Favorable results of acetabular reconstruction with impacted morsellized bone grafts in patients younger than 50 years

A 10- to 18-year follow-up study of 34 cemented total hip arthroplasties

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ABSTRACT – We report a long-term review of 41 acetabular reconstructions using impacted morsellized bone grafts and a cemented total hip arthroplasty (THA) in patients younger than 50 (22–49; average 38) years. Reconstruction was performed in 23 primary THA (19 patients) and 18 revision THA (17 patients). 3 patients were lost to follow-up and 3 (4 hips) died within 10 years of surgery; none had a revision. Thus, 34 hips (30 patients) were reviewed with an average follow-up of 13 (10–18) years.

In 2 hips, a revision was performed for aseptic loosening of the acetabular component 7 and 11 years after surgery. One additional cup was revised after 12 years during a femoral stem revision due to wear and matching problems, but was well fixed. The survival rate of the acetabular reconstruction technique was 94% (95% CI: 90–98%).

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The outcome of total hip arthroplasty (THA) in younger patients, with a cemented or a cementless hip design, is still disappointing (Chandler et al. 1981, Cornell and Ranawat 1986, Halley and Wroblewski 1986, White 1988, Dorr et al. 1990, Collis 1991, Barrack et al. 1992, Solomon et al. 1992, Boeree and Bannister 1993, Raut et al. 1996). The outcome of arthroplasty in young patients with preexisting acetabular bone stock loss can be expected to be even worse.

On the basis of reports by Hastings and Parker (1975) and McCollum et al. (1980), we started in 1979 to reconstruct bone-deficient acetabuli with impacted bone grafting and a cemented socket. (Slooff et al. 1984). Good results were obtained in a group of patients of widely varying ages (23–83 years) (Schreurs et al. 1998).

In this study, we evaluated the outcome of this technique used in patients younger than 50 years and with a minimal follow-up of 10 years.

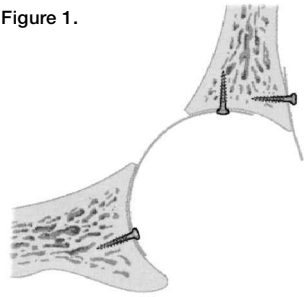
Patients and methods

All consecutive patients, both primary and revision THA, who were younger than 50 years at surgery and who had had an acetabular reconstruction with impacted morsellized cancellous bone grafts and a cemented cup and a minimum follow-up of 10 years were included in the study. We excluded 1 patient revised for a septic loosening 3 years after surgery. 36 (21 women) consecutive patients with 41 reconstructions remained (23 primary THA; 18 revision THA). The mean follow-up, excluding 3 patients lost to follow-up and 3 who had died, was 13 (10–18) years. The Harris hip score of the deceased patients averaged 90 (88–92) at the latest follow-ups 4, 6 and 8 years after surgery.

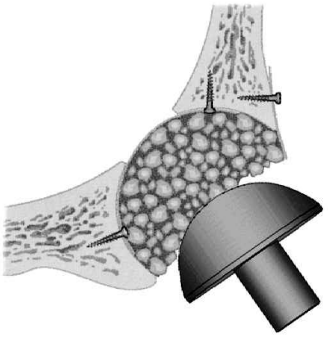
The mean age at surgery was 38 (22–49) years. Bilateral reconstructions were performed in 4 primary and 1 revision THA.

Indications for the 17 primary THA were primary osteoarthrosis (OA) in 2, secondary OA in 9

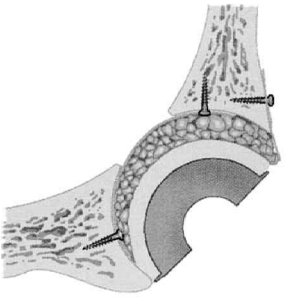
Figure 1.



Medial and peripheral wall defects are closed by a metal mesh and a contained defect is created.



This defect is filled with morsellized bone grafts. The grafts are compressed by impactors and a hammer.



After pressurizing of the cement, a cup is inserted.

and rheumatoid artritis (RA) in 6 hips. The indications for the acetabular revision were aseptic loosening in all 17 hips; 11 THAs, 5 resurfacing of prostheses and 1 hemiprosthesis, were removed. In 15 hips, this was the first revision and in 2 hips, the second revision. 6 surgeons were involved in the study.

Surgical technique

The posterolateral approach was used without trochanteric osteotomy. In revision THA, after removal of the components, samples from the interface were sent for frozen section analysis. If an infection was suspected, a 2-stage revision procedure was performed.

The acetabulum was reamed to create a bleeding trabecular bone-bed. If necessary, sclerotic areas were perforated by multiple drill holes (diameter of drill, 2 mm). Segmental defects in the medial wall of the acetabulum were closed with a slice of cortico-cancellous bone. The femoral head autograft was used in 15 of 17 cases with primary THA, in 1 hip, an iliac crest autograft and in 1 one hip, both an autograft of the iliac crest and an allograft were used. The femoral head allograft was used in 10 hips during revision, in 3 hips, an autograft of the femoral head was used in cases with a failed resurfacing prosthesis. 3 early revisions (before 1984) had an autograft alone from the iliac crest and in 1 other case, autografts and allografts were combined. The grafts were morsellized with a rongeur and cancellous bone chips with a diameter of 0.7–1.0 cm were created. A socket-trial prosthesis was used to distribute and impact the bone grafts with a hammer (Figure 1). The original center of rotation was reconstructed by impaction grafting, using the level of the transverse ligament as a reference. The last trial prosthesis used was made at least 2 mm larger than the proposed cup, to create a cement mantle of sufficient thickness. The impacted graft was covered with a thin vitallium wire mesh in 30 cases. After pressurizing the bone cement, a 32 mm polyethylene cup was inserted. The Müller cup was used in 24 hips, and an Allopro cup in the remaining 17 hips (Sulzer, Wintherthür, Switzerland). In primary THA, regular bone cement was used, while in the revision cases, we used the same cement, but with the addition of gentamicin (Palacos R or Palacos R with gentamicin; Merck, Darmstadt, Germany). Postoperative treatment included 6 weeks of bed rest for all the patients, systemic antibiotics for 5 days postoperatively, indomethacin for 7 days as prophylaxis against heterotopic ossification and oral anticoagulation therapy for 3 months. After 24 hours, passive motion exercises were allowed, followed by ambulation with partial weight-bearing after 6 weeks and full weight-bearing after 3 months.

Follow-up protocol

The Harris hip score (HHS) was used for clinical evaluation. In 6 patients, this score was obtained by telephone or by another orthopedic surgeon. 1 patient refused to cooperate for the HHS. As the preoperative HHS had not been recorded before the operation, we performed a rough recalculation based on 10 patient files and estimated the mean preoperative score at 45.

Serial radiographs were reviewed to classify the

Characteristics of the 34 hips treated with a bone graft and total hip arthroplasty

A	B	C	D	E	F	G	H	I	J	K	L	M
1	37	F	L	sOA	1	M	+	Cav	N	93	221	2
2	45	M	R	sOA	1+2	M	–	Cav	N	73	209	–
3	49	F	L	sOA	1	M	+	Com	N	92	208	1
4	27	M	L	sOA	1	M	+	Com	N	96	207	–
5	22	F	L	RA	1	M	+	Cav	N	100	184	1
6	23	F	R	RA	1	M	+	Cav	Y	–	77	3
7	34	F	R	RA	1	A	+	Cav	N	81	165	–
8	40	F	L	RA	1	A	+	Cav	N	83	163	–
9	43	F	R	sOA	1	M	+	Cav	N	83	161	–
10	38	M	R	sOA	1	A	+	Cav	N	100	152	–
11	47	F	L	sOA	1	M	–	Com	N	–	140	–
12	39	F	L	sOA	1	M	+	Cav	N	96	138	–
13	39	F	R	sOA	1	M	+	Com	N	99	137	–
14	23	F	L	sOA	1	M	+	Com	N	91	200	–
15	29	M	R	sOA	1	M	–	Com	N	93	185	–
16	31	M	R	pOA	1	A	–	Cav	N	60	171	1
17	37	M	R	RA	1	M	+	Cav	N	82	135	1
18	37	M	L	RA	1	M	+	Cav	N	91	135	–
19	34	F	R	sOA	2	M	+	Com	N	100	134	–
20	47	F	R	sOA	1	A	+	Cav	N	54	132	–
21	45	F	L	pOA	1	A	–	Cav	N	100	120	–
22	42	F	L	pOA	1	M	+	Seg	N	87	120	–
23	40	M	R	sOA	2	A	–	Cav	N	99	155	2
24	28	M	R	sOA	1	M	–	Cav	N	100	136	–
25	35	M	R	sOA	2	A	+	Cav	N	96	168	–
26	36	F	L	sOA	1+2	A	+	Com	N	97	157	–
27	30	F	L	RA	2	M	+	Com	Y	–	148	–
28	39	F	L	sOA	2	M	+	Com	Y	–	140	3
29	38	F	R	RA	2	A	+	Com	N	88	151	–
30	44	M	R	sOA	2	A	+	Cav	N	88	177	–
31	45	F	L	sOA	2	A	+	Com	N	100	172	–
32	43	M	L	sOA	2	M	+	Cav	N	100	127	–
33	41	M	L	sOA	2	M	–	Cav	N	–	153	–
34	38	M	L	sOA	2	A	–	Cav	N	45	131	–

A Case
B Age at time of operation
C Sex
D Side
E Primary diagnosis
  pOA primary osteoarthritis
  sOA secondary osteoarthritis
  RA rheumatoid arthritis
F Graft type
  1 autograft
  2 allograft
G Cup type
  M Müller
  A Allopro
H Mesh
I Defect
  Cav cavitary defect
  Seg segmental defect
  Com combined defect
J Revision of the cup
  N No
  Y Yes
K Harris hip score
L Follow–up, months
M Radiolucency
  1 non–progressive lines
  2 progressive lines in 1/2 zones
  3 progressive lines in 3 zones

defect in the acetabulum, to determine migration of the cup, the presence of radiolucent lines and the incorporation of the graft. The acetabular defects were classified by consensus among 3 of the authors (T.J.J.H.S., B.W.S., T.G. v T.) according to the classification of the American Association of Orthopaedic Surgeons (AAOS) Committee on the Hip (D'Antonio et al. 1989), using the pre- and postoperative radiographs and the surgical notes.

Radiographic data were complete in 33 hips and incomplete in 1 patient (1 hip). A cavitary defect was seen in 21 hips, a segmental defect alone in 1 and a combined cavitary-segmental defect was present in 12 hips. To determine the migration of

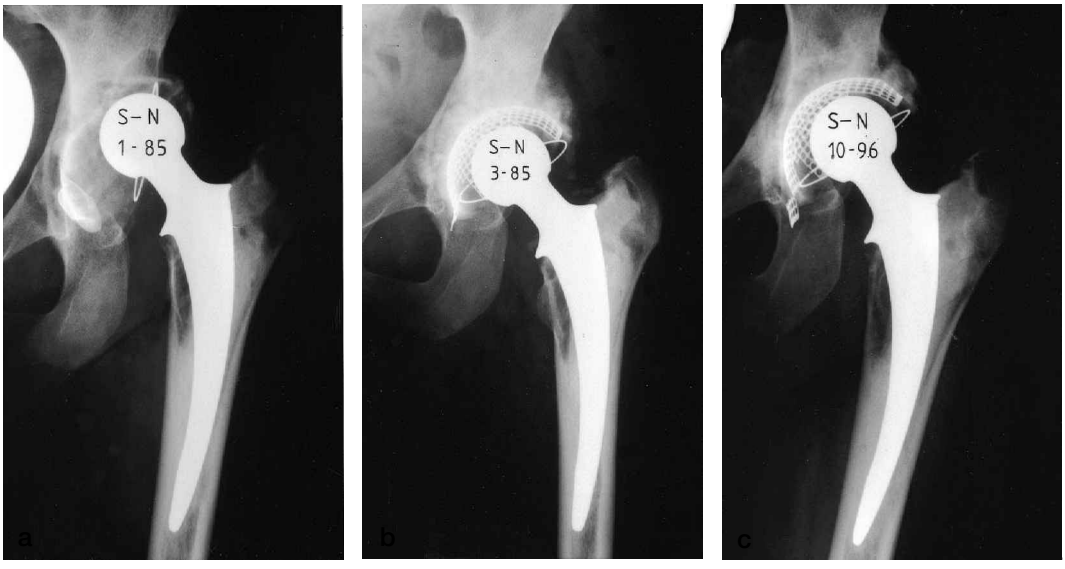


Figure 2. Case 27. Reconstruction after aseptic cup loosening in a patient with rheumatoid arthritis. Age at reconstruction 30 years. Preoperative (a), postoperative (b) and 11-year (c) follow-up views. No radiographic signs of aseptic loosening. However, the cup was changed 12 year postoperatively in a femoral revision for aseptic loosening due to matching problems and some polyethylene wear.

the component, the inter-teardrop line was used with Goodman et al.'s method (1988). Zones of radiolucency were assessed on the anteroposterior radiographs with the method of DeLee and Charnley (1976); a radiolucent line of more than 2 mm was considered positive. Clinical failure was defined as the need for revision of the acetabular component, for any reason. Radiographic loosening of the component was defined as radiolucent lines in all 3 zones or as migration of more than 5 mm in any direction on AP-pelvic views.

Results

Hip and pain scores

At a mean follow-up of 13 (10–18) years, the mean HHS was 89 (54–100). 2 patients (cases 20 and 16) with a HHS of 54 and 60 had moderate pain. No patient had severe pain.

Cup revisions

3 acetabular reconstructions were revised. 2 were revised for aseptic loosening at 7 and 11 years after reconstruction (cases 6 and 28). These failures occurred in 1 primary THA and in 1 revision THA. The third cup was removed during a femoral stem revision for aseptic loosening because of matching problems with the new femoral head and polyethylene wear (case 27; Figure 2). However, this cup was peroperatively well fixed and not loose on radiographs.

Other re-operations and stem revisions

During follow-up, 2 stems were revised, both for aseptic loosening; in 1 hip, only the stem was revised (case 25), in the other, the stem was removed including the still well-fixed cup, as mentioned previously (case 27). No further re-operations were performed.

The survival rate regarding aseptic loosening at 10 years was 97% (95% CI: 94–100%). At 13 years, the survival rate was 94% (95% CI: 90–98%) due to 1 additional failure that caused aseptic loosening at 11 years after re-operation. Using cup revisions for aseptic loosening and radiographic failure as end point, this percentage remained 94%.

In a worse case scenario, considering all losses to follow-up as failure, the survival rate was 86%.

Radiographic analysis

Most hips had a stable radiographic appearance with uniform radiodensity of the graft and host

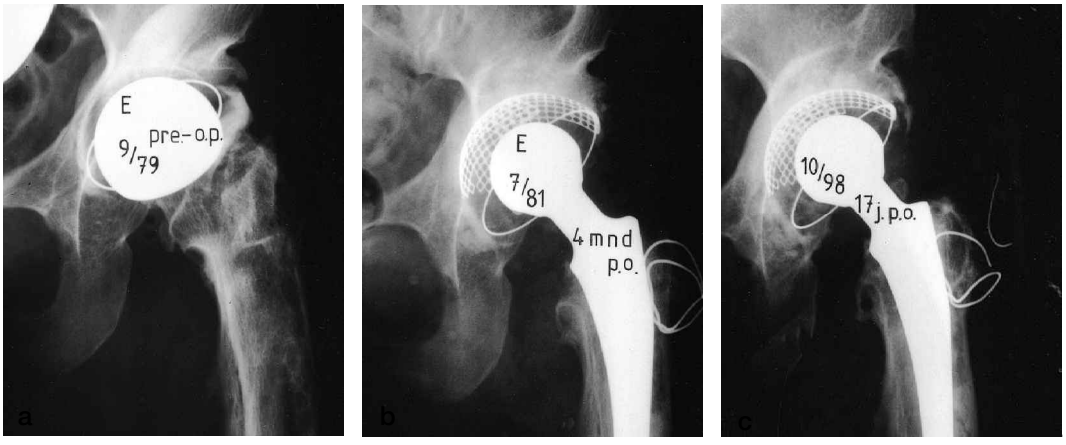


Figure 3. Case 14. Before and after acetabular reconstruction using a morsellized graft, wire mesh and cement. A woman aged 23 years was reconstructed in 1981 after a failed hemisurfacing prosthesis with protrusio. Pre-operative (a), postoperative (b) and 17-year follow-up (c) views show the incorporation of the reconstruction with no radiolucency.

bone (Figure 3). In 1 hip (case 3), the acetabular component tilted and migrated 13 mm within 2 months after the operation, but then remained stable; this was not recorded as radiographic failure. The cups revised for aseptic loosening showed progressive radiolucent lines within 2 years after operation. 6 other hips showed radiolucent lines. In 4 hips, such lines were seen on radiographs immediately after surgery, but they did not change. In 2 hips, we found progression in 1 or 2 zones.

Discussion

Although the average age of our patients was substantially lower than in 2 previous studies (37 vs. 56 and 59 years), the survival rate as regards aseptic loosening is comparable. (Schreurs et al. 1998, Welten et al. 2000)

One may object that the outcome of our study was strongly affected by the high number of patients with rheumatoid arthritis who did not overload their THA. In that respect, Rosenberg et al. (2000) showed favorable results with morsellized bone grafting in cases with protrusio acetabuli due to rheumatoid arthritis. However, both Chmell et al. (1997) and Malchau et al. (1993) stated that the survival of THA in young women with RA was lower than that in women with arthritis younger than 50 years.

Conn et al. (1985) suggested radiographic criteria to assess bone graft incorporation. In our opinion, these are difficult to interpret. Incorporation cannot be proved on standard AP radiographs, only histological examination is conclusive. Heekin et al. (1995) showed incorporation of morsellized bone grafts on the acetabular side in retrievals. We studied 9 human core biopsies from 8 patients who had had acetabular reconstruction with impaction grafting (Buma et al. 1996). Histology showed, with time, a complete consolidation, revascularization and incorporation of the graft. This incorporation process was also seen in impaction grafting studies on both the acetabular and femoral sides in a realistic goat model (Schreurs et al. 1994, Schimmel et al. 1998). The incorporation of impacted bone grafts was not hampered by bone cement, as suggested by Hungerford and Jones (1988). Incorporation of the bone graft, despite the contact with bone cement, had already been reported by Roffman et al. (1982, 1983).

These long-term results of acetabular impaction grafting in young patients are satisfactory, but the technique is demanding. Impaction must be tight enough to create stability. Grafts were always made by hand with a rongeur to create chips of a substantial size. The use of bone mills is tempting, but most of them create smaller chips. Few data are available on the effect of chip size on stability in the acetabular side. Recently, we performed an in vitro loading experiment on human pelvic bones, using bone chips created by a rongeur or a bone mill (Verdonschot et al. 1999). We conclud-

ed that acetabular stability was improved and less surgeon-dependent when larger bone chips were used. Another concern is the reported application of this technique using bone processed in different ways. The mechanical behavior of freeze-dried bone or radiated bone may not be comparable to that of the fresh-frozen grafts which we used. Besides, the incorporation capacity may be affected by the processing method.

Finally, the role of postoperative treatment is not clear. All our patients had a strict protocol of bed rest for 6 weeks. Nowadays, most of our patients are mobilized on crutches after a 2-week rest period. However, the period of immobilization must be adjusted to the extent of the preoperative bone stock loss.

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