Intramedullary and total femur replacement in revision arthroplasty as a last limb-saving option

IS THERE ANY BENEFIT FROM THE LESS INVASIVE INTRAMEDULLARY REPLACEMENT?

There has been a substantial increase in the number of hip and knee prostheses implanted in recent years, with a consequent increase in the number of revisions required. Total femur replacement (TFR) following destruction of the entire femur, usually after several previous revision operations, is a rare procedure but is the only way of avoiding amputation. Intramedullary femur replacement (IFR) with preservation of the femoral diaphysis is a modification of TFR. Between 1999 and 2010, 27 patients with non-oncological conditions underwent surgery in our department with either IFR (n = 15) or TFR (n = 12) and were included in this study retrospectively. The aim of the study was to assess the indications, complications and outcomes of IFR and TFR in revision cases. The mean follow-up period was 31.3 months (6 to 90). Complications developed in 37% of cases, 33% in the IFR group and 4% in the TFR group. Despite a trend towards a slightly better functional outcome compared with TFR, the indication for intramedullary femur replacement should be established on a very strict basis in view of the procedure’s much higher complication rate.

Modular revision prostheses may be used for revision hip replacement when there is proximal femoral bone deficiency, and occasionally a mega-endoprosthesis is required. Complete destruction of the femur may require total femoral replacement (TFR) and previously amputation may have been the only realistic alternative under these circumstances. However, the development of megaprostheses, initially for the management of bone tumours, has made it possible to carry out limb-preserving surgery. The first TFR was implanted in 1952. There have only been a few studies recording the functional results and complications following implantation of a TFR for non-oncological reasons.

Intramedullary femur replacement (IFR) with preservation of the femoral diaphysis is a modification of TFR. The hip and knee joints are replaced using revision prostheses, which are then connected using an intramedullary rod. An IFR may be used when the following criteria are met: 1) the presence of the greater trochanter; 2) the presence of enough diaphysis to allow fixation of the prosthesis; and 3) adequate bone quality in the distal femur to allow fixation of a rotating hinge knee prosthesis (Fig. 1).

A TFR may be considered under the following circumstances: 1) the greater trochanter need not be present, 2) there may be combined peri-prosthetic hip and knee infection, with only a short intact length of femoral diaphysis, or when the tips of the stems are touching; and 3) when the quality of the femoral diaphysis is poor and inadequate fixation for fixation of a stem in the proximal or distal femur. At least 12 cm must be present for adequate osseous fixation of the stem (Fig. 2).

The aim of this study was to assess the indications, complications and outcomes after IFR and TFR in end-stage revision cases. To the best of our knowledge there have been no previous studies comparing these two types of reconstruction in patients with extensive femoral defects.

Patients and Methods
Between 1999 and 2010, 27 patients (21 women and six men) with non-oncological conditions underwent massive replacement with either an IFR (n = 15; mean age 73 years...
using the Modular Universal Tumor and Revision System (MUTARS; Implantcast, Buxtehude, Germany) or a TFR (Implantcast) (n = 12; mean age 73 years (55 to 88)) in our institution and were included in this retrospective study. All of the knee joints were coupled using a rotating hinge mechanism, and since 2005 the TFRs have had a silver coating (n = 10).

Radiological and clinical follow-up examinations were available for 27 patients. If a patient had died, their relatives were contacted: four in the IFR group and one in the TFR group had died. One patient was lost to follow-up in each group. The mean follow-up for the remaining 25 patients was 31.3 months (6 to 90), with no significant differences between the groups.

The indication(s) for revision, documentation of prosthesis type before revision and the number of previous revision operations were recorded. In relation to the implantation of an IFR or a TFR, blood transfusion data, operating times and intra- and post-operative complications were recorded.

The femoral defects were classified radiologically according to Paprosky.9 Peri-prosthetic fractures in the area of the hip or knee prosthesis were classified pre-operatively using the Vancouver or the Lewis-Rorabeck system.10,11 Function was assessed according to the Musculoskeletal Tumor Society (MSTS) system II.12 The Harris hip (HHS)13 and the Knee Society scores (KSS)14 were also noted pre-operatively and during follow-up.

Statistical analysis. Statistical analysis was carried out using the PASW Statistics program, version 18 (SPSS Inc., Chicago, Illinois) by using the t-test for independent random sample with a level of significance set at p < 0.05.

Results

Intramedullary femur replacement. Before implantation of an IFR the patients had undergone a mean of 3.2 (1 to 7) operations on the hip and 1.5 (0 to 6) operations on the knee joint. Peri-prosthetic infections were present in five patients in the IFR group. A two-step exchange was carried out in these cases. A total of ten patients had aseptic loosening (nine hip and one knee replacement), associated in two cases with a type B2 peri-prosthetic fracture and in four cases with a type C peri-prosthetic fracture according to the Vancouver classification, and in two cases with a type 2 fracture under the Lewis-Rorabeck classification.

Using the Paprosky classification for femoral defects, the IFR group included one type IIIA, two type IIB and 12 type IV defects. The greater trochanter was intact in 13 patients; one had an old fracture/dislocation and one had no trochanter.
The acetabular component was revised in six patients in this group, using an Avantage-type tripolar component (size 60 mm; Biomet, Warsaw, Indiana) in one, a cementless pressfit component with a diameter of 32 mm in four and a cementless pressfit component with a diameter of 28 mm in one.

The mean operating time was 305 minutes (190 to 410), and intra- and post-operatively patients received a mean of 4.7 units (2 to 8) of packed red blood cells.

Four patients developed an infection, at a mean of 15.3 months (11 to 23) after the operation. Two underwent a disarticulation of the hip; one died of sepsis and one underwent further acetabular revision and long-term antibiotic treatment. Peri-prosthetic infection also had the indication for a two-stage revision with a total femoral replacement (TFR) in two of these patients. Two other wound healing problems in the IFR group led to further surgery; and one intra-operative patellar tendon rupture was repaired. One patient developed loosening of the acetabular component, one suffered a dislocation and one developed wear of the coupling mechanism in the knee joint. The dislocation occurred after a two-step exchange with no greater trochanter present and a head size of 32 mm.

The mean MSTS score at final follow-up was 65% (27% to 87%).

In the IFR group the mean HHS improved from 24 (12 to 32) to 58 (13 to 93), the KSS improved from 34 (11 to 60) to 73 (40 to 98), and KSS function improved from 8 (0 to 20) to 32 (10 to 80).

During the follow-up, two patients were mobilised in wheelchairs, six patients required at least one crutch, two had two crutches and one was mobile without crutches. Only one patient in the IFR group had no Trendelenburg sign.

Total femoral replacement. Before implantation of a TFR the patients had undergone a mean of 3.5 (0 to 10) operations on the hip and 1.8 (0 to 7) operations on the knee joint. Pre-operatively, peri-prosthetic infections were present in five patients (41.6%), and aseptic loosening in seven patients (58.4%; five hip and two knee prostheses), in one associated with a type B2 fracture. Using the Paprosky classification for femoral defects, the TFR group included one type II and eight type IV defects, and three cases of no classification (with a distal femoral replacement and no hip replacement in two and a proximal femoral replacement with an infected knee replacement in one).

In the TFR group the greater trochanter was intact in two cases, five patients had an old fracture/dislocation and the trochanter was not present in five cases. The acetabular component was revised in seven patients, using an Avantage-type tripolar component of varying diameter in six patients and a 28 mm cementless pressfit component in one. In three patients a Trevira attachment tube
(Implantcast) was used to create a new hip joint capsule in an aseptic exchange.

The mean operating time was 231 minutes (120 to 335), resulting in a significant difference (t-test, p = 0.013). Intra- and post-operatively a mean of 3.4 units (1 to 10) of packed red blood cells were administered.

No infections occurred. The indication for two-step implantation of a TFR was a peri-prosthetic infection in five patients. One revision was due to a post-operative sciatic nerve palsy, and in this patient the prosthesis was shortened and the palsy resolved. There were no other complications.

The mean MST5 score at final follow up was 69% (37% to 87%). There was no significant difference between the mean scores in the two groups (t-test, p = 0.5).

In the TFR group the mean HHS improved from 30 (6 to 43) to 61 (20 to 79), the mean KSS improved from 39 (11 to 83) to 77 (40 to 98), and the mean KSS function score improved from 3 (0 to 25) to 13 (0 to 40). There were no significant differences between the two groups in the scores noted by the t-test (all p > 0.05).

In the TFR group two patients required a wheelchair, eight were mobilised with two crutches, and one patient had one crutch.

**Discussion**

Total or intramedullary femoral replacement is often the last option available to preserve the limb. Thanks to their modular nature, both the IFR and TFRs in the MUTARS system allow precise restoration of length and are easy to use.

Improvements in the HHS and the KSS were observed in both groups. These results are comparable to those reported by Peters et al8 and Berend et al9 and the MST5 scores are comparable to those reported by Ahmed.3 However, our study showed that mobility remained limited after this form of surgery. All but one patient in the study required walking aids. More patients in the IFR group were mobile using fewer aids than in the TFR group. This is probably attributable to a slightly more stable hip joint, usually with a preserved greater trochanter. Although all but one patient in the IFR group had a positive Trendelenburg sign, only two required a wheelchair. Bickels et al15 and Ruggieri et al2 reported that 16% and 22% of their patients, respectively, had a positive Trendelenburg sign. In another study, by contrast, walking aids were needed in 93% of the patients, a finding that is similar to ours.6

Although these functional results are sobering, it needs to be borne in mind that disarticulation of the hip is a major undertaking with a significant associated mortality rate.16 17

Disarticulation is difficult to manage with a prosthesis, which is cumbersome and physically demanding.18 In addition, Chin et al19 have shown that the mobilisation of elderly patients following disarticulation of the hip is very limited, and that wheelchair use represented an alternative and realistic goal. There may also be significant psychological sequelae.20

We therefore consider that when there is a realistic chance of preserving the limb, this should be attempted. Implanting this type of megaprosthesis is, of course, associated with a high complication rate at 25% to 37%.6 7 21 Patients must be counselled appropriately and warned of the possible subsequent need for disarticulation. In our study, major complications occurred in 37% of cases, 33% in the IFR group and 4% in the TFR group. All the post-operative peri-prosthetic infections occurred in the IFR group. This distribution is most probably attributable to the compromised circulation in these patients, with preservation of a previously damaged femoral diaphysis, compared to the radical debridement that accompanies TFR. In addition, ten TFRs were covered with an antimicrobial silver coating. Hardes et al22 in a study including 51 oncological patients with tumour prostheses reported that infection rates declined from 17.6% in the titanium group to 5.9% in the group with silver-coated proximal femoral and proximal tibial replacements.

In view of the high dislocation rate of 14.3% (four of 28) following proximal femur replacement in revision cases, we have increasingly used a tripolar cup.4 These were used in one patient in the IFR group and six in the TFR group. The overall dislocation rate was 4%, with no cases in the TFR group. In 85 hips with recurrent dislocation, the redislocation rate after revision using dual-mobility cemented acetabular component was only 1.1% after a two- to five-year follow-up.23

Implantation of a TFR in revision surgery provides satisfactory results for the patient, who can be mobilised with walking aids, usually without a wheelchair. However, the patient needs to be aware that mobility will be limited, and that activities of everyday life may be restricted. Because of the data presented here, the indications for using an IFR are very limited in our clinic. The slightly better functional outcome following use of an IFR does not outweigh the much higher complication rate, particularly in relation to peri-prosthetic infection and hip dislocation, which may be prevented by using a tripolar component.

**Supplementary material**

A table detailing the type of prosthesis pre-operatively, indications and classifications for all 27 patients is available with the electronic version of this paper on our website at www.jbjs.org.uk

**References**


