Femoral cortical sleeve in revision arthroplasty

24 patients followed 2–10 years

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22 women and 2 men with a mean age of 75 (51–90) years underwent replacement of the proximal femur for failed total hip arthroplasty by a modular femoral resection endoprosthesis (KMFTR). The indications were bone loss in aseptic loosening (n 8), fracture (n 12) and Girdlestone hips (n 4). After a mean follow-up of 5 (2–10) years, the Harris Hip Score improved from an average of 17 (4–43) to 79 (50–97). In 19 patients, the proximal femur was kept as an autograft and was wrapped around the resection parts of the modular prosthesis as a cortical sleeve. Bone formation in these 19 hips took place in 18 at the dorsal, in 17 at the medial, in 8 at the lateral and in 7 at the ventral aspect of the femur. The bone bridge formed within the first year and persisted in amount and distribution during the time of observation.

In the 5 patients without a remaining cortical sleeve around the resection parts of the prosthesis, no bone bridge was formed. These 5 patients showed stress-shielding at the prosthesis-bone-junction. Until now, none of the 24 patients has undergone additional surgery.

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Bone loss in revision hip arthroplasty can be treated in different ways. One method is to retain a cortical sleeve (Wagner 1987, 1989, Wehrli 1991, Rinaldi and Vaienti 1992) in combination with a modular resection prosthesis (Kotz et al. 1986, 1988, Kotz and Ritschl 1989). We report on our results with a cortical sleeve that forms bridging-bone around a modular endoprosthesis. We analyzed the bone stock of this cortical sleeve and the formation of bridges to the remaining proximal femur.

Patients and methods

Between 1982 and 1990, 24 patients (22 women) having an average age of 75 (51–90) years had a replacement of the proximal femur for a non-neoplastic condition as a salvage procedure. 8 patients suffered bone loss because of aseptic loosening, 12 had proximal femur fractures, and 5 had Girdlestone hips due to failed total hip arthroplasty. They had had 67, mean 2.8 (1–7), previous operations. Their mean age at the time of the salvage operation was 75 (51–90) years and the mean follow-up was 59 (24–120) months. Patients were seen for clinical examination and radiograms every 3 months within the first 2 years and later at intervals of 6 months. 19 prostheses were implanted without cement. 14 patients had an additional revision of the acetabular cup. 8 acetabular cups were implanted uncemented, 2 cemented (6 metal-backed). 3 patients exhibiting severe acetabular bone loss required anti-protrusio cages and 1 patient a saddle prosthesis (Nieder and Friesecke 1993). In 3 cases the cortical sleeves were fixed by cerclage wires around the prostheses. In the remaining cases, non-resorbable or resorbable sutures were used. 1 patient had a cerclage for fixation of the greater trochanter. In 1 case, a trochanter fixation plate of the modular prosthesis was used. In all other cases, we performed a myodesis of the m. gluteus medius to the m. vastus lateralis and the fascia lata. In 4 patients with Girdlestone hips, no reconstruction with cortical sleeves was possible. In 1 case of infection, a complete removal of bone and prosthesis was carried out by subperiosteal exposure and resection distal to the tip of the prosthesis before provision with the modular femoral endoprosthesis.

The Harris (1969) Hip Scores were calculated at each follow-up. For radiographic analysis, the immediate postoperative radiographs, those after 1 and 2 years, as well as the last follow-up radiographs in the standard anteroposterior and lateral views were used. The criteria established for implants by the International Society of Limb Salvage (Glasser and Langlais 1991) were used for evaluation.

Surgical technique

The patients were operated on in the supine position using a lateral incision with the possibility for addi-

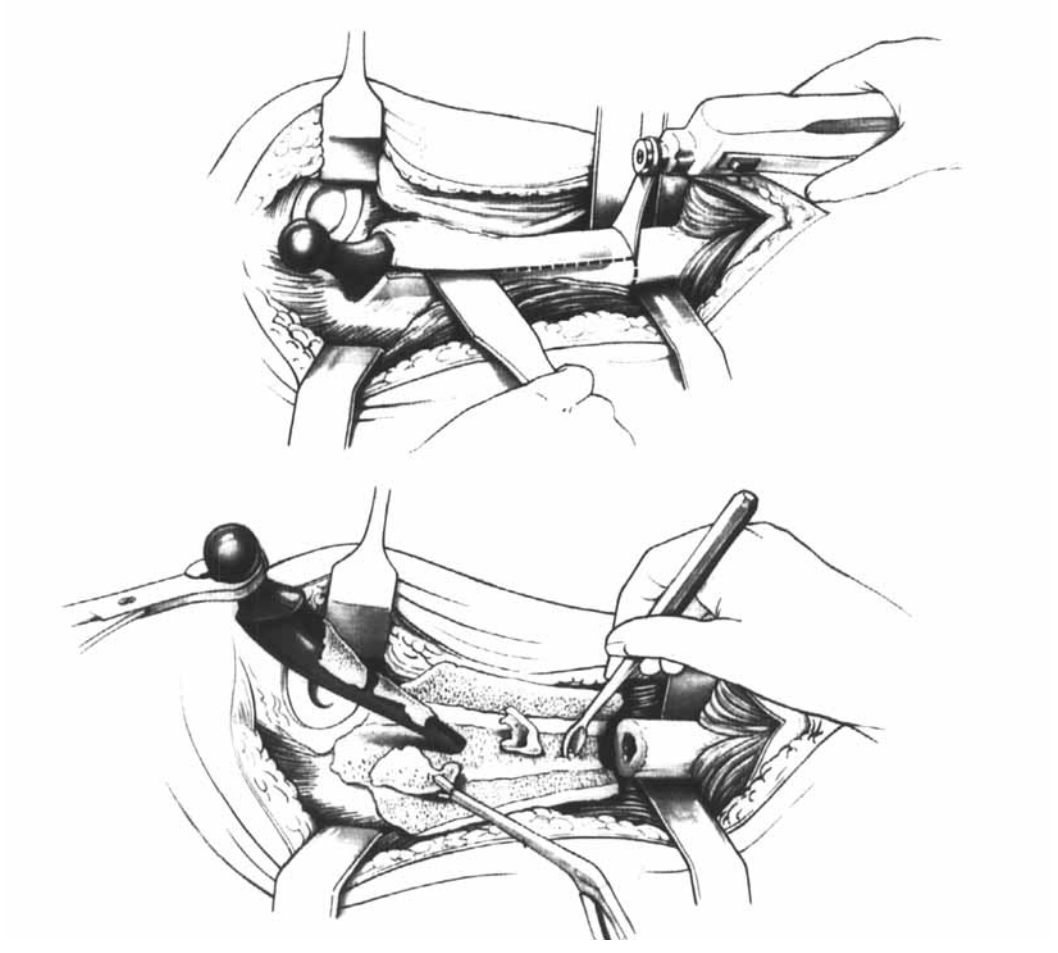


Figure 1. A wide exposure of the loosened cemented prosthesis is possible with a transverse cut at the tip of the prosthesis and a lateral or anterolateral longitudinal cut.

tional distal exposure of the femur. The incision was always extended to an area with a healthy cortex. The bony cortex around a loosened prosthesis was cut longitudinally in the anterior or lateral aspect of the femur and transversely at the tip of the prosthesis. Thereafter the removal of bone cement was easy (Figure 1). In the case of infection, a complete removal of bone and prosthesis was performed by subperiosteal exposure and resection distal to the tip of the prosthesis. The healthy femoral canal was progressively reamed for a tight fit of the anchorage stem of the revision prosthesis. A straight anchorage piece of the prosthesis was introduced, so that the plates were positioned on the anterior and lateral surfaces of the cortex. We used the Kotz Modular Femur Tibia Reconstruction (KMFTR®, Howmedica Ltd.) system (Kotz et al. 1986). After revision of the acetabular cup in case of loosening, the resected part was connected with the diaphyseal anchorage piece. The bony fragments were wrapped around the body of the prosthesis to function as a cortical sleeve, in some cases together with small cancellous freeze-dried allografts. Refixation of the m. gluteus medius was done with a trochanter fixation plate or with myodesis of the muscle to the m. vastus lateralis and the fascia lata. The mean duration of surgery was 3.7 (2–5.5) hours. The patients received an average of 12 (2–22) units of blood during and after the operations. They stayed on the ward for an average of 20 (7–68) days. They were immobilized in a plaster spica cast for 6 weeks during the postoperative period to prevent dislocation. Protected weight bearing with crutches, together with muscle strengthening exercises, were recommended for 3 months.

Table 1. Gradation of pain, number of patients

Amount of pain	Preop.	1 year postop.	Last follow-up
None	–	18	18
Slight	–	5	5
Mild	–	–	–
Moderate	2	1	1
Marked	11	–	–
Disabling	11	–	–

Table 2. Analysis of gait, number of patients

	Preop.	1 year postop.	Last follow-up
Limping			
none	–	1	1
slight	–	8	7
moderate	–	14	14
severe	24	1	2
Support required			
none	–	3	3
single cane for long walks	–	3	3
single cane most of the time	–	7	6
1 crutch	–	8	9
2 canes	5	3	1
2 crutches or unable to walk	19	–	2
Walking distance			
unlimited	–	9	12
6 blocks	2	12	8
2 or 3 blocks	2	1	–
indoors only	7	1	2
bed and chair	13	1	2

Results

Clinical findings

The Harris Hip Scores improved from an average of 17 (4–43) preoperatively to 80 (50–97) points one year postoperatively and to 79 (50–97) points after a mean follow-up of 5 (2–10) years (Tables 1 and 2).

Flexion in the hip joint increased from an average of 42 (10–90) degrees to 93 (20–110) degrees. 2 patients had a pain-free limb with excellent function, but at the last follow-up were bedridden because of other diseases. 18 of the patients had limb-shortening by more than 4 cm preoperatively. After surgery 7 patients had an average discrepancy of limb-length of 1 (0.5–2) cm. In 2 cases, the discrepancy was due to a Girdlestone hip and aseptic loosening of THA on the contralateral side. In 17 patients, limb length was equal.

Only 1 patient felt moderate pain and had some limitation of ordinary activities 1 year postoperatively and at the last follow-up. Only 3 patients walked without support.

Radiographic findings

The bone bridge at the interface between the cortical sleeve and femoral bone and the amount of bone around the prosthesis, the cortical sleeve, were assessed separately for the anterior, posterior, ventral and dorsal aspects of the femur (Figure 2). In 4 Girdlestone hips and 1 infected femoral fracture without a cortical sleeve no formation of bone was observed. Bone formation at the cortical sleeve showed a characteristic distribution. It had established itself within the first year and persisted in amount and distribution during the observation time (Table 3).

We found extracortical bone bridging in 18 of the remaining 19 patients at the dorsal and in 17 of the 19 cases at the medial aspect of the femur (Figure 3). Furthermore, new bone formation occurred in 8 of the 19 cases at the lateral aspect of the femur and in 7 of the 19 cases at the ventral side.

All 5 patients without a cortical sleeve showed stress-shielding (Capanna et al. 1994), but no radiolucent lines around the stem of the prosthesis were observed (Figure 4).

Complications

The first 8 patients were not immobilized in a spica cast, and 5 of them dislocated. The hips were reposi-

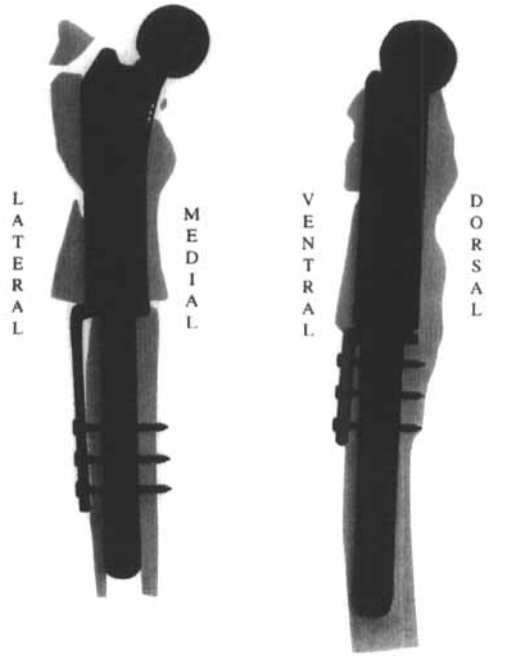


Figure 2. The Kotz prosthesis with an excellent covering of the resection prosthesis by the remaining femoral bone forming a cortical sleeve (schema).

Table 3. Radiographic evaluation of the 19 patients with the cortical sleeve

	Immediately postoperative					Last follow-up				
	E	G	F	P	Total E+G+F	E	G	F	P	Total E+G+F
Medial	11	4	1	3	16	17	1	1	–	19
Lateral	10	3	4	2	17	8	6	3	2	17
Ventral	9	5	4	1	18	7	4	5	3	16
Dorsal	16	2	–	1	18	18	–	–	1	18
Whole aspect	10	5	4	–	19	11	7	1	–	19

E excellent (75–100% bridging without radiolucent lines)
G good (50–75% bridging formation)
F fair (25–50% bridging formation)
P poor (< 25% bone bridging and cortical resorption)

tioned and immobilized in a plaster spica cast for 6 weeks. A postoperative cast was applied for 6 weeks in all other cases and no further dislocations occurred.

1 patient suffered from a severe postoperative pneumonia. 1 patient had a knee-contracture mobilized under general anesthesia.

Discussion

Bone bridging never occurred in the absence of a cortical sleeve. According to Shapiro (1988), the amount of bone bridging is influenced by the position and amount of the remaining cortical bone. The reduced quantity of bone formation and bridging bones at the lateral and ventral aspects of the femur may be explained by the numerous previous operations using a lateral or anterolateral approach and resulting in poorer blood supply through scar tissue. Compressive forces occur only at the medial or posterior aspect of the femur, possibly influencing the remodeling process. It is possible that new bone formation develops only under such stress (Sim and Chao 1981). The cortical sleeve persisted in amount and distribution over the years of observation.

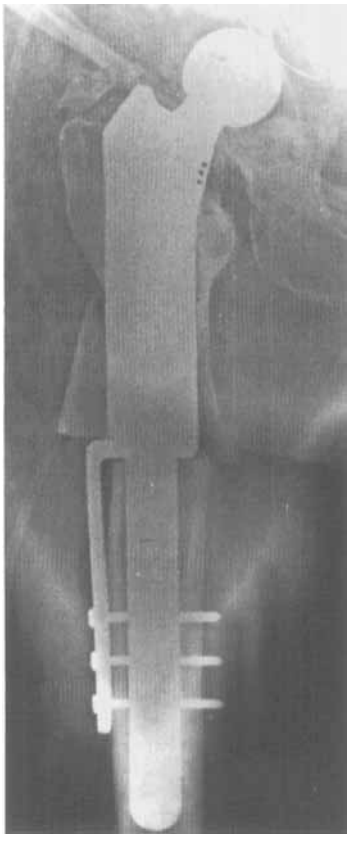
Our current system has full modularity to build up the individual prosthesis for the patient in the operating room with respect to stem diameter for press-fit and the length of the prosthesis to achieve equal leg length. This is an advantage of prostheses, which are limited to a set of parts with different lengths and stem diameters. The length achieved by a cement-free system with screw fixation is permanent, in contrast to conical press-fit stems which may subside. Massive allografting restores the osseous anatomy and may leave the patient with a better bone stock in the future, but it shows a higher rate of infection and loosening and, in many cases, requires further surgery (Nelson et al. 1990, Allan et al. 1991, Berry et al. 1991). The remarkably good functional results achieved by our type of revision hip arthroplasty might be explained by the bone bridge established mainly at the medial and posterior aspects of the femur. The muscular attachment to the cortical sleeve—dorsal at the linea aspera, medial at the insertion of the adductor muscles—may improve stability and muscular balance and therefore may lead to better function.

The high rate of complications (5 dislocations, 1 pneumonia, 1 knee-flexion deficit) in these patients may be explained by their age and the poor condition of the bone around the site. None of our patients developed a superficial or deep infection. In conventional revision total hip arthroplasty, only Marti et al. (1990) (6 of 60 with a follow-up of 9 years) and Gie et al. (1993) (7 complications in 68 patients) reported a lower complication rate. Berry and Müller (1992) (6 of 18 failed), Engelbrecht et al. (1990) (17 of 138 with additional surgery and a nonunion of the trochanter in 22 percent), Head et al. (1987) (9 of 22 with additional surgery after 28 months) and Oakeshott et al. (1987) (21 complications in 72 patients) had a higher rate of complications and required additional surgery to achieve satisfactory results.

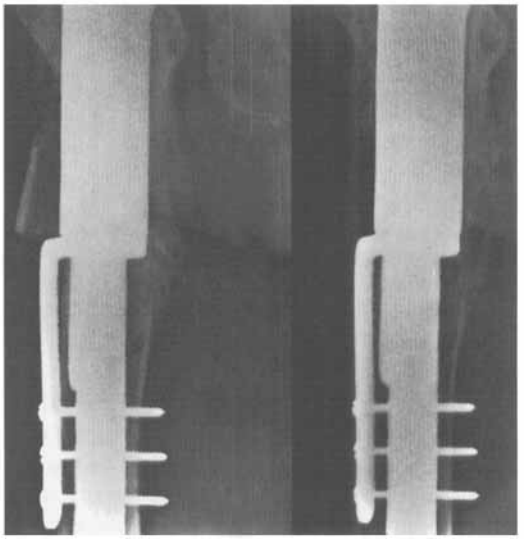
After 1 year postoperatively, no further improvement in our patients was noticed, either clinically or radiographically, in accordance with Kavanagh and Fitzgerald (1987).

All 5 patients without a cortical sleeve showed stress-shielding around the anchorage-parts of the modular prosthesis. This bone resorption was not seen in the 19 patients with an established bone bridge induced by a cortical sleeve.

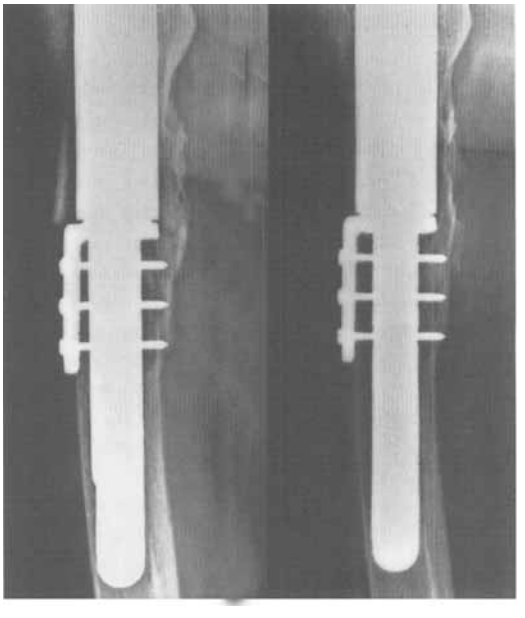
Figure 3. A 69-year-old woman with a follow-up of 113 months after replacement of the proximal femur because of fracture of a cemented total hip arthroplasty in 1975.



Immediate postoperative radiograph, with fragments placed around the KMFTR prosthesis.



AP-view 3 and 6 months postoperatively with bone-bridging medially and remodeling of the bony cortex lateral.



Axial view 3 and 6 months postoperatively.

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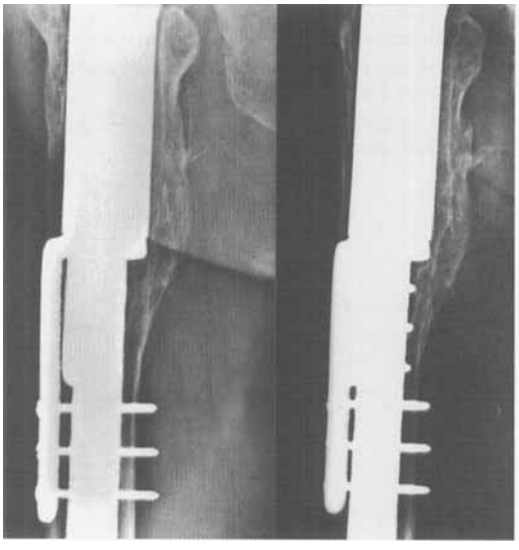
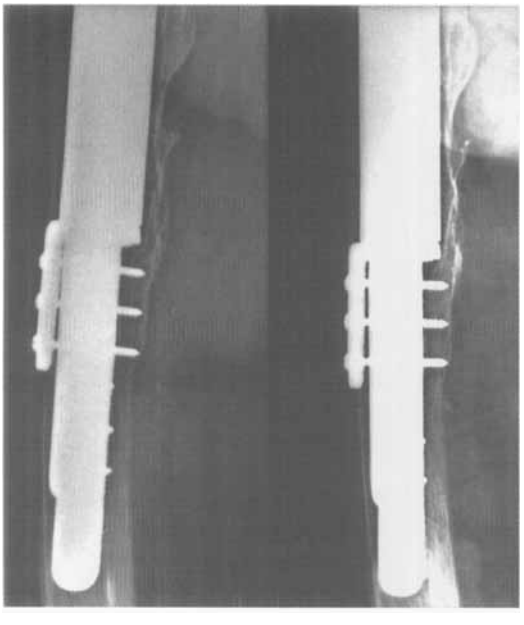
Figure 3 continued.

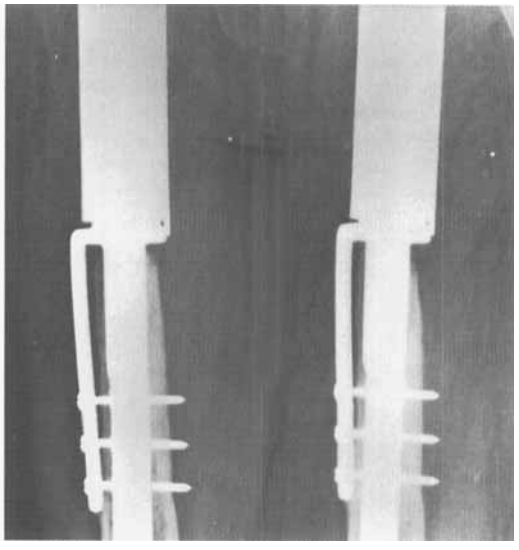


Bone bridge in the AP-view 12 (left) and 113 months postoperatively having excellent bridging without radiolucent lines at the site of the stem anchorage.



Axial view 12 (left) and 113 months postoperatively with an unchanged bone bridge.

Figure 4. A 60-year-old woman had a cemented THA 1983 and a Girdlestone hip for infection 1988.



Radiographs taken 1 and 2 years after implantation of KMFTR prosthesis 1990 show a progressive stress-shielding.

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