Bone grafting in cemented knee replacement

45 primary and secondary cases followed for 2–5 years

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From 1989 through 1993, we treated 36 knees in 30 patients by bone grafting (31 tibial and 14 femoral grafts) and a cemented total knee prosthesis. We used 23 morsellized and 22 solid bone grafts. After a mean follow-up period of 3 years, the mean clinical (IKS) knee score was 90. Radiographic signs of incorporation of the tibial bone graft were noted in 28 cases. Of the 8 solid femoral bone grafts, we observed twice a disintegration of the graft.

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Options to solve the problem of bone defects in total knee replacement surgery include bone cement, custom-made implants, metal wedges in modular total knee systems or bone grafting. For reasons of versatility, economy and policy we have used bone grafts, in combination with a cemented total knee prosthesis to restore normal bone stock. We report our results in 36 knees.

Patients and methods

We performed a prospective study of 36 knees in 30 patients (9 men and 21 women) with a mean age of 65 (39–87) years. The right side was affected in 13 cases, the left side in 13 cases and both sides in 5 cases. 16 patients had rheumatoid arthritis, 14 patients primary or secondary arthrosis. In 23 knees it concerned a primary replacement and in 13 knees a revision of a total knee prosthesis. The indications for revision were aseptic loosening (5 knees), septic loosening (4 knees), malpositioning (1 knee) and polyethylene wear with instability in 3 knees. 45 bone grafts were placed, 14 on the femoral side, 31 on the tibial side.

In 34 knees a nonconstrained total condylar knee prosthesis (Kinematic, Howmedica and PFC, Johnson & Johnson) was used and in 2 cases a constrained type (GSB, Allopro and PFC, Johnson and Johnson). On the tibial side there were small (11 knees), medium (6 knees) and large (14 knees) bony defects. A defect was considered small when it was less than 4 cm^3 and large when it was more than 10 cm^3.

Small defects were filled with one piece of cancellous bone. Medium and large noncontained defects were reconstructed with a piece of corticocancellous bone fixed with K-wires or screws. All other defects were filled with small pieces (0.5 cm) of morcellized cancellous bone and impacted into the defect (Table 1). The tibial bone grafts consisted of morsellized bone in 17 knees, of solid cancellous bone in 11 knees and of solid corticocancellous bone in 3 knees. On the femoral side, 2 small, 5 medium and 7 large bone grafts were used. In 6 knees a contained defect (cyst) was present, which was filled with morsellized graft. In the other 8 cases with a noncontained defect, the defect was reconstructed with a solid corticocancellous or solid cancellous graft and internal fixation. All prostheses were fixed with cement. Only the constrained type of prosthesis had an intramedullary stem fixation of the femoral component. In case 9 the entire stem was surrounded by bone graft.

Apart from patients with large and/or noncontained bone grafts all patients were allowed full weight bear-

Table 1. Type of tibial bone graft in relation to the size and containment of the defect

Size of tibial defect	No. of knees	Type of bone graft
Small		
contained	10	Solid cancellous
noncontained	1	Solid cancellous
Medium		
contained	4	Morsellized
noncontained	2	Solid corticocancellous
Large		
contained	13	Morsellized
noncontained	1	Solid corticocancellous

Table 2. Assessment of incorporation of the bone graft

	Radiographic aspect of the bone graft		
	Trabeculae	Border of the graft	Bone density
Evident incorporation	normal pattern	absent	normal
Unclear incorporation	not organized	vague	normal
Sclerosis of the graft	not organized	clear	increased
Disintegration	absent	–	–

ing 6 weeks postoperatively. Clinical and radiographic controls were performed 3, 6, and 12 months postoperatively, and yearly thereafter. Incorporation of the grafts was judged after a minimum of 1 year (Table 2). 2 patients had died for reasons not related to the surgery.

Results

At the latest follow-up after a mean postoperative observation period of 3 (1–5) years, the mean International Knee Score (IKS, Insall et al. 1989) was 90 (70–100) points in 35 knees. 1 knee was excluded because of early revision (case 13). In the 2 patients who had died, the IKS score at the time of their last visit was taken.

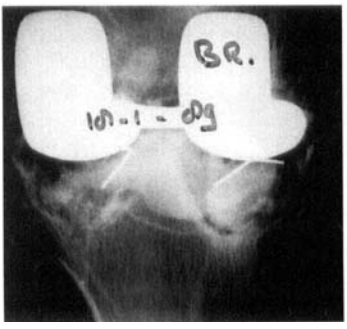
Radiographic evaluation revealed a clear incorporation of the tibial bone graft in 28 knees (Table 3 and Figure 1). Only 1 knee (case 12) showed a demarcation around the tibial component, without signs of migration. The knee score was 74.

In 3 out of 14 femoral bone grafts it was impossible to evaluate incorporation because the graft was located entirely behind the metallic prosthesis. In 9 knees there was an incorporation of the femoral graft, whereas 2 femoral grafts (1 patient operated on for bilateral septic loosening) had disintegrated, with loosening of the prosthesis. Radiographic signs of incorporation were observed after a mean period of 1 (0.5–3) year for the tibial grafts and 1 (0.5–2) year for the femoral grafts. We found no differences in ingrowth between allografts and autografts.

Discussion

Deficiency of bone stock in the proximal part of the tibia and/or distal part of the femur may be managed by different techniques, e.g., cement (Brooks et al. 1984), augmented tibial components, custom-made implants (Bartel et al. 1982, Brooks et al. 1984, Scuderi and Insall 1993) or bone grafting (Alexiades et al. 1989, Fipp 1989, Whiteside 1993). In primary cases as well as in revision surgery we prefer to use bone grafts. In our view, it is more natural to fill bone defects with bone. In case of future revisions, bone stock will probably be better preserved than in cases with only bone cement or augmented components. Therefore, both in primary and revision knee replacements one should not resect to the level of the defect on the tibial side, but build up the defect to the level of the cut (Dorr 1989, Hill and Philips 1992). Many defects on the tibial side in primary and revision cases are (semi)-contained (Dorr 1989, Wilde et al. 1990). This implies a bony rim sufficient to fill the

Figure 1. Case 17.



Geomedic knee prosthesis 16 years after implantation in the proximal tibia with massive bone loss.

Reconstruction with a cemented prosthesis and impacted morsellized bone graft.

4 years after revision the graft is incorporated in an almost normal bony structure.

Table 3. Observation in 36 cases of bone grafting in total knee arthroplasty

							Femoral grafts						Tibial grafts						
Case	F-U time	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	R	S	T
1	62	65	2	1	1	1							1	3	1	1	1	0	87
2	62	65	2	1	1	1							1	3	1	1	1	0	92
3	46	72	2	1	1	1	2	3	1	1	1	0	1	1	1	2	1	0	92
4	54	83	1	1	1	1							1	2	2	3	1	0	87
5	55	48	2	1	1	1							1	1	1	2	1	0	82
6	53	76	1	1	1	1	1	2	2	3	1	0							95
7	51	74	2	1	1	1							1	2	1	1	1	0	96
8	53	62	2	1	1	1							1	1	1	2	1	0	94
9	50	69	2	2	2	2	2	3	2	4	2	0	2	3	1	4	1+3	0	97
10	34	62	3	2	2	1	1	2	2	3	2	1							84
11	48	87	1	1	1	1							1	1	1	2	1	0	97
12	37	42	2	2	3	1	2	3	2	3	4	2	2	3	1	1	1	1	74
13	18	42	2	2	3	1	2	3	2	3	4	2	2	3	2	3	3	0	52
14	35	41	1	2	3	1	2	3	2	3	1	0	2	3	1	1	1	0	93
15	44	59	2	1	1	1							1	1	1	2	1	0	97
16	44	71	2	2	2	1							2	3	1	1	1	0	87
17	40	69	1	2	2	1	2	3	2	3	2	0	2	3	1	1	1	0	85
18	38	39	2	2	5	1	1	1	2	2	1	1							70
19	36	83	2	1	1	1							1	1	1	2	1	0	93
20	32	63	2	1	1	1							1	3	1	1	1	0	99
21	31	71	4	1	1	1	1	2	1	1	1	0							99
22	31	71	4	1	1	1	1	2	1	1	1	0							94
23	28	61	2	2	4	1							2	3	1	1	1	0	92
24	25	78	1	2	3	1	2	1	1	1	1	0	2	3	1	1	1	0	90
25	26	71	1	1	1	1							1	1	1	2	1	0	87
26	24	70	1	2	4	1							1	2	1	1	1	0	91
27	24	65	2	2	2	2							2	3	1	1	2	0	97
28	19	62	2	1	1	1							1	1	1	2	1	0	99
29	12	75	1	1	1	1							1	1	1	2	1	0	90
30	18	62	2	1	1	1	1	3	1	1	1	0	1	1	2	2	1	0	100
31	16	44	1	1	1	1							1	1	1	2	1	0	89
32	12	79	2	1	1	1							1	2	1	1	1	0	92
33	12	42	1	2	4	1							1	3	1	1	1	0	78
34	12	81	4	1	1	1							1	2	2	3	1	0	99
35	12	65	2	1	1	1	1	2	1	1	1	0	1	3	1	1	3	0	99
36	40	63	2	1	1	1							1	2	1	1	1	0	93

A Age at time of surgery
B Diagnosis
- 1 arthrosis
- 2 rheumatoid arthritis
- 3 hemophilic arthropathy
- 4 osteonecrosis

C Primary or revision surgery
- 1 primary
- 2 revision

D Indication for operation
- 1 degeneration
- 2 aseptic loosening
- 3 septic loosening
- 4 wear of polyethylene
- 5 malposition of prosthesis components

E Type of prosthesis used at index operation
- 1 non/semi-constrained total condylar
- 2 constrained prosthesis

F Source of the femoral bone graft
- 1 autologous
- 2 homologous
- 3 combination

G Size of the femoral bone graft
- 1 small, < 4 cm^3
- 2 medium, 4–10 cm^3
- 3 large, > 10 cm^3

H Containment of the femoral bone graft
- 1 contained
- 2 non-contained

I Structure of the femoral bone graft
- 1 morsellized
- 2 cancellous
- 3 solid corticocancellous
- 4 combination of morsellized and solid bone

K Radiographic incorporation of the femoral bone graft
- 1 incorporation
- 2 unclear incorporation
- 3 sclerosis of the graft
- 4 disintegration

L Radiographic signs of the femoral component
- 0 no
- 1 demarcation
- 2 migration

M Source of the tibial bone graft, see F
N Size of the tibial bone graft, see G
O Containment of the tibial bone graft, see H
P Structure of the tibial bone graft, see I
R Incorporation of the tibial bone graft, see K
S Radiographic signs of loosening of the tibial component, see L
T Knee score according to the International Knee Society

defect with a solid or morsellized bone graft (Whiteside 1993), which is a relatively simple procedure.

Our results show that morsellized bone grafting is successful in large tibial defects, with a radiographic incorporation of the graft in 11 out of 14 cases. In the

3 remaining cases diffuse sclerosis of the grafts was visible, but its clinical relevance is unknown.

Radiographic signs of incorporation of the tibial graft were usually present by 1 year, somewhat later than stated by Samuelson (1988). Strict criteria for graft incorporation at this time have not been established. We think our division in 4 groups is reliable, in which 3 radiographic aspects of the graft are assessed.

On the femoral side we used 8 solid corticocancellous grafts (7 medium or large-sized) of which 2 disintegrated. The solid grafts were necessary because of noncontainment of the defect. As shown in orthopedic oncology (Enneking and Mindell 1991) as well as in revision arthroplasties (Gerber and Harris 1986, Jasty and Harris 1990, Kwong et al. 1993), solid grafts are liable to disintegrate. It is because of our experience with impacted morsellized bone-grafting in cemented primary and revision hip surgery (Slooff et al. 1984, 1993, Buma et al. 1992, Schimmel 1993, Schreurs et al. 1994) that we prefer to use nonsolid grafts wherever possible.

In conclusion, we found a high percentage of incorporation of both solid and morsellized tibial grafts. Out of 8 solid femoral bone grafts we observed a disintegration of the graft in 2 cases.

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