Cementless fixation of megaprosthesis using a conical fluted stem in the treatment of bone tumours

We reviewed 25 patients in whom a MUTARS megaprosthesis with a conical fluted stem had been implanted. There were three types of stem: a standard stem was used in 17 cases (three in the proximal femur, nine in the distal femur and five proximal tibia), a custom-made proximal femoral stem in four cases and a custom-made distal femoral stem in four cases. The mean age of the patients was 40.1 years (17 to 70) and the mean follow-up was for 2.5 years (0.9 to 7.4).

At follow-up two patients had died from their disease: one was alive with disease and 22 were disease-free. One of 23 prostheses had been removed for infection and another revised to a cemented stem. The mean Musculoskeletal Tumor Society score was 24.9 (12 to 30) and the mean Karnofsky index was 82% (60% to 100%).

There was no radiological evidence of loosening or subsidence. Stem stress shielding was seen in 11 patients and was marked in five of these.

There were five complications, rupture of the extensor mechanism of the knee after extra-articular resection in two patients, deep venous thrombosis in one, septic loosening in one, and dislocation of the hip in one.

The survival rate after seven years was 87% (95% confidence interval (CI) 83 to 91) for the patients and 95% (95% CI 91 to 99) for the megaprosthesis. A longer follow-up is needed to confirm these encouraging results.

Reconstruction of a large defect of long bone using a megaprosthesis is a well-established technique.1-10 Aseptic loosening, however, remains a significant problem.1-12 Megaprostheses may be cemented or uncemented and there are a number of different systems available.1-9,12-14 Both septic and aseptic loosening occur more commonly after replacement with a megaprosthesis than with a standard implant.11,12

Cementless fixation should not be a problem if there is sufficient remaining bone, but becomes a problem in the femur if a very long section is resected, leaving a short proximal or distal remnant. Given the success of the conical fluted stem introduced by Wagner and Wagner15 for primary and revision hip replacement,16-22 we designed a similar stem for the cementless fixation of a modular megaprosthesis (MUTARS, Implantcast, Buxtehude, Germany).13 The purpose of this paper is to report the results of this technique.

Patients and Methods

We reviewed 25 patients who had a MUTARS prosthesis with a conical fluted stem implanted between 1994 and 2005. There were 12 females and 13 males with a mean age of 40.1 years (17 to 70). The initial diagnosis was sarcoma in 22 cases, metastasis in one, femoral dysplasia in one and echinococcal osteomyelitis in one. There were 17 primary implantations and eight revisions of other megaprosthesis which had failed as a result of aseptic loosening in six, fracture in one or infection in one.

Pre-operative planning included standard anteroposterior (AP) and lateral radiographs of the affected part and MRI.

At operation, the mean length of femur resected was 21.2 cm (14 to 30).

The MUTARS system is modular to enable different lengths of component to be assembled. For intramedullary fixation there are three types of stem (Fig. 1). The standard stem (type A) is non-custom-made and available with different diameters between 14 mm and 21 mm. This stem had been used in 17 patients, three times in the proximal femur, nine times in the distal femur and five times in the proximal tibia.

The type B stem is a custom-made diaphyseal implant or fixation in the proximal
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Each stem is tapered with a cone angle of 2˚, fluted with eight radially-arranged fins and made of Ti-A16V4 with a rough-blasted surface. Pre-operative planning included standard AP and lateral radiographs and MRI.

The remaining segment of femur is reamed to endocortical diameter of its transected surface.

Types B and C stems were produced in three different sizes according to the pre-operative planning in order to ensure sufficient fixation. In type C stems adjustment is even more critical so as to avoid perforation of the intercondylar groove at the knee joint. For preparation of the femoral or tibial shaft standard reamers were used.

Where the femoral neck required retrograde preparation this was achieved using standard burrs. For implantation of custom-made components distally only the proximal part of the remaining distal femur was reamed. The remaining distal metaphysis remained untouched to avoid damage to the cancellous bone.

Post-operative regimen. All patients were mobilised on the first or second post-operative day and were kept non-weight-bearing for six weeks using crutches. After this they gradually increased to full weight-bearing at 12 weeks.

If the hip was replaced, adduction and rotation were restricted. If the knee was replaced, no restrictions were imposed unless the extensor mechanism had been reconstructed, in which case the knee was braced in extension for six weeks.

At follow-up, functional scoring was carried out using the Musculoskeletal Tumor Society (MSTS) system\textsuperscript{23} and functional health status assessed using the Karnofsky Index.\textsuperscript{24} Duration of survival was also recorded. The radiological outcome was assessed by comparing the current radiographs with those taken in the immediate post-operative period, noting any subsidence, loosening or stem-shielding.

Kaplan-Meier survival curves were constructed for the patients and the prostheses, and the 95\% confidence intervals (CI) were calculated.

Results
The mean follow-up was 2.5 years (0.9 to 7.4). There had been two deaths from disease, one patient was alive with disease, and the remaining 22 were disease-free, although one of the prostheses had been removed because of infection, and another was revised to a cemented stem one year after the primary surgery.

The mean MSTS score was 24.9 (12 to 30). The mean Karnofsky index was 82\% (60\% to 100\%).

There were five recorded complications, two patients had a rupture of the extensor mechanism after an extra-articular resection, one had deep-vein thrombosis, one septic loosening and one dislocation of the hip after replacement of the proximal femur.
There was no radiological evidence of loosening or subsidence. Stress shielding was seen in 11 patients and was marked in five of these.

The cumulative expected survival of the patients was 87% (95% CI, 83 to 91) and of the megaprostheses at 7.4 years was 95% (95% CI, 91 to 99), using the Kaplan-Meier method.

Discussion

Conical fluted stems are widely used for primary and revision total hip replacement (THR) and their success is well documented. They have not, however, been used with modular tumour endoprosthetic systems.

In our series, the standard stem was used in most patients. In cases where there was a short proximal remnant into which to fix the stem, we used a custom-made stem which was designed to perforate the trochanteric fossa. Similarly, if the distal remnant was short, we used a custom-made stem which was designed to reach as far distally as possible and which was perforated to allow ingrowth of bone.

Successful fixation with all three types of stem depended on precise pre-operative planning, as others have noted with the Wagner stem. Although to our knowledge the problems with fixation after very long resection are rare there are no well-known alternative techniques.

Our rate of stem subsidence was markedly lower than that described for the original Wagner stem in revision THR. Weber et al quoted a figure of 13% after three months and 21% after 12 months. Hartwig et al found that 64% of their prostheses subsided by 1 cm to 2 cm, Kolstad et al noted a similar degree of subsidence in 19% of their patients within three months of operation and Grünig, Morschler and Ochsner reported subsidence of up to 6.1 mm. Similar results have been reported by Ponziani et al and Isacson, Stark and Wallenstein.

Böhm and Bischel stated that they had observed a tendency towards more extensive subsidence after the transfemoral approach for revision THR and with more severe pre-operative bone defects. Bircher et al found that subsidence of < 1 cm in the first three post-operative months did not lead to stem loosening and did not influence their long-term results.

The reason for our low rate and extent of subsidence may be that our patients were much younger and had better quality bone than those who had a Wagner stem implanted for revision THR. Also, none of our patients needed a transfemoral approach. On the other hand, several patients had adjuvant chemotherapy, which may have affected the quality of the bone and impaired fixation of the stem. Bisphosphonates were given during chemotherapy to minimise this risk.

Only one of 21 (5%) hips dislocated. This compares well with the results of Wagner stems implanted for primary THR in which the rate of dislocation varies between 5% and 21%. Weber et al and Grünig et al reported a rate of 12.5%, and commented that dislocation was the most common complication in their series. We believe that the difference is that the MUTARS system allows the surgeon to adjust the degree of femoral anteversion after fixation of the stem, whereas the Wagner system does not. It is also much simpler to orientate the acetabular component in tumour cases since the acetabulum is unaffected by the disease.

The question of the minimum necessary length of bone engagement for femoral fixation has not been confirmed by clinical or experimental biomechanical studies. Wagner and Böhm suggested that the ideal length of fixation should be 10 cm, and that 7 cm should be the minimum. Bircher et al recommended 8 cm to 12 cm, and noted a lower revision rate when this was observed.

We are aware that our results are short-term, but they do show promise. These stems now need to be compared with other standard megaprostheses in order to assess their relative merits.

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References


