Arthroplasty for congenital hip dislocation

Techniques for acetabular reconstruction

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We investigated a series of 63 arthroplasties for chronically dislocated hips or severe dysplasia with at least two thirds of the femoral head uncovered. Direct cementation into the neoacetablum at the pelvic wing was followed by 6/20 revision arthroplasties and 3/20 impending failures. Cups supported by cortical bone grafts were revised in 8/16 and found loose in 2/12 arthroplasties. The best technique was restoration of the rotational center of the hip joint and roof reconstruction with a femoral head graft with 2/25 revisions and signs of loosening in 2/25.

Charnley and Feagin (1973) considered total hip arthroplasty for congenital dislocation of the hip inapplicable because of the distorted anatomy and the thin bone stock. Since then, special stem designs for hypoplastic femoral shafts and different techniques for positioning and reconstruction of the acetabulum have been presented (Dunn and Hess 1976, Harris et al. 1977, Harris 1978, Hess and Umber 1978, Ritter and Trancik 1985, Dorey and Amstutz 1986, Gerber and Harris 1986). Most series are rather small with short follow-up and concentrate more on the clinical results than the technical aspects of the acetabular reconstruction (Crowe et al. 1979, Fredin and Unander-Scharin 1980, McCollum et al. 1980, Mayer and Hartseil 1984, Kolmert et al. 1986, Lund and Termansen 1985).

We have compared different techniques for solving the acetabular problem.

Patients and methods

Sixty-five total hip arthroplasties were performed in 52 patients with painful arthrosis following severe acetabular dysplasia, with more than two thirds of the femoral head uncovered after congenital dislocation of the hip. The median age of the patients was 48 (21–73) years, and 47 were females.

The operations were performed from 1975 through 1984 by the two senior authors, either through an anterolateral (CCA) or a posterolateral (JSJ) approach without trochanteric osteotomy. Standard prosthetic stems (Stanmore or Lubinus) could be applied in only 20 cases; the remaining 45 required smaller stems (Arnoldi cemented 13, Arnoldi noncemented 15, Legrange-Letournel 12, Lubinus Dysplasia 5).

Prophylactic antibiotics were routinely given. Postoperatively, the patients were usually mobilized within a few days, but double-crutch support was recommended for at least 6 weeks in cases with major bone grafting.

No deep infections occurred. Nerve palsies were recorded in 9 cases; 6 of these were associated with roof reconstruction, of which 5 had limb lengthening exceeding 25 mm.

For comparative purposes, a patient series of 47 cemented cups in moderately dysplastic hips without need for acetabular reconstruction was followed for 5 (2–9) years. These patients were aged 47 (17–68) years, and 42 were females.

Acetabular techniques

The first three of the following techniques were used at the beginning of the period and the latter especially during the last 3 years. All the cups were made of polyethylene and were cemented with conventional techniques with anchoring holes, but without pressurization. In the 45 cases requiring small prosthetic designs,

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the cup size was usually 40 mm, matching 22- or 26–mm heads.

Cementation into the neoacetabulum (20 hips) followed reaming of the neoacetabular floor at the pelvic wing to the inner cortical layer (Lund and Termansen 1985). If necessary a roof support was made from cement, which was combined in 1 case with a cancellous screw.

Medial wall depression (2 hips) was performed bluntly after reaming the neoacetabulum to improve the superior bone support (Dunn and Hess 1976, Hess and Umber 1978).

Cortical bone grafting (16 hips). After reaming in areas with solid bone stock near the anatomic acetabulum, a roof support was attempted by adding corticocancellous bone beams above the cup after roughening the pelvic bone. The beams were harvested from the pelvic wing or cut from the femoral head and neck. If the beams were of substantial sizes, a cancellous screw support was applied; otherwise, the grafts were held in place by the cement.

Roof reconstruction with the femoral head (25 hips). Reestablishment of the natural hip center of rotation was attempted by identifying the true acetabulum, which was initially reamed. The iliac bone was roughened, and a femoral head was machined to fit and then fixed with 2–3 AO cancellous bone screws. The acetabular reaming was completed through the inferior part of the graft and the true acetabulum to the inner cortical layer. The contact line between the free bone graft and the iliac bone was packed with bone slurry and the cup was cemented in place (Figure 1; Harris 1978, Harris et al. 1977). In three hips where the patients own femoral head gave insufficient coverage, allografts from the bone bank were applied instead.

Follow-up

Sixty-three hips in 44 patients were followed radiographically for a median of 5 (2–9) years. Two patients had died 1.5 and 12 months postoperatively from unrelated causes. The radiographs were evaluated by one of the authors (JBR). The quality of cementation (>2mm thickness sufficient) was recorded. Measurements were made of the angular percentage of the cup protruding outside the lateral corner of the acetabular bone roof and the cup inclination with reference to a line intersecting the teardrops. Further, the valgus coefficient of the stem was calculated (Kristiansen and Jensen 1985). The elongation of the limb was measured as the vertical displacement of the lesser trochanter in relation to the teardrop. Failures were defined as recurrent dislocations or gross loosening with displacement or migration of the cup, leading to revision surgery. Impending failure was defined as a progressive radiolucency exceeding 2 mm in more than two zones (DeLee and Charnley 1976).

The Kruskall-Wallis tests and contingency tables were used, and survival curves calculated (Dobbs 1980).

Figure 1. Case 39. A 26-year-old woman with arthrosis secondary to congenital dislocation had a total hip arthroplasty near the natural rotation center with a roof reconstruction utilizing her own femoral head graft.

Results

Cementation into the neoacetabulum (Table 1) was followed by revision for recurrent dislocation after 1 month in 1 case and for gross cup loosening in 5 cases, 3 of which were more than 25 percent uncovered by bone (Figure 2). The only risk factor identified was uncoverage of the cup ($P < 0.03$). The median cup inclination was 49°, and the limb lengthening was 14 mm.

Medial wall depression. One of the patients was revised for cup loosening after 6 years; the central acetabular wall consisted exclusively of fibrous tissue . The other patient showed impending failure after 8 years.

Cortical bone grafting (Table 2). Revision was performed for recurrent dislocation after 1 month (1 case) and for cup loosening (7 cases). No risk factors could be identified for loosening or impending failure. The median limb lengthening was 25 mm and the cup inclination 40°, which was different from the former series ($P < 0.01$).

Table 1. Cementation into neoacetabulum at the pelvic wing in 20 hips

	Reoperation (n 6)	Radiolucency (n 3)	Firmly fixed (n 11)
Uncovered cups (percentage)	4/6 (25–40)	1/3 (15)	3/11 (10–20)
Insuff cement	0	0	3/11
Acetab inclin* (degrees)	52 (40–60)	47 (45–50)	47 (30–55)
Postop disloc	4/6	0	3/11
Valgus coeff*	0.62 (0.47–0.80)	0.54 (0.50–0.58)	0.55 (0.47–0.64)
Limb lengthening* (mm)	10 (0–20)	23 (15–35)	14 (0–35)
Failure time* (mo)	26 (1–93)	44 (3–70)	
Observ time* (mo)		81 (49–110)	63 (29–110)

* Values are median (range).

Figure 2. Case 17. A 57-year-old woman with the cup cemented into the neoacetabulum. The cup was steeply inclined and lacked 25 percent bone coverage, resulting in loosening and dislocation after 4 years.

Table 2. Cortical bone beam support in 16 hips

	Reoperation (n 8)	Radiolucency (n 2)	Firmly fixed (n 6)
Uncovered cups (percentage)	2/8 (10–20)	1 (10)	
Insuff cement	0/8	0	1/9
Acetab inclin[a] (degrees)	43 (20–60)	30 (30–45)	39 (30–45)
Postop disloc	1/8	0	0
Valgus coeff[a]	0.55 (0.43–0.65)	0.60 (0.56–0.63)	0.56 (0.43–0.70)
Limb lengthening[a] (mm)	28 (10–60)	23 (20–25)	22 (0–30)
Failure time[a] (mo)	48 (2–92)	12 (12–12)	
Observ time[a] (mo)		47 (36–58)	63 (38–92)

[a] Values are median (range).

Table 3. Acetabular roof reconstruction with femoral head grafts in 25 hips

	Reoperation (n 2)	Radiolucency (n 2)	Firmly fixed (n 21)
Uncovered cups (percentage)	0	0	0
Insuff cement	0	0	3/21
Acetab inclin[a] (degrees)	52 (45–60)	47 (45–50)	44 (20–65)
Postop disloc	1/2	0	0
Valgus coeff[a]	0.60 (0.05–0.69)	0.56 (0.53–0.59)	0.51 (0.26–0.65)
Limb lengthening[a] (mm)	53 (35–70)	10 (5–15)	29 (0–70)
Failure time[a] (mo)	11 (1–20)	35 (3–67)	
Observ time[a] (mo)		61 (39–82)	50 (29–93)

[a] Values are median (range).

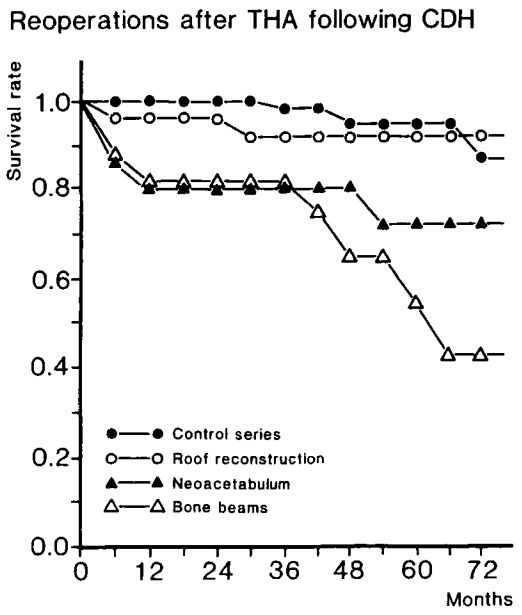

Figure 3. Survival curves for total hip arthroplasty following congenital dislocation of the hip. Reoperations defined as revision surgery for any acetabular problem.

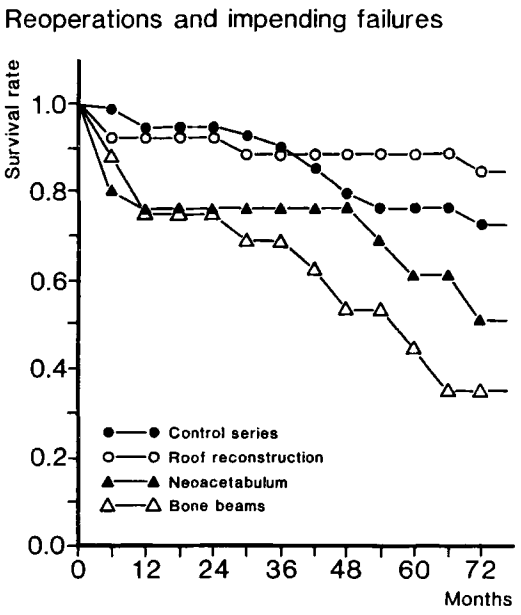

Figure 4. Survival curves for total hip arthroplasty following congenital dislocation of the hip. Impending failure was defined as acetabular radiolucency > 2 mm in more than two zones (DeLee and Charnley 1976).

Acetabular roof reconstruction (Table 3) was followed by two revisions for recurrent dislocation after 2 weeks and 20 months, respectively. The latter case had an excessive valgus position of the prosthesis due to an uncorrected subtrochanteric valgus osteotomy, and in the other case the cup was inclined 60° to achieve bone coverage with a rather small graft. The limbs were lengthened 35 and 70 mm. Two impending failures showed radiolucency in the middle and inferior zones after 3 and 67 months. Among the firmly fixed cups, an insufficient cement layer was observed in 3 cases, located in the middle and inferior zones. An improved bone coverage was obtained compared with the former methods ($P < 0.001$), and also the median limb lengthening of 29 mm increased ($P < 0.01$), whereas the cup inclination of 44° did not differ significantly.

The roof reconstruction technique with femoral head grafts was superior to all the other methods ($P < 0.03$), illustrated by the survival curves (Figures 3 and 4), which also demonstrate the survival of the roof reconstructions as being rather equivalent with the control series.

Table 4. Obtained limb lengthening (mm) in 61 hips

	Cementation in neoacetabulum		Cortical bone beams		Roof reconstruction	
Radiolucency	+	–	+	–	+	–
0–15	5	6	2	1	2	6
16–25	3	3	5	3		7
26–40	1	2	2	2	1	5
60–70	–	–	1	–	1	3
Median	14	14	28	22	31	29

Discussion

The major problem in total arthroplasty for arthrosis secondary to severe dysplasia of the hip is anchorage of the acetabular component. Previous series have not presented survival curves for the cup, as advocated by Dorey and Amstutz (1986). The striking feature in our series was the declining survival except for reconstructions with the aid of the femoral head.

Already from a theoretical point of view, the medial wall depression (Dunn and Hess 1976, Hess and Umber 1978) cannot be recommended; the highest stresses are transmitted to the depressed medial wall in cemented polyethylene cups (Crowninshield et al. 1983).

Reconstruction of the natural center of rotation and cementation into the true acetabulum has been emphasized (Tronzo and Okin 1975, Harris et al. 1977, Harris 1978, Crowe et al. 1979, Fredin and Unander-Scharin 1980, Ritter and Trancik 1985, Gerber and Harris 1986, Kolmert et al. 1986), and is also logical, as the joint force in this position is minimized. Mechanically, it is desirable to use a cup of reasonable size to enlarge the stress distribution area. The stiffness of the cup is increased and material preserved by using a small head diameter. Extra small and thin cups (Tronzo and Okin 1975) can thus not be considered feasible.

Positioning the cup into the true acetabulum will leave part of the cup uncovered by bone if a roof reconstruction is not performed. Experimentally, Roffman et al. (1983) have shown that cementation does not prevent the ingrowth of bone grafts. The use of cortical bone beams was not successful in our series, as more than half had failed after 5 years. A probable explanation is that, although the load patterns were restored better, the rather small shelf did not contribute substantially to the stress distribution area.

Reoperations or impending failure were experienced in about every tenth hip after 5 years. These results were slightly better than a control series of dysplastic hips operated on with insertion of the cup directly into the acetabulum. The remodeling of the bone graft has not been studied as yet, but has proved to be firmly fixed at reoperations (Woolson and Harris 1983, Gerber and Harris 1986), which has also been our experience on a few occasions during past years. Radiographically, some resorption from the lateral aspect of the graft has been described (Woolson and Harris 1983), but this has not been a feature in this series. A recent long-term follow-up of 47 cases (Gerber and Harris 1986) has, however, reported four revisions for loosening after 5 years, six definitely and four possibly loose related to resorption of more than half of the graft in 14 cases after 7 (5–11) years. However, Ritter and Trancik (1985) had no graft failures after 5 (3–7) years in 20 cases. Clearly, the long-term results of these procedures must be followed closely.

One advantage of the operation is lengthening of the limb, which in unilateral cases can equalize the leg length. This is not free from risk, as approximately every fourth patient sustained a temporary paralysis of the foot dorsiflexion, particularly in cases with substantial lengthening.

Considering the rather low age of patients with symptomatic secondary arthrosis in the neoacetabulum of chronically dislocated hips, the safest possible reconstruction should be used to secure the longevity of the hip. We disagree with the cementation into the neoacetabulum recommended by Lund and Termansen (1986), and strongly advocate the roof reconstruction technique with femoral head grafting and full bone coverage (Harris 1978, Kolmert et al. 1986). In our opinion the surgery in these cases is so complex and demanding that centralization seems well justified (Kolmert et al. 1986).

Table 5. Acetabular cup reconstruction for congential dislocation of the hip in 63 adult patients

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	32, f	3	1	1	25		60	47	20	2	1	1	1
2	56, f	5	1	2			40	56	10	2	2	1	
3	49, f	1	1	7	25		60	80	20	2	7	1	1
4	56, f	3	1	49			55	71	10	2	49	1	1
5	63, m	5	1	93	40		40	57	0	2	93	1	
6	58, f	5	1	1	25		55	58	0		1	1	1
7	57, f	1	1	85			45	54	15	2	70		
8	39, f	4	1	49			50	58	18	1	3		
9	48, m	5	1	110	15		45	50	35	1	60		
10	57, f	2	1	29			50	56	35				1
11	32, f	3	1	38			55	53	16				
12	48, f	3	1	47	12	1	45	57	10				1
13	48, f	3	1	47	10		45	62	0				1
14	58, f	5	1	50		4	45	59	20				
15	56, f	3	1	63			50	50	5				
16	39, f	1	1	66		1	45	47	10				
17	57, f	3	1	79		4	50	58	0				
18	57, f	3	1	80		4	50	54	0				
19	51, f	1	1	84			55	50	35				
20	62, f	5	1	110	20		30	64	20				
21	49, f	1	3	48		2	20	50	20	2	48	1	
22	52, f	4	3	74			55	65	15	2	74	1	
23	70, f	4	3	3		3	50	58	35	1	3	1	
24	52, f	4	3	12		2	60	63	25	1	12	1	
25	25, f	3	3	71	20		50	50	10	1	71	1	
26	67, f	1	3	81			40	43	25	1	81	1	
27	27, f	1	3	92			30	50	30	1	92	1	
28	61, f	2	3	1		2	40	60	60			1	1
29	34, f	4	3	58			30	56	20		12		
30	47, f	3	3	36	10		30	63	25		12		
31	47, f	5	3	38			45	56	25	2			
32	57, f	5	3	39			40	70	0	1			
33	54, f	3	3	44			30	52	30				
34	36, m	2	3	58		4	40	50	20				
35	54, f	5	3	88			35	62	25				
36	50, f	1	3	92		1	45	43	30				
37	21, f	3	4	69		2	50	58	45	2	3	1	
38	70, f	5	4	93			65	58	10	2	93		
39	26, f	2	5	1			60	50	70		1	1	1
40	56, f	3	5	20			45	69	35		20	1	
41	63, f	1	5	39			50	53	15	1	3		
42	64, f	4	5	82			45	58	5	1	67		
43	34, f	2	5	25		2	45	43	70				
44	50, f	2	5	30			45	50	20				
45	62, f	5	5	35			65	43	10				
46	43, f	2	5	35			45	62	30				
47	45, f	2	5	36		3	50	50	0				
48	43, f	2	5	38		2	45	56	23				
49	33, f	2	5	38		2	50	50	25				
50	53, f	1	5	39		2	50	65	35				
51	32, f	2	5	39		2	40	50	60				
52	55, f	4	5	39			45	60	9				
53	26, f	2	5	42			40	57	65				
54	53, f	1	5	47			20	57	15				
55	54, f	4	5	48			30	58	34				
56	73, m	1	5	48			40	43	40				
57	53, f	1	5	50			45	50	20				
58	36, f	2	5	57		4	45	50	25				
59	47, f	3	5	69		4	45	26	17				
60	46, f	3	5	72		6	25	42	25				
61	55, f	4	5	78		2	45	50	40				
62	65, f	4	5	91			45	50	15				
63	62, f	4	5	93			45	50	15				

A Case number.
B Age, sex.
C Type of prosthesis: 1 Lubinus, 2 noncemented Arnoldi, 3 cement Arnolidi, 4 Legrande-Letournel, 5 Stanmore.
D Technique: 1 cementation into neoacetabulum, 3 cortical bone grafting, 4 medial wall depression, 5 roof reconstruction with femoral head graft.
E Months of follow-up.
F Percentage of cup protruding outside bone support.
G Cement layer less than 2 mm: 1 = zone I, 2 = zone II, 3 = zone III, 4 = zone I + II, 6 = zone II + III.
H Degrees of cup inclination.
I Valgus coefficient multiplied by 100.
J Elongation in mm.
K Acetabular rediolucency exceeding 2 mm: 1 in the central and distal zone, 2 in all tree zones.
L Months until observation of rediolucency.
M Reoperation: 1 cup revision.
N 1 Dislocation.

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