

# Kotz modular femur and tibia replacement

## 28 tumor cases followed for 3 (1–8) years

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In the period 1984–1991, 33 lower limb reconstructions were performed with an uncemented Kotz modular femur tibia reconstruction (KMFTR) prosthesis after resection of 32 malignant bone tumors and 1 benign giant cell tumor. Tumor localization was proximal femur in 12, distal femur in 17, and proximal tibia in 4. The mean age of the patients was 38 years. 28 patients with a minimum follow-up of 1 year were studied after 3 (1–8) years. 7

patients were reoperated because of complications. Good or excellent results were obtained in 6 of the 10 proximal and 13 of the 14 distal femur reconstructions. In 2 of the 4 patients undergoing combined distal femur and proximal tibia resection, a deep infection developed, and above-knee amputation was performed. One local recurrence occurred after proximal femur resection.

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We report our short-term results with the cementless KMFTR (Kotz modular femur and tibia reconstruction) endoprosthesis (Kotz et al. 1986).

### Patients and methods

In the period 1984–1991, the KMFTR prosthesis was used for reconstruction in 33 patients with bone tumor, i.e., 32 primary malignant bone tumors and 1 benign giant cell tumor (Table 1). 12 of these were located in the proximal femur, 17 in the distal femur, and 4 in the proximal tibia. At surgery, the mean age of the patients was 38 (14–76) years.

In 2 cases with a proximal femur tumor, an extra-articular resection was performed. For reconstruction of the acetabulum, a screw ring was used. 1 of these with supplementary autogenous bone grafting. In the remaining 10 cases, the resection of the proximal femur was intra-articular. The joint was reconstructed with a bipolar joint component of the KMFTR proximal femur (Figure 1). The fixation of the diaphyseal component was press-fitted in 12 cases. In Case 6 the femoral component was cemented because of an incongruence between the largest available prosthetic stem and the width of the intramedullary canal. The reconstruction of the abductor mechanism was performed by fixation of the gluteal muscles on the iliotibial tract in 12 cases; the trochanter fixation device was used in Case 7.

Extra-articular resection of the knee joint was performed for 8 femoral and 3 tibial tumors. In all 11 extra-articular and in 4 of the 10 intra-articular knee joint resections a cementless PCA Howmedica patellar prosthesis was implanted (Figure 2). A hamstring transfer was performed in Cases 18 and 20 in order to strengthen extension of the knee. In all proximal tibia resections the patellar tendon was sutured to the anteriorly rotated gastrocnemius muscles (Malawar and McHale 1989).

28 patients with a minimum follow-up of 1 year were evaluated according to the modified classification of the Musculoskeletal Tumor Society (Enneking 1987). The mean follow-up of these patients was 3 (1–8) years. 5 patients had died with metastases. 31 patients were radiographically evaluated using the system of Capanna et al. (1989). Cases 30 and 32 were excluded from radiographic evaluation because of a prosthetic infection followed by knee amputation.

### Results

At follow-up at 6 years, Case 6 had a local recurrence of a proximal femur chondrosarcoma. 5 patients died of disseminated tumor, 5 with Stage IIB tumors and 1 Stage III. At follow-up, 28 of the 33 patients had no evidence of disease. However, Cases 27 and 32 had had a thoracotomy for lung metastases.

Table 1. Follow-up of femur and/or tibia replacement for tumor

| Case | A | B  | C  | D | E | F  | G | H | I | J | K  | L | M | N | O      | P   | Q | R | S | T | U | V | W | X | Y | Z   |
|------|---|----|----|---|---|----|---|---|---|---|----|---|---|---|--------|-----|---|---|---|---|---|---|---|---|---|-----|
| 1    | 2 | 50 | 1  | 1 | 1 | 23 | - | - | 1 | 1 | 23 | 1 | 1 | 0 | -      | -   | 0 | 2 | 3 | 3 | 1 | 3 | 3 | 2 | 3 | 47  |
| 2    | 2 | 31 | 1  | 4 | 1 | 26 | - | - | 1 | 2 | 95 | 1 | 3 | 0 | 4      | -   | 0 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 91  |
| 3    | 1 | 13 | 9  | 4 | 1 | 37 | - | - | 2 | 1 | 81 | 1 | 4 | 0 | -      | -   | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 96  |
| 4    | 1 | 35 | 1  | 4 | 1 | 21 | - | - | 1 | 1 | 89 | 3 | 2 | 1 | -      | -   | 0 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 75  |
| 5    | 2 | 56 | 1  | 3 | 1 | 19 | - | - | 1 | 1 | 88 | 1 | 3 | 1 | -      | -   | 0 | 2 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 86  |
| 6    | 1 | 76 | 1  | 4 | 1 | 31 | - | - | 1 | 1 | 76 | 4 | 2 | 2 | -      | -   | 0 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 2 | 77  |
| 7    | 1 | 44 | 9  | 4 | 1 | 21 | - | - | 2 | 1 | 56 | 1 | 1 | 1 | -      | -   | 0 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 78  |
| 8    | 1 | 14 | 9  | 4 | 1 | 18 | - | - | 1 | 1 | 13 | 1 | 3 | 0 | -      | -   | 1 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 66  |
| 9    | 2 | 20 | 9  | 4 | 1 | 19 | - | - | 1 | 1 | 47 | 1 | 3 | 1 | 13     | 3   | 1 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 61  |
| 10   | 2 | 41 | 2  | 4 | 1 | 14 | - | - | 1 | 1 | 16 | 1 | 1 | 0 | -      | -   | 0 | 2 | 2 | 4 | 1 | 3 | 3 | 2 | 3 | 51  |
| 11   | 1 | 45 | 3  | 5 | 1 | 21 | - | - | 2 | 2 | 19 | 2 | 3 | 3 | 1,2,4  | -   | 5 | - | - | - | - | - | - | - | - | -   |
| 12   | 2 | 21 | 9  | 4 | 1 | 30 | - | - | 1 | 1 | 19 | 2 | 1 | 0 | -      | -   | 0 | - | - | - | - | - | - | - | - | -   |
| 13   | 1 | 60 | 1  | 2 | 1 | 17 | 1 | 1 | 2 | - | 57 | 1 | 4 | 0 | -      | 6,6 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 87  |
| 14   | 2 | 36 | 4  | 6 | 1 | 15 | 1 | 2 | 1 | - | 61 | 1 | 4 | 0 | 10     | 6   | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 100 |
| 15   | 2 | 18 | 5  | 4 | 1 | 17 | 1 | 1 | 2 | - | 29 | 2 | 1 | 0 | -      | -   | 0 | - | - | - | - | - | - | - | - | -   |
| 16   | 1 | 36 | 6  | 2 | 1 | 24 | 1 | 1 | 2 | - | 44 | 1 | 4 | 0 | 9,11   | -   | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 85  |
| 17   | 1 | 21 | 9  | 4 | 1 | 28 | 1 | 2 | 1 | - | 79 | 1 | 1 | 0 | -      | 7,7 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 92  |
| 18   | 1 | 47 | 8  | 4 | 1 | 20 | 1 | 2 | 1 | - | 20 | 1 | 3 | 0 | -      | -   | 0 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 2 | 72  |
| 19   | 2 | 49 | 7  | 4 | 1 | 17 | 1 | 1 | 1 | - | 16 | 1 | 1 | 0 | -      | -   | 0 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 80  |
| 20   | 2 | 43 | 3  | 4 | 2 | 10 | 1 | 2 | 1 | - | 13 | 1 | 1 | 0 | 11     | -   | 0 | 1 | 2 | 3 | 3 | 4 | 3 | 3 | 3 | 48  |
| 21   | 2 | 21 | 9  | 4 | 1 | 31 | 1 | 2 | 1 | - | 12 | 2 | 1 | 0 | -      | -   | 0 | - | - | - | - | - | - | - | - | -   |
| 22   | 2 | 26 | 7  | 4 | 1 | 17 | 1 | 2 | 1 | - | 12 | 2 | 4 | 0 | -      | -   | 0 | - | - | - | - | - | - | - | - | -   |
| 23   | 2 | 56 | 1  | 1 | 1 | 11 | 1 | 1 | 2 | - | 30 | 1 | 2 | 0 | -      | -   | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 86  |
| 24   | 1 | 47 | 10 | 7 | 1 | 10 | 1 | 1 | 1 | - | 16 | 1 | 1 | 0 | -      | -   | 0 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 100 |
| 25   | 1 | 19 | 8  | 4 | 1 | 16 | 1 | 1 | 2 | - | 18 | 1 | 1 | 0 | -      | -   | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 100 |
| 26   | 2 | 62 | 11 | 4 | 1 | 12 | 1 | 1 | 1 | - | 12 | 1 | 1 | 0 | 11     | -   | 0 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 87  |
| 27   | 2 | 21 | 8  | 4 | 1 | 21 | 1 | 1 | 1 | - | 35 | 1 | 3 | 0 | -      | -   | 0 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 100 |
| 28   | 1 | 64 | 8  | 2 | 1 | 17 | 1 | 1 | 2 | - | 38 | 1 | 2 | 0 | -      | -   | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 92  |
| 29   | 1 | 59 | 1  | 1 | 1 | 14 | 1 | 1 | 2 | - | 36 | 1 | 3 | 0 | 8      | -   | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 89  |
| 30   | 2 | 51 | 8  | 3 | 1 | 26 | 2 | 1 | 2 | - | 2  | 2 | - | 0 | 5,8    | -   | 1 | - | - | - | - | - | - | - | - | -   |
| 31   | 2 | 17 | 8  | 4 | 1 | 28 | 2 | 1 | 1 | - | 23 | 1 | 3 | 0 | 1,9,12 | -   | 0 | 2 | 1 | 4 | 3 | 4 | 3 | 3 | 4 | 52  |
| 32   | 1 | 24 | 8  | 5 | 1 | 25 | 2 | 1 | 2 | - | 17 | 1 | - | 0 | 5      | -   | 3 | - | - | - | - | - | - | - | - | -   |
| 33   | 1 | 22 | 8  | 4 | 1 | 20 | 2 | 1 | 2 | - | 18 | 1 | 4 | 0 | -      | -   | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 95  |

## A Sex

- 1 male
- 2 female

## B Age of patient

## C Diagnosis

- 1 chondrosarcoma
- 2 non-Hodgkin lymphoma
- 3 synovial sarcoma
- 4 giant cell tumor
- 5 undifferentiated sarcoma
- 6 malignant fibrous histiocytoma
- 7 osteosarcoma
- 8 hemangiosarcoma
- 9 Ewing sarcoma
- 10 malignant giant cell tumor
- 11 fibrous sarcoma

## D Stage

- 1 IA
- 2 IB
- 3 IIA
- 4 IIB
- 5 III
- 6 3
- 7 4

## E Margins

- 1 wide
- 2 marginal

## F Resection length (cm)

## G Resection place

- 1 distal femur
- 2 proximal tibia and distal femur

## H Patellar prosthesis

- 1 yes
- 2 no

## I Acetabular socket

- 1 yes
- 2 no

## J Joint resection

- 1 intra-articular
- 2 extra-articular

## K Follow-up in months

## L Recent tumor status

- 1 no evidence of disease
- 2 tumor-related death
- 3 metastasis
- 4 local recurrence

## M Radiographic observations

- 1 no reaction
- 2 hypertrophy
- 3 diffuse osteoporosis
- 4 distal hypertrophy and proximal osteoporosis
- 5 distal hypertrophy and proximal reabsorption of cortex

## N Periarticular ossification

- 0 no signs
- 1 degree 1
- 2 degree 2
- 3 degree 3
- 4 degree 4

## O-P

## Early (O) and late (P) complications

- 1 wound infection
- 2 dislocation
- 3 broken fixation screw
- 4 ischial neuropraxia
- 5 infected prosthesis
- 6 bearing wear
- 7 broken intramedullary stem
- 8 peroneal nerve paralysis
- 9 peroneal dysesthesia
- 10 delayed wound healing
- 11 fracture tibia
- 12 patellar tendon avulsion

## Q Number of reoperations

## Functional result according to Enneking

- R Motion
- S Pain
- T Stability
- U Deformity
- V Strength
- W Function
- X Emotional acceptance
- Y Total result

## R-Y

- 1 excellent
- 2 good
- 3 fair
- 4 poor

## Z Harris Hip Score or HSS Knee Score

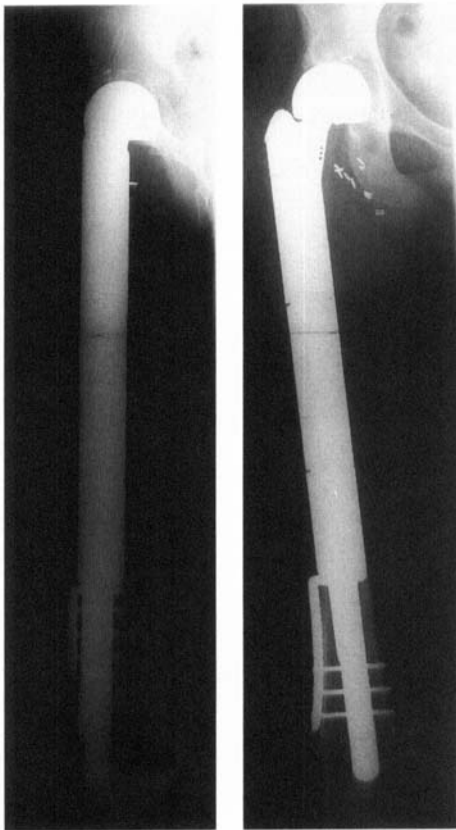


Figure 1. Case 12. Postoperative result after proximal femur reconstruction.



Figure 2. Case 25. Postoperative result after distal femur reconstruction.

### Complications

After proximal femur resection, Case 11 had an infected hematoma, which healed with drainage and gentamicin beads, and dislocation, treated by closed reduction and a plaster of Paris for 6 weeks; the hip then remained stable.

After distal femur reconstruction, 6 of 17 patients had complications without effect on the final functional result. 3 patients had fracture of the tibial cortex near the tip of the prosthesis. The fractures healed after conservative treatment. Case 17, a very keen golfer, broke the proximal diaphyseal intramedullary anchorage stem twice. This part was exchanged. 2 1/2 years after surgery, the polyethylene bearings of Cases 13 and 14 were worn out, resulting in varus/valgus instability. The bearings were exchanged for a new design.

3 of the 4 patients with a combined distal femur and proximal tibia reconstruction had serious early complications with 2 above-knee amputations for deep infection. The third patient developed skin necrosis, infection and patellar tendon avulsion. For

the large skin defect, a free vascularized latissimus dorsi myocutaneous flap and split-thickness skin graft were used. The infection healed with antibiotics.

### Function

After proximal femur reconstruction, 6 of 10 patients had good or excellent results. Fixation of the abductor muscles to the iliotibial tract resulted in Grade 4-5 abductor strength in 7 patients. However, 8 patients used one or more crutches/canes. The walking distance was limited in 7 patients.

In 13 of 14 patients undergoing distal femur resection, the result was assessed as good or excellent. 3 patients needed a crutch or cane, and 8 had some restriction in walking. Case 20 had weak extension despite hamstring transfer and was evaluated as fair.

After combined distal femur and proximal tibia resection, only 1 was excellent, and 3 had poor function because of patellar tendon avulsion or above knee amputation.

### Radiographic evaluation

No acetabular protrusion was observed in patients with a bipolar component or screw ring. However, Case 1 had chondrolysis of the acetabulum. The bipolar component was revised with a screw ring 30 months postoperatively because of pain. Case 12 showed signs of osteonecrosis of the femoral head after radiotherapy for Ewing sarcoma in the distal femur.

At follow-up, there were no radiographic signs of prosthetic loosening. Periarticular ossification (Brooker et al. 1973) was seen in 6 patients with proximal femur reconstructions.

### Discussion

Postoperative infection rates of 8–25 percent have been reported after reconstruction of the knee joint with a large custom-made prosthesis (Sim and Chao 1979, Bradish et al. 1987, Horowitz et al. 1991). However, in 2 previous Kotz prosthesis series, the infection rate was less than 5 percent (Kotz et al. 1986, Capanna et al. 1989). This difference could not be explained by operative procedures.

Postoperative dislocation of the hip is a frequent complication (4–27 percent; Ritschl and Kotz 1987, Capanna et al. 1989, Jessop et al. 1989). We had only one hip dislocation, even though we never used a plaster cast postoperatively. Bipolar components instead of an acetabular (screw) cup and a careful muscle reconstruction around the prosthesis help to prevent postoperative dislocation. Our short-term results with the bipolar component the Kotz femur prostheses are favorable with respect to joint stability, absence of protrusion, and hip pain. Fixation of the abductor muscles to the iliotibial tract seems to be a good method for preserving the abductor strength.

Fracture of the tibia occurred in 3 of our 17 patients; all healed. In the study by Capanna et al. (1989), this complication was seen in 9 percent of the patients. The fractures were the result of the relatively large straight diaphyseal stem inserted into the tibia. Loosening of the uncemented prosthesis did not occur in our patients or in other series (Kotz et al. 1986, Ritschl and Kotz 1987, Capanna et al. 1989). However, loosening may become a common long-term problem.

The good functional results especially of the distal femur reconstructions in this study are comparable to the results of others (Capanna et al. 1985, Kotz et al. 1986, Capanna et al. 1989).

Serious complications occurred with the distal

femur and proximal tibial reconstructions. The combination of an extensive resection followed by poor soft tissue coverage of the tibia and prosthesis resulted in impaired wound healing and increased risk of deep infection. These problems can be prevented by adequate soft tissue coverage—e.g., by transfer of the gastrocnemius muscles to the front of the tibia or by the use of free flaps (Kotz et al. 1989, Malawar and McHale 1989, Horowitz et al. 1991).

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