at a mean follow-up of 25.7 months (8 to 120). Two patients received an uncemented THR with a 32 mm head. One was successful, but the other continued to dislocate and has undergone further revision with the insertion of a mesh around the prosthesis. Both adult patients were successfully revised to cemented THRs with a 32 mm head.

Discussion

We began to use unipolar heads for patients with a proximal femoral endoprosthesis in 1990 because of the unacceptably high rate of dislocation (11%) which we had encountered when using cemented hip replacements.¹⁵ The rate of dislocation was high because there was usually a considerable loss of muscle around the hip, and both psoas and the abductors were detached from the proximal femur.^{11,12,15}

We used cemented unipolar replacements in patients with an otherwise normal acetabulum, expecting that in elderly patients this would cause little problem and that in younger patients it would preserve the acetabulum for as long as possible. The problem of dislocation has virtually been abolished by the use of the unipolar replacement. In the elderly group the unipolar replacement has been very

successful at intermediate follow-up. Many of these patients will have a limited life expectancy and a unipolar reconstruction offers a simple, stable and inexpensive option.

There have been studies which have compared the outcome of unipolar, bipolar and THR in patients with intracapsular fractures of the neck of the femur.⁸⁻¹⁰ They have a low life expectancy which may explain the low incidence of complications which included infection, dislocation, acetabular erosion, protrusion acetabulum, periprosthetic fractures and revision.^{3,7,12,15}

Our study included patients of all age groups with both primary and secondary bone tumours involving the proximal femur without acetabular involvement. The patients with metastatic tumours of the proximal femur with unipolar heads had a shorter life expectancy and the implant survived without the need for acetabular revision in all but two. This group of patients is more comparable with the elderly patients with a fractured neck of femur with low life expectancy and the revision rates for acetabular symptoms are similar. Therefore, it is reasonable to use unipolar heads if the life expectancy is less than five years. It is still too early to identify whether older patients with a good prognosis will develop problems in the future from a unipolar reconstruction.

An alternative may be to use a bipolar component, but Nakata et al⁹ observed that 77% of bipolar components migrated superiorly with 18% requiring revision within 7.4 years. Pellegrini et al¹⁶ found that 81% of the primary bipolar arthroplasties for osteoarthritis of the hip survived without acetabular revision after a mean follow-up of 12.2 years. We are unable to comment on the advantages of bi- over unipolar heads in patients with tumours of the proximal femur since we do not have long-term experience of their use.

The dilemma of THR in young children with bone tumours has been discussed by van Kampen et al³ and our study confirms that the high rate of revision for acetabular symptoms continues for patients up to the age of 21 years at the time of insertion. We are not able to make a definite recommendation about the best type of hip reconstruction for younger patients. The bipolar hip may be better,¹⁷ or possibly a hip replacement with a large size of head. Although we have used the modular components from metal-on-metal hip resurfacings for most of the revisions in younger patients, we are mindful of the ongoing controversy in relation to the release of metal ions from these implants, which may be of considerable relevance in this young population.¹⁸⁻²⁰ Young patients and their parents should be informed about the potential risk of carcinogenicity from metal ions and the six- to ten-fold increase in the occurrence of a second malignancy²¹⁻²³ in survivors of childhood cancer because of treatment by chemotherapy and sometimes radiotherapy. Until there is proven evidence of a significant adverse effect secondary to metallosis, metal-on-metal THR remains a possible option in young patients.

Unipolar proximal femoral endoprosthetic replacement is useful for primary and secondary bone tumours when the life expectancy is less than five years since there is unlikely to be need for early revision for acetabular erosion. There is,

however, a high rate of failure in young patients and we recommend that an alternative hip reconstruction should be considered. Uni- or bipolar heads may still have a role in children aged less than 11 years in order to preserve acetabular growth and development.

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

1. **Damron RA, Sim FH.** Surgical treatment for metastatic disease of the pelvis and the proximal end of the femur. *Instr Course Lect* 2000;49:461-70.
2. **No authors listed.** British Orthopaedic Association and the British Orthopaedic Oncology Service. Metastatic bone disease: a guide to good practice. 2001.
3. **van Kampen M, Grimer RJ, Carter SR, Tillman RM, Abudu AT.** Replacement of the hip in children with a tumor in the proximal part of the femur. *J Bone Joint Surg [Am]* 2008;90-A:785-95.
4. **Tillman RM.** The role of the orthopaedic surgeon in metastatic disease of the appendicular skeleton: working party on metastatic bone disease in breast cancer in the UK. *J Bone Joint Surg [Br]* 1999;81-B:1-2.
5. **Unwin PS, Cannon SR, Grimer RJ, et al.** Aseptic loosening in cemented custom made prosthetic replacements for the bone tumours of the lower limb. *J Bone Joint Surg [Br]* 1996;78-B:5-13.
6. **Jeys LM, Grimer RJ, Carter SR, Tillman RM.** Risk of amputation following limb salvage surgery with endoprosthetic replacement in a consecutive series of 1261 patients. *Int Orthop* 2003;27:160-3.
7. **Manoso MW, Boland PJ, Healey JH, Tyler W, Morris CD.** Acetabular development after bipolar hemiarthroplasty for osteosarcoma in children. *J Bone Joint Surg [Br]* 2005;87-B:1658-2.
8. **Coleman SH, Bansal M, Cornell CN, Sculco TP.** Failure of bipolar hemiarthroplasty: a retrospective review of 31 consecutive bipolar prostheses converted to total hip arthroplasty. *Am J Orthop* 2001;30:313-19.
9. **Nakata K, Ohzono K, Masuhara K, et al.** Acetabular osteolysis and migration in bipolar arthroplasty of the hip: five to 13 year follow-up study. *J Bone Joint Surg [Br]* 1997;79-B:258-64.
10. **Kiekens G, Somville J, Taminiau A.** Clinical relevance of acetabular erosion in young patients with a bipolar hip prosthesis. *Acta Orthop Belg* 2000;66:455-60.
11. **Gosheger G, Gerbert C, Aherns H, et al.** Endoprosthetic replacement in 250 patients with sarcoma. *Clin Orthop* 2006;450:164-71.
12. **Menendez LR, Ahlmann ER, Kermani C, Gotha H.** Endoprosthetic reconstruction for neoplasms of the proximal femur. *Clin Orthop* 2006;450:46-51.
13. **Myers GJ, Abudu AT, Carter SR, Tillman RM, Grimer RJ.** Endoprosthetic replacement of the distal femur for bone tumours: long term results. *J Bone Joint Surg [Br]* 2007;89-B:521-6.
14. **Myers GJ, Grimer RJ, Abudu A, Carter SR, Tillman RM.** Endoprosthetic replacement of the proximal tibia for bone tumours: the long term results. *J Bone Joint Surg [Br]* 2007;89-B:1632-7.
15. **Kabukcuoglu Y, Grimer RJ, Tillman RM, Carter SR.** Endoprosthetic replacement for primary malignant tumours of the proximal femur. *Clin Orthop* 1999;358:8-14.
16. **Pellegrini VD Jr, Heiges BA, Bixler B, Lehman EB, Davis CM 3rd.** Minimum ten-year results of primary bipolar hip arthroplasty for degenerative arthritis of the hip. *J Bone Joint Surg [Am]* 2006;88-A:1817-25.
17. **Yun AG, Martin S, Zurakowski D, Scott R.** Bipolar hemiarthroplasty in juvenile rheumatoid arthritis: long-term survivorship and outcomes. *J Arthroplasty* 2002;17:978-86.
18. **Dunstan E, Sanghrajka AP, Tilley S, et al.** Metal ion levels after metal-on-metal proximal femoral replacements: a 30 year follow up. *J Bone Joint Surg [Br]* 2005;87-B:628-31.
19. **Keegan GM, Learmonth ID, Case CP.** Orthopaedic metals and their potential toxicity in the arthroplasty patients: a review of current knowledge and future strategies. *J Bone Joint Surg [Br]* 2007;89-B:567-73.
20. **Rasquinha VJ, Ranawat CS, Weiskopf J, et al.** Serum metal levels and bearing surfaces in total hip arthroplasty. *J Arthroplasty* 2006;21:47-52.
21. **Jenkinson HC, Hawkins MM, Stiller CA, et al.** Long-term population-based risks of second malignant neoplasms after childhood cancer in Britain. *Br J Cancer* 2004;91:1905-10.
22. **Macarthur AC, Spinelli JJ, Rogers PC, et al.** Risk of a second malignant neoplasm among 5-year survivors of cancer in childhood and adolescence in British Columbia, Canada. *Pediatr Blood Cancer* 2007;48:453-9.
23. **Henderson TO, Whitton J, Stovall M, et al.** Secondary sarcomas in childhood cancer survivors: a report from the Childhood Cancer Survivor Study. *J Natl Cancer Inst* 2007;99:300-8.