Acetabular revision with allograft bone

103 revisions with 3 reconstruction alternatives, followed for 0.3–13 years

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We reviewed 103 consecutive acetabular revisions in 92 patients, for whom allograft bone and 1 of 3 alternative acetabular components had been used: Harris-Galante cup (HGC, 38 hips), Müller acetabular roof reinforcement ring (ARR, 39 hips), or Burch-Schneider antiprotrusio reinforcement cage (APC, 26 hips). The mean follow-up was 4.5 (0.3–13) years.

7 HGCs, 1 ARR, and 1 APC required revision because of aseptic loosening. Using the endpoint revision because of such loosening, the HGC gave 73% survival after 8 years, the ARR 89% after 13 years, and the APC 94% after 11 years. Using a worst-case criterion, survival was 69% for the HGC after 8 years, 84% for the ARR after 13 years, and 83% for the APC after 11 years. Radiographic incorporation of the allograft, no resorption of the allograft, use of a bulk allograft, male gender, and implantation of a reinforcement device were associated with a lower mechanical failure rate.

Good durability of allograft bone in reconstructions of bone deficiencies in acetabular revision surgery can be expected when the implant can bridge the temporary period of mechanical weakness of the allograft. Therefore, in severe acetabular deficiencies, reinforcement devices with sufficiently stable fixation in the host bone should be preferred.

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Acetabular revision arthroplasty may well be the most challenging of all arthroplasty surgery (McGann et al. 1988). After revision for acetabular loosening, radiographic loosening occurs in up to 50% of the cases after a follow-up of 4.5 years if there is no biological augmentation of the deficient bone (Kavanagh et al. 1985). Therefore, bone-grafting is thought to be necessary for long-lasting results (Morscher et al. 1989, Postel 1989, Morsi et al. 1996b). The use of allografts continues to be controversial. Whereas some authors have seen an overall success rate of only 28% at 2.5 years (Hoikka et al. 1993), a cumulative survival of 54% at 8 years (Jasty and Harris 1990) decreasing to about 30% at 13 years (Kwong et al. 1993), or a survival of 56% at a mean of 4 years (Hooten et al. 1994), others have reported a survival of about 90% after a mean of 5 and 12 years (Paprosky and Magnus 1994, Morsi et al. 1996b).

In 1984, we started to use allografts for the reconstruction of severe acetabular defects in revision hip arthroplasty. We reviewed the outcome with regard to radiographic course and survivorship.

Patients and methods

Between January 1984 and March 1996, we performed 103 revision arthroplasties (51 right hips) of the acetabular component with bone allografting and 1 of 3 acetabular alternatives: 1) Harris-Galante cup (HGC) (Lachiewicz and Hussamy 1994), 2) Müller acetabular roof reinforcement ring (ARR) (Gurtner et al. 1993) or 3) Burch-Schneider antiprotrusio reinforcement cage (APC) (Schneider 1980). The HGC was used in 38 hips, the ARR in 39, and the APC in 26.

The operations were performed on 92 patients by 5 surgeons. No patient was excluded from the study. 72 revisions were performed on women and 31 on men. At the time of revision, the mean age of the patients was 61 (31–86) years. Their average weight was 69 kg, 77 (65–100) kg for men and 66 (43–100) kg for women. 9 patients received corticosteroids because of rheumatoid arthritis (4 patients) or other diseases (5 patients) like rheumatic polymyalgia or bronchial asthma. Diclofenac prophylaxis (150 mg/day) against heterotopic

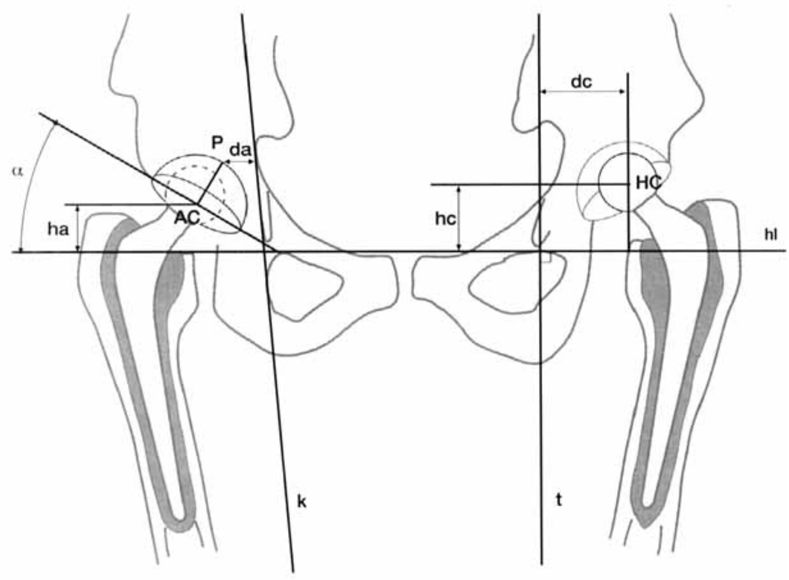


Figure 1. Schematic drawing of an anteroposterior radiograph of the pelvis, showing how the position and migration of the hip center and the acetabular component were assessed.

hl horizontal reference line,
k Köhler line,
AC center of the acetabular component,
ha cup height,
da horizontal distance between P and Köhler line,
α cup angle,
t perpendicular through the tear drop,
HC hip center,
hc height of the hip center,
dc horizontal distance of the hip center.

ossification was given to 50 patients for 2–6 weeks.

The indications for revision were painful aseptic loosening in 94 hips, septic loosening in 6 hips (*Staphylococcus epidermidis* in 5 cases, *Pseudomonas* in 1 case), and in 3 cases, a second stage reimplantation after deep infection (in 1 case, intraoperative culture at reimplantation operation was still positive for *Enterococcus faecalis*). The revision of the cup was the first revision in 75 hips, the second revision in 22, the third revision in 4, and the fourth revision in 2. The initial diagnosis had been arthrosis in 56 hips, developmental dysplasia of the hip (DDH) in 21, fracture in 14, rheumatoid arthritis in 8, slipped capital femoral epiphysis in 3 and osteonecrosis of the femoral head in 1.

Bulk allografts were used in 55 cases, morselized allografts in 15, and combined in 33. The ARR and APC were fixed by 4.5 mm cortical screws or fully threaded 6.5 mm cancellous screws. A polyethylene cup was fixed in the ring or cage with cement. As fixation of the ARR and APC to bone is done with screws, it is defined as an uncemented type of fixation (Zehntner and Ganz 1994). When bulk allografts were used in conjunction with HGC, the allografts were fixed with screws. In conjunction with reinforcement devices, bulk and morselized allografts were fixed between the host bone and reinforcement device. Only frozen femoral heads, harvested at primary THRs and stored at –70 °C, were used. The bone banking practice followed the guidelines laid down by the "Wissenschaftlicher Beirat der Bundesärztekammer" (Vilmar and Bachmann 1996).

The preoperative acetabular defects were classified using the system of the American Academy of Orthopaedic surgeons (D'Antonio et al. 1989) and the system proposed by Paprosky et al. (1994). The classification was based on the preoperative radiographic appearance and descriptions of deficiencies in the operation notes.

Radiographic results were evaluated by comparing an anteroposterior radiograph of the pelvis made in the immediate postoperative period with the most recent radiographs. The radiographic measurements used are illustrated in Figure 1.

Allografts were assessed for union to host bone, as evidenced by trabecular bridging of host-graft interface, fragmentation and radiolucent lines (Morsi et al 1996b), as well as return of graft density to normal (Azuma et al. 1994). A clear reduction in density or breakdown of the transplanted bone was defined as bone resorption (Kondo and Nagaya 1993). Radiolucent lines were recorded in the 3 zones of DeLee and Charnley (1976).

The patients were followed for a mean of 4.5 (0.3–13) years. We performed survival analyses up to 1997, using the following endpoints: infec-

Table 1. Defect classification of 103 acetabular revisions with allogeneic bone

	Paprosky and Magnus						AAOS				
	1	2A	2B	2C	3A	3B	1	2	3	4	5
HGC (n 38)	2	1	5	15	6	9	14	6	17	1	0
ARR (n 39)	0	5	13	7	5	9	10	4	22	3	0
APC (n 26)	0	0	3	3	7	13	3	1	18	4	0
All (n 103)	2	6	21	25	18	31	27	11	57	8	0

tion, revision of the cup because of aseptic loosening, revision of the cup because of infection or aseptic loosening, and the "worst case", defined as revision of the acetabular component for any cause and/or deep infection and/or loss to follow-up. We used the Kaplan-Meier method and present the survival curves, with 95% confidence intervals. The p-value for non-crossing survival curves was calculated by the log-rank test and for crossing curves by the Wilcoxon test.

Results

In 101 of 103 operations, follow-up data were available. 2 patients came from abroad and returned to their homes 4 months postoperatively, and only a follow-up period of 4 months was possible. 5 patients died of unrelated causes after 0.5 years (2 patients), 2 years, 4 years, 5 years and 6 years. The data of these patients were included up to their last follow-up. The average follow-up was 4.2 (0.3–8) years for the HGC, 4.2 (1–13) years for the ARR, and 5.3 (0.5–11) years for the APC.

Complications

In 7 cases, a transient femoral nerve (3 patients) or peroneal nerve (4 patients) palsy occurred. 1 patient had a dislocation and 1 patient an intraoperative clotting disorder. 11 patients developed heterotopic ossifications.

In 7 patients, intraoperative cultures were positive: *Staphylococcus epidermidis* (5), *Pseudomonas* (1), *Enterococcus* (1). 4 deep infections occurred after 3 weeks, 2 years, 2 years, and 6 years, respectively (infection rate: 3.9%). The infection 3 weeks postoperatively (*Corynebacterium*) was successfully treated with irrigation and antibiotics. 1 infection with *E. coli* after 2 years was also treated successfully with antibiotics. In 2 other infections (2 years: *Pseudomonas*, 6 years: no positive test), removal of the implants was necessary. No reinfection was seen in the 9 patients with septic loosening or second-stage implantation after chronic deep infection.

Table 2. Radiolucent lines and revisions

Zone of radiolucent lines	Number of cases	Aseptic revisions
Zone I	5	2
Zone II	0	0
Zone III	14	2
Zones I and II	1	0
Zones I and III	0	0
Zones II and III	1	0
Zones I–III	1	0
All	22	4

Radiographic evaluation

The results of the preoperative classification of defects indicate that with increasing defects more stabilizing acetabular components were used (Table 1). The postoperative inclination averaged 41 (12–78) degrees. The average hc was 29 mm (range, 10 mm below hl to 72 mm above hl), indicating the tendency to a higher positioning of the hip center than in the normal hip (14 mm) (Rusotti and Harris 1991). The average distance dc was 33 (15–56) mm (lateral to t), which was 4 mm medial to the normal position, according to Rusotti and Harris (1991). A migration of the cup, according to the above-mentioned criteria, was seen in 13 sockets. Of these, 9 sockets (7 HGCs, 1 ARR, 1 APC) were revised because of aseptic loosening. In 4 APCs with radiographic migration (defects: Paprosky 3B: 3 cases, 2C: 1 case; allografts: bulk and morzelized combined: 3 cases, morselized: 1 case), no revision was necessary until the most re-

Table 3. Data of cases revised for aseptic loosening

Case	Gender	Age	Defect (Paprosky)	Acetabular component	Type of graft	Time to revision years
1	f	48	3a	HGC	b/mo	5
2	f	57	3b	HGC	b/mo	7
3	f	66	3a	HGC	mo	2
4	f	41	2c	HGC	b	0.5
5	f	70	2b	HGC	b/mo	0.75
6	f	52	3b	HGC	b	0.5
7	f	72	2a	HGC	mo	0.25
8	f	51	3a	ARR	mo	6
9	f	75	3a	APC	b	4

b bulk allograft, mo morselized allograft

Table 4. Cumulative survival after acetabular revisions with allografts, in percent with 95% confidence intervals (CI)

Failure definition	HGC, 8 years	ARR, 13 years	APC, 11 years
Deep infection	100	94 (87–100)	88 (73–100)
Removal of the cup for any cause	73 (52–93)	86 (66–100)	87 (70–100)
Removal of the cup because of aseptic loosening	73 (52–94)	89 (68–100)	94 (84–100)
Worst case (removal of the cup and/or infection and/or lost to follow-up)	69 (49–89)	84 (63–100)	83 (65–100)

cent follow-up 2 years, 4 years, 5 years and 6 years postoperatively. The average migration in cranial direction was 2.3 mm (range, 11 mm caudally to 13 mm cranially), in medial direction 0.2 mm (range, 12 mm medially to 10 mm laterally), and the average inclination increased by 1° (range, –17° to 25°).

Allografts were assessed for union to host bone in 84 reconstructions at between 3 and 24 months postoperatively, being 5.4 months on average in morselized allografts and 6.0 months in bulk allografts. Aseptic loosening occurred in 4 of 19 cases without clear radiological signs of bony consolidation. Radiolucent lines developed in 22 cases with an average width of 2.3 (1–6) mm, and in 4 of these 22 cases, revision was necessary (Table 2). In 13 cases, resorption of the allograft was radiographically evident, mostly at the acetabular rim, but sometimes osteolytic zones between allograft and pelvic bone were also seen. In 3 of these 13 cases, aseptic loosening occurred.

Survivorship analysis

11 of 103 acetabular components had to be revised during the follow-up period. In 9 cases, the indication for revision was aseptic loosening (Table 3) and in 2 cases, deep infection. Cumulative survival of all acetabular components was 82% after 13 years (Table 4). Using the endpoint deep infection, cumulative survival was 94% after 13 years. Using the worst-case criterion, survival was 69% for the HGC after 8 years, 84% for the ARR after 13 years, and 83% for the APC after 11 years. In the ARR and APC, there was no reduction in survival after the sixth year. Using the endpoint revision because of aseptic loosening, the HGC had a 73% survival after 8 years, the ARR 89% after 13 years and the APC 94% after 11 years (Figure 2).

When comparing the three types of defect, according to the classification of Paprosky et al. (1994), and the 4 types, according to the classification of the AAOS (there was no type V defect), no significant difference was detected with regard to survival. In both Paprosky type 1 defects, HGC

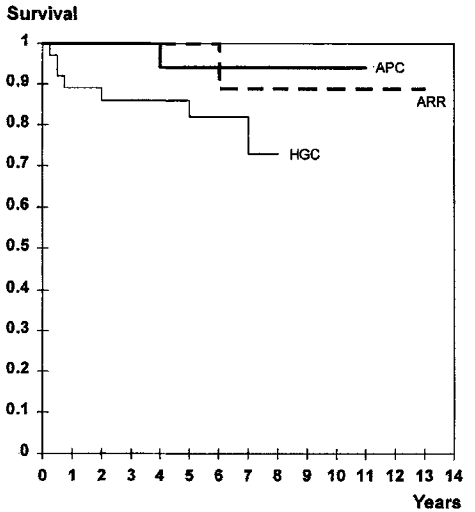


Figure 2. Survival analysis of the three acetabular components HGC, ARR, and APC (failure definition: revision because of aseptic loosening).

Table 5. Positive influence of different factors on mechanical outcome

Factor	P-value
Defect	
Paprosky types 1,2,3	0.2
D'Antonio types 1,2,3,4	0.5
Body weight (>70 kg)	0.2
Male gender	0.03
Implant	
ARR versus HGC	0.05
APC versus HGC	0.08
APC versus ARR	0.9
Vertical anatomic position	0.8
No radiolucent lines	0.5
Radiographic incorporation of allograft	0.002
No resorption of allograft	0.03
Bulk or combined versus particulate allograft	0.05
Bulk versus particulate allograft	0.04
No cortisone	0.06

The p-value for non-crossing survival curves was calculated by the log-rank test and for crossing curves by the Wilcoxon test

was used and there was no failure. 3 of the 21 Paprosky type 2 defects, in which HGC had been used, failed (14%), whereas none of the 31 Paprosky type 2 cases in which a reinforcement device had been used, failed (ARR: 25, APC: 6). In Paprosky type 3 defects, 4 of 14 HGCs failed (27%), whereas only 1 of 14 ARRs (7%) and 1 of 20 APCs (5%) failed.

We investigated the influence of various factors on mechanical failure of the acetabular component (Table 5): Cumulative survival of the cups of patients with less than 70 kg body weight (n 47) was only 72% compared to 96% in the heavier patients (n 56). All 9 cases of mechanical failure occurred in female patients. Considering the failure definition of revision because of aseptic loosening, cumulative survival of the 72 acetabular components of female patients was 77% after 13 years, compared to 100% of the 31 components in male patients.

Rusotti and Harris (1991) defined a high hip-center as 35 mm superior to hl. Using this definition, we found a high hip-center in 30 cases, and cumulative survival of these 30 hips was 74% after 11 years, compared to 88% after 13 years in the other 73 hips. The cumulative survival in hips with development of radiolucent lines was 64%, compared to 92% in hips without radiolucent lines. Revisions were necessary only in cases with radiolucent lines which showed an increasing width. Survival of incorporated allografts was 91% after 13 years, whereas survival of the 17 cases without bony incorporation was 74% after 13 years. Survival of the 13 cases with resorption of the allograft was 64% after 13 years, compared to 88% of the cases without resorption. Cumulative survival of cups with bulk allografts alone was 86% after 13 years, of cups with bulk allografts combined with morselized allografts 88% after 13 years, whereas survival of cups with only morselized allografts was 68% after 8 years.

Discussion

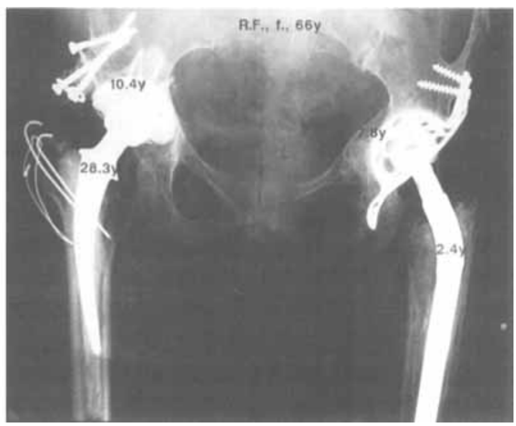
Reconstruction of severe acetabular deficiencies may be one of the main problems in revision THR. Bulk filling of defects with cement resulted in early cemented acetabular loosening (Callaghan et al. 1985). Using a mathematical approach, anterior, medial, and inferior cup positions may be ideal (Johnston et al. 1979). Yoder et al. (1988) showed that the risk of femoral loosening was related to cup height, cup horizontal distance, and cup height and horizontal distance combined, whereas the risk of acetabular loosening was not related to

Figure 3. This woman developed coxarthrosis on both sides, after an epiphysiolysis capitis femoris. At the age of 38 years, a THR was necessary on both sides within 1 month.

11 years after the THRs, aseptic loosening of the left cup, with perforation of the medial wall of the acetabulum had occurred. Revision of the acetabular component was performed. After reconstruction of the medial wall by means of autogenous bone, a cemented cup was implanted.

The radiograph, made about 18 years after the THR, showed aseptic loosening of the cup on the right side. A bulk allograft was fixed by screws for reconstruction of the combined defect and a HGC was implanted.

The radiograph, made 1.8 years after revision of the right side, and about 9 years after revision of the left side again showed aseptic loosening of the left cup, with a Paprosky 3B defect. After reconstruction of the bone stock with bulk allografts, an APC was implanted. 5.5 years later, revision of the loose left stem became necessary.



Radiograph made 28 years after the primary THR. There are no radiological signs of loosening of the implants which have been in situ 28 years (right stem), 10.4 years (right cup), 7.8 years (left cup), and 2.4 years (left stem). The allogenous bone shows good radiological incorporation.

cup position. Treatment of combined acetabular defects with cementless centric or eccentric components in revision THR was followed by a mechanical failure rate of 26%, at an average follow-up period of 4 years (Sutherland 1996). Allografts have yielded excellent short- or intermediate-term results when restoring bone stock and correctly positioning the cup (Samuelson et al. 1988, Jasty and Harris 1990). Using bulk femoral allografts and cemented polyethylene cups, Harris and his group reported cumulative survival rates of 100% at 3.6 years, 54% at 8 years, and only about 32% at 13 years (Jasty and Harris 1990, Kwong et al. 1993). Concern about the long-term durability of bulk femoral head allografts prompted some authors to recommend placing the cup at a high hip-center to avoid the use of bulk allografts (Rusotti and Harris 1991, Schutzer and Harris 1994). High placement of acetabular components in revision THR, however, is thought to be an option only in the elderly patient with a low activity level, because at a follow-up period of 3 years, this tech-

Table 6. Survival after acetabular allografting in revision hip arthroplasty with aseptic loosening as endpoint

Author	N	Cup	Follow-up mean (range)	Cumulative survival year	%	Overall succes rate year	%	Defects/Grafts
Present study (1999)	103	All types	4.5 (0.3–13)	13	85	4.5	89 [a]	
	38	HGC		8	73	4.2	82 [b]	
	39	ARR		13	89	4.2	97 [c]	
	26	APC		11	94	5.3	96 [d]	
Schreurs et al. 1998	60	C+ PE [e]	11.8 (10–15)				94	Type [f]: II–37, II–23 morselized allo- and autografts
Massin et al. 1998	81	ARR	8 (5–14)	11	55			Type: I–7, II–18, III–52, IV– 4; bulk femoral head allografts
Garbuz et al. 1996	25	PCA [g]					92	morselized allografts
	16	Müller [g]	6.7 (5–12)				100	morselized allografts
	10	Bipolar [g]					70	morselized allografts
	29	Various [h]	7.1 (5–12)				86	bulk allografts
	33	Various [i]	7.1 (5–11)				55	bulk allografts
Morsi et al. 1996a	16	C– porous [j]				6.5	94	bulk allografts
Morsi et al 1996b	29	C+ and C–				7.1	86	bulk allografts
Peters et al. 1995	28	APC	2.6 (2–4.9)	4.9	100	2.8	100	Type: I–1, II–5, III–22; cancellous allograft
Hooten et al. 1994	31	C–mod.scr. [k]	4.2 (2.5–5.9)			3.8	56 [l]	bulk allografts
Lachiewicz et al. 1994	60	HG I	5 (2–8)				100	Type: 0–7, I–7,II–25, III–21; bulk and morselized allograft
Zehnter & Ganz 1994	27	ARR	7.2 (5.5–10)	10	80			morselized
Hoikka et al. 1993	18	Threaded cup	2.5 (1.1–4.2)			2.5	28	bulk femoral head allografts and autogenous bone
Gurtner et al. 1993	150	ARR	7 (6–14)	10	74			morselized allografts
Kwong et al. 1993	30	C+ PE	10 (8–13)	13	32	10	53	bulk femoral head allografts
Gross et al. 1993	32	C– [g]	3.8				94	morselized allografts
	15	ARR [g]	3.8				100	morselized allografts
	11	Bicentric [g]	3.8				64	morselized allografts
	22	Various [h]	3.4				86	bulk allografts
	28	Various [h]	3				71	bulk allografts
Pollock & Whiteside 1992	20	C–	> 2				65	bulk allografts
Berry & Müller 1992	20	APC	5 (2–11)				70	bone grafts
Itoman et al. 1992	8	Ring–	4.6 (1–9)			no migration	25	allogenous cancellous bone blocks with chips
	17	Ring+				no migration	88	
McFarland et al. 1991	81	Bipolar	16 (12–36)			16 m	87	bulk and morselized allografts
Jasty & Harris 1990	38	C+ PE	5.9 (4–9.1)	3.6	100			revision THR-29, primary THR-9
				8.1	54			
Emerson et al. 1989	37	Bipolar	2.3 (1–4)				86	morselized and bulk allografts
	13	Threaded	3.3 (1.3–4.7)				69	morselized and bulk allografts
	46	PP?	1.8 (1–2.7)				100	morselized and bulk allografts
	7	C+	1.4 (1.1–2)				29	bulk allografts
Samuelson et al. 1988	37	Ring+				1.5	100	morselized allo- and autografts

[a] Worst case survival 78%; worst case success rate 85%
[b] Worst case survival 69%; worst case success rate 76%
[c] Worst case survival 84%; worst case success rate 92%
[d] Worst case survival 81%; worst case success rate 86%
[e] C+ cemented, PE polyethylene cup
[f] Defect type according to AAOS
[g] Contained defects
[h] Minor column defects
[i] Major column defects
[j] C– cementless
[k] Modular cup with screws
[l] Radiographically

nique was associated with high loosening rates, with 25% in the femur and 5% in the acetabulum (Kelley 1994). There is unanimous agreement that the surgeon should strive to place the hip center at the anatomical position whenever possible. In severe cranial defects, however, restoration of the anatomical hip center can be achieved only by massive allografts. The consequence of this technique would be that the implant mainly had contact with the allograft and, during the period of its temporary weakening, mechanical protection of the transplant by means of a sufficiently stable fixation of the implant in the host-bone might not be available. In these cases, we therefore prefer only moderate correction of the hip center, but rigid fixation of the implant in the cranial host bone.

In 1984, the place for allografts was uncertain also because of possible bacterial contamination (Elson 1984). In our series, there was only one early infection. The other 3 infections occurred 2–6 years postoperatively. In the series of Gross et al. (1993), the overall deep sepsis rate was 6.8% for the solid allografts and 3.4% for the morselized allograft group. Both in the series of Samuelson et al. (1988) (37 hips) and Jasty and Harris (1990) (38 hips), no deep infection was reported. Considering the infection rates of about 3.3% after a second revision and 11% after a third revision using cemented techniques (Retpen et al. 1992), the risk of bacterial infection after acetabular revision with allograft bone seems to be similar to THR revision without allografting.

Our experiences with acetabular allografting in revision THR confirm the encouraging results of some recently published studies (Zehntner and Ganz 1994, Peters et al. 1995, Morsi et al. 1996a, b) (Table 6). However, when analyzing our results in detail, we conclude that the answer to the place for allografts in the treatment of severe acetabular deficiencies must be a differentiated one.

The cumulative survival of 89% for the ARR after 13 years and of 94% for the APC after 11 years clearly show that breakdown of the allografts after a period of about 4–6 years, as assumed by some authors (Jasty and Harris 1990, Kwong et al. 1993, Hooten et al. 1994), is not inevitable. On the contrary, since no further mechanical failure of the ARR occurred after the sixth year and of the APC after the fourth year, there is good reason to believe that, after the initial weakness of the construct, stability of the acetabular bed may even increase by creeping substitution of the allograft.

The reconstruction—being composed of the load-bearing host bone, allograft, and implant—will be successful only if the whole compound is stable and remains stable. Considering the various possibilities of failure, we can distinguish 3 biomechanical situations:

1. Primary stability is insufficient. In such cases, mechanical failure will occur within a few weeks or months. In our HGC series, 4 cups failed in the first year and, after analyzing the postoperative radiographs, we realize that primary stability was insufficient in all these cases.

2. Primary stability is sufficient, but stability of the whole reconstruction for the most part depends on the structural integrity and biomechanical stability of a bulk allograft. The cases presented in the paper by Kwong et al. (1993) may represent a similar biomechanical situation. The fixation of threaded cups, which do not permit improvement in stability of the implant by means of transacetabular screws, may be weaker than cemented cups or than in press-fit cups with additional transacetabular screws (Hoikka et al. 1993). In all these cases, the failure theoretically may occur not before some years postoperatively.

3. If the implant can bridge the initial period of mechanical weakness of the reconstruction by means of a sufficiently stable anchorage in host bone, from the biomechanical viewpoint a permanently stable situation can be expected. One may assume that replacement of the transplant by new bone may result in increasing stability of the bony acetabular bed.

In our series, bulk allografts alone or in combination with morselized allografts had a better outcome than morselized allografts alone. This fact, however, cannot be discussed without considering the above-mentioned criteria for mechanical stability. Schreurs et al. (1998) had excellent long-term results in acetabular reconstruction with impacted morselized cancellous autogenous and allogenous bone grafts and cement. The majority of their patients had cavitary defects and their technique is obviously an excellent one for reconstruction of cavitary and limited segmental defects. In large segmental or combined defects, it may be very difficult to achieve enough primary stability with this technique.

Our results have led to the following policy for acetabular revision. Cementless standard cups like the HGC, even if they give excellent results in primary THR (Böhm and Bösche 1998), are used only for cavitary or small segmental defects, i.e., Paprosky type 1 and selected type 2 defects. The extent of the deficiency should not exceed the minimally required host-bone support of a standard cup. Well-fixed transacetabular screws may be necessary for sufficient primary stability, because good press-fit, followed by bone ingrowth within a short time is difficult to achieve in acetabular revision. Paprosky type 3 defects are managed with reinforcement devices. Apart from the larger contact-area and the broader brim, additional fixation of the caudal tip in the ischium or pubic bone ensures greater stability in the fixation of the APC, compared to the ARR. According to Berry and Müller (1992), the APC provides a bridge from host bone to host bone, allowing bone graft to be placed medial to the cage, where it is protected from excessive forces. When limited migration occurs during the first few months after reconstruction of large defects, the design of the APC permits secondary stabilization in some cases. In Paprosky type 3B defects, we therefore prefer the APC.

Reconstruction of bone-deficient acetabulum in revision arthroplasty of the hip is a difficult and complex problem and it is obvious that no single procedure is universally good. We agree with Retpen et al. (1992) that reoperations for failed arthroplasties in general, and especially acetabular revisions with severe bone-stock deficiencies, should be performed in centers that are experienced in revision surgery and bone-grafting techniques. Centralization of this type of surgery is advocated in order to diminish the problems and complications associated with the learning curve of the surgeon (Strömberg and Herberts 1994).

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