Charnley cups retained during revision of the femoral component

Repeated clinical and radiographic observations of 49 cups for 7–15 years

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Submitted 00-10-19. Accepted 01-02-06

ABSTRACT – This article concerns 49 consecutive polyethylene cups retained in cemented first revisions of the femoral component and evaluated on several occasions 7–15 years after the index operation. At the last follow-up 5 cups were revised, 3 were radiographically loose, 1 was revised because of recurrent dislocation and 1 stable cup was revised because the surgeon wished to use a 28 mm head. Moreover, 1 unrevised cup was radiographically loose. This corresponded to a mechanical failure rate of 0.1 (5/49) and revision rate of 0.1 (4/49). 3 cups which were radiographically loose (100% radiolucency) had not been revised when the stem was exchanged. If these cups were excluded, the revision rate would have dropped to 0.02 (1/46) and the mechanical failure rate to 0.04 (2/46). This indicates the importance of careful preoperative radiographic evaluation on both AP and lateral views. Progression of radiolucent lines always occurred as an increase in extension from the periphery to the central region of the interface.

In conclusion, Charnley cups with non-circumferential radiolucent lines and little, if any, wear can be retained without compromising the longevity of the implant. However, it should be stressed that this conclusion is based on a patient population in which four-fifths of the patients at the index operation were 65 years of age or older.

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Whether to revise or retain a well-fixed cemented acetabular component during revision of a loose femoral component is a dilemma. There are few reports on survival of retained cemented acetabular components (Callaghan et al. 1985, Kavanagh et al. 1985, Engelbrecht et al. 1990, Kerhaw et al. 1991, Berger et al. 1999). Several studies have shown accelerated acetabular loosening with time. This speaks in favor of exchange, at least in younger patients (Charnley 1979, Stauffer 1982, Sutherland et al. 1982, Wroblewski 1985, Hodgkinson et al. 1988). However, the results after revision of the acetabular component are inferior to those obtained after primary total hip arthroplasty (Hunter et al. 1979, Amstutz et al. 1982, Callaghan et al. 1985, Kavanagh et al. 1985, Pellicci et al. 1985, Engelbrecht et al. 1990, Strömberg et al. 1992, Garcia-Cimbrelo et al. 1995, Ash et al. 1996). This indicates that the cup will be retained at least with a well integrated interface.

We report the clinical and radiographic results obtained with well-fixed cemented acetabular components of Charnley design, which had been retained at the time of revision of the femoral component.

Patients and methods

Between 1983 and 1991, 49 primary Charnley cups were retained in 48 consecutive patients during revision of the femoral component (referred to as the index operation) at our hospital. The patients were followed consecutively and prospectively with clinical and radiographic evaluations for a minimum of 7 years.

The study comprised 27 women (28 hips) and 21 men (21 hips). The mean age at the primary THA operation was 66 (45–80) years and at the

Table 1. Clinical and radiological follow–up after index operation

Time after operation			Follow–up				Lost to follow–up	
Years	Interval	n [a]	Clinical	Radiographic	Died	Revised	Clinical	Radiographic
1	0.5–2	49	42	42	1	–	6	6
3	2–4	48	33	33	3	–	12	12
5	4–6	45	38	34	2	1	4	8
7	6–8.5	42	37	39	5	1	0	0
10	8.5–11.5	22	21	21	–	1	0	0
13	11.5–14	3	2	2	–	1	0	0
15	14–16	1	1	1	–	1	0	0

[a] Number of available cases, excluding deceased and revised patients, at each follow–up

index operation 71 (55–88) years. Before the index operation, 24 patients (24 hips) had unilateral hip disease (Charnley category A), 17 (18 hips) had bilateral hip disease (B) and 7 (7 hips) had multiple joint involvement (C). The mean weight of the patients was 73 (53–105) kg.

The primary diagnoses were primary arthrosis (n 39), rheumatoid arthritis (n 3), congenital dislocation (n 1) and sequelae after hip fractures (n 6). The reasons for femoral revision were aseptic loosening (n 45), fracture of the femoral component (n 2) and periprosthetic femoral fracture (n 2).

Surgical procedure

All of the extracted prostheses were cemented Charnley stems. A new Charnley stem (8 with standard length, 41 long stems) was recemented, using high-viscosity cement (Palacos cum gentamicin, Schering-Plough Labo NV, Belgium) and second- or third-generation cementing technique. The choice of stem was based on th surgeon's preference. Trochanteric osteotomy was done in 29 hips, 22 according to Charnley, 5 with cable grip (Howmedica, USA) and 2 with cramps (3M, USA). All patients received prophylactic parenteral antibiotics for 24 hours (Isoxacillin or Fucidinic acid). Antithrombotic prophylactics were given either as dextrane, heparin or low-molecular weight heparin. Intraoperative cultures showed no deep infection in any of the cases.

There were 5/2 (40/43 mm) standard, 12/15 standard LPW, 1/1 flanged, 2/4 flanged LPW and 0/7 Ogee cups. The decision to retain the cemented acetabular component was based on both radiographic and clinical (intraoperative) considerations. Usually, there were no signs of radiographic loosening (presence of a complete radiolucent line or progressive migration) and little, if any, wear, but the radiographic appearance was not observed in detail. During the operation, an impactor was used to apply stresses manually to the acetabular component. The interfaces were inspected for motion, with use of manual loading and traction. If there was no motion, severe wear or abrasions (as judged by the individual surgeon) the component was retained. 3 cups with 100% lucency according to our evaluation, but macroscopically stable at the operation were retained. The other cups had little, if any, partial radiolucencies. The mean operation time at 10-minute intervals and blood loss in ml were compared to 40 previously reported cases revised with a Charnley stem and cup (Hultmark et al. 2001b).

Clinical evaluation

The patients were scheduled for follow-up at 1, 3, 5, 7, 10, 13 and 15 years. End-points for the study were revision, removal or the patient's death. They all underwent at least one follow-up examination (Table 1). The mean clinical follow-up times after the index operation (stem revision) and primary THA were 8.0 (0–14) years and 13 (6–25) years, respectively. If the 8 patients who died before 7 years were excluded, the follow-up times were 8.9 (5–14) and 14 (6–25) years. The average time between the primary THA and index operation was 5.5 (1–18) years. At the end of 1998 (latest follow-up), 12 patients had died.

Pre- and postoperative patient characteristics and clinical data were collected prospectively.

The Harris (1969) hip-rating system was used. The patient's opinion about the operated hip was divided into 3 classes: satisfied, uncertain or dissatisfied. The functional status of the patients was classified with Charnley's method (1979) and the activity level was roughly assessed as frequency of walks longer than 1 km. An independent observer (P.Hu) did all clinical examinations after the 5-year follow-up.

Radiographic evaluation

All patients, except 2 who died 0.8 and 3.4 years after the index operation, underwent at least one follow-up examination. 2 patients, who died 3.2 and 7.7 years after the index operation, participated only in the 1-year follow-up radiographic examination. Moreover, 1 patient who died after 5.7 years was not seen at the follow-up at 5 years. The remaining patients were evaluated at the latest possible follow-up examination (Table 1). The mean radiographic follow-up time after the index operation and primary THA were 8.0 (0–14) years and 14 (2–25) years, respectively (excluding 8 patients who died before the 7-year follow-up: 9.0 (2–14) and 14 (2–25) years). The radiographic examinations were done at our hospital. Standardized anteroposterior (AP) and lateral projections of the hips were obtained, as well as a pelvic view centered on the symphysis. An independent observer (P.Hu) evaluated all radiographs.

Radiographic loosening was judged by comparing the postoperative radiographs with those obtained at each follow-up. Proximal and distal migration of the acetabular component was measured as change in the vertical distance (after reduction for polyethylene wear) between the center of rotation of the hip and the inferior margin of the teardrop. Medial and lateral migration was measured as change in the horizontal distance between the inferior margin of the teardrop and the center of rotation and the perpendicular distance between Köhler's line (a line along the medial aspect of the ilium and ischium, Hubbard 1969) and the most medial (inner) margin of the cup (positive value = medial to Köhlers line). The inclination of the cup on the AP view was determined using the teardrop line as reference. These measurements and determination of the angle of the cup were also used to find the position of the cup on the postoperative radiographs (Massin et al. 1989).

On the radiographs, the acetabular components were divided into 60° sections on the AP (regions 1–3) and lateral projections (regions 4–6). Radiolucent lines (or linear periprosthetic bone loss) were regarded as present if they had a width of at least 0.3 mm and occupied more than 50% of the interface in each region (AP and lateral views). The widths of the cement mantle and radiolucent lines were measured in the middle of each region. The acetabular component was considered radiographically loose if either of the following criteria were met: cup migration exceeding 5 mm, cirumferential radiolucency of ≥ 0.3 mm width on AP or lateral projection or a change in the inclination of the cup exceeding 10° on the AP projection. The choice of 0.3 mm limit was primarily based on long experience of the radiographer in this study. Smaller radiolucencies were not regarded as reproducibly detectable. The intraobserver variability of this person has previously been studied (Hultmark et al. 2001a). Repeated observations of 40 radiographic examinations at intervals of 1 year showed standard deviations of 0 (regions 2 and 5), 0.1 (region 1), 0.2 (regions 3 and 6) and 0.3 mm (region 4). The corresponding interobserver variability varied between 0.0 and 0.2 mm for observer 1 and between 0.0 and 0.6 mm for observer 2. The high standard deviation in one region for observer 2 was due to different interpretation of a localized osteolysis in region 4.

Osteolysis was defined as a focal resorption of bone with an area of at least 3 × 3 mm. Classification of the postoperative cement mantle on the AP and lateral radiographs was divided into categories A) complete cement filling, B) cement-bone radiolucency < 50%, C) radiolucency ≥ 50% and D) defects in the cement mantle. Categories A and B were considered as good or acceptable and C and D as poor cementing.

Penetration (wear) of the femoral head and direction of wear were determined by the method of Livermore et al. (1990). The direction of wear was defined relative to a vertical line drawn through the center of the femoral head and perpendicular to a tangent to the teardrop line. If medial to this vertical line, it was defined as a positive angle and if lateral, as a negative angle. Heterotropic ossification was graded by Brooker et al.'s method (1973). All measurements were done manually, using a digitized slide caliper with a 1/100 mm scale.

Survival (Kaplan and Meier) was calculated with two definitions for failure: revision and mechanical. Mechanical failure was defined as revision or aseptic cup loosening.

Result

Revision and survival

At the last follow-up, 5 of 49 cups (1 Ogee, 1 flanged, 3 standard) had been revised: 4 revisions because of cup failure, 3 of these were radiographically loose and 1 was changed because of recurrent dislocation. In the 5th case, the surgeon wished to change the femoral head diameter from a 22 to 28.

2 of the 4 failed cups were found to be macroscopically loose during revision. 1 of these had 100/66% (AP/lateral) radiolucency at the index operation and developed 100/100% radiolucency (both components revised after 5.5 years) (Figure 1). The other had 33/33% at the index operation and developed 100/100% after 14 years (cup revision the same year).

3 of the 5 revised cups exchanged 6.5, 9.1 and 12 years after the index operation were judged to be stable at the revision. The first had 100/66% lucency as early as the index operation, but the other 2 cups had incomplete (33/33% and 33/66%) radiolucent lines both at this time and at revision (33/66% and 33/66%).

Only 1 radiographically-loose cup was not revised. This woman, 92 years of age, had 33/100% lucencies at the index operation and 66/100% at the latest follow-up (7 years). She had a low activity level and moderate pain at the latest follow-up. None of the other cups showed signs of impending failure (i.e., 66% radiolucency on frontal and lateral views). The overall mechanical failure rate was 0.1 (5/49) and radiographic loosening rate 0.1 (4/49). 3 of the 4 cups with 100% lucency were radiographic failures as early as the index operation. The average time for the 4 radiographically-loose cups and for the 45 stable cups from primary THA to the index operation was 2.2 (2–9) years and 5.7 (1–18) years, respectively (p = 0.2, Mann-Whitney test).

Table 2. Harris hip and pain scores (median and range)

Years	Harris hip score	Pain score
Preop. (index op)	44 (7–88)	20 (0–40
1	80 (40–99) [a]	40 (20–44) [a]
3	83 (34–99)	40 (10–44)
5	80 (25–100)	44 (10–44)
7	76 (46–99)	40 (20–44) [b]
10	79 (44–100)	44 (20–44)
13	89 (86–91)	42 (40–44)
15	88	40
Latest follow-up	75 (25–100)	40 (10–40)

[a] 0–1 years, $p < 0.0005$, [b] 5–7 years, $p < 0.01$, Wilcoxon signed rank test

The 10-year survival rates after index operation, based on revision or mechanical failure, were 93% (SD 9.6) and 93% (SD 7.8), respectively.

Clinical results

The median Harris hip and pain scores increased from 44 (7–88) and 20 (0–40) before index operation to 75 (25–100) and 40 (10–44) at the latest follow-up ($p < 0.0005$, Wilcoxon signed rank test). Both parameters improved at 1 year ($p < 0.0005$); thereafter, no change in total score was noted (p = 0.1–0.8). The pain score decreased slightly between 5 and 7 years ($p < 0.01$) (Table 2). The Harris hip and pain scores and the differences between the preoperative values and the latest follow-up did not vary between the Charnley categories (p = 0.4–0.8, Kruskal Wallis one-way ANOVA). 42 patients were satisfied with the outcome of the operation at the latest follow-up, 3 were uncertain (1 with trochanteric pain, 2 with thigh pain due to stem loosening—both revised) and 4 were dissatisfied (1 with recurrent subluxations, 1 with dislocation—revised, 2 with thigh pain due to stem loosening—1 revised). 21 patients walked more than 1 km 5–6 times a week, 2 walked 5–6 times a month and 26 had no regular physical activity.

The mean operation time was 187 (80–380) minutes and mean intraoperative blood loss 1.5 (0.4–6) L. In our previous material, where both components were revised to a Charnley design, the corresponding operation time and blood loss were 193 (110–270) minutes and 1.9 (0.4–4.5) L (p = 0.2, 0.004, Mann-Whitney test), respectively.

Table 3. Cross-table showing extension of radiolucent lines in 49 cups on AP and lateral views at the index operation and latest follow-up. Cases placed in squares with white color had unchanged extension. 17 cases below the white squares showed progression and 2 above regression

Latest follow-up	Index operation (%AP/lateral)										
	0/0 n 12	0/33 n 9	0/66 n 1	33/0 n 11	33/33 n 11	33/66 n 2	66/33 n 0	33/100 n 1	66/100 n 0	100/66 n 2	100/100 n 0
0/0	9			1							
0/33	1	8			1						
0/66	2	1	1								
33/0				5							
33/33				3	5						
33/66				2	4	2					
66/33					1						
33/100											
66/100								1 [a]			
100/66										1 [c]	
100/100					1 [d]					1 [b]	

[a-d] according to Table 4

Radiographic results

Classification of the cement mantle after the primary operation resulted in 29 cups in category A, 19 in B and 1 in C. The mean thickness of the cement mantel varied between 3.0 mm (region 5) and 7.1 mm (region 3). No fractures of the cement mantle were seen.

The mean postoperative position of the cup in relation to the teardrop (proximal/distal and medial/lateral) and to Köhler's line was 22 (12–34) mm, 30 (20–37) mm and –5 (–13–7) mm, respectively. The corresponding mean change to latest follow-up was 0.1 (–3–4) mm, –0.9 (–4–3) mm and 0.1 (–3–3) mm, respectively.

3 cups migrated 2–4 mm proximally, 11 1–2 mm and 35 less than 1 mm. The 4 cups with extensive radiolucent lines (classified as loose) migrated 4.2, 1.4, –0.4 and –1.0 mm. 4 cups migrated 3–4 mm medially (none were radiographically loose), 7 2-3 mm, 12 1–2 mm and 21 less than 1 mm.

The mean cup inclination was 47.1° (34°–62°) postoperatively. The mean change to the last follow-up was minimal –0.2°(–4°–6°).

The wear at the latest follow-up was 2-3 mm in 4, 1-2 mm in 5 and less than 1 mm in 40 cups. The mean wear-rate per year was 0.07 (–0.3–0.07) mm. The mean wear-angle at latest follow up was –15.8° (–35°–0°), corresponding to femoral head penetration in the proximal-lateral direction.

Heterotopic ossification grade I occurred in 39, grade II in 5 and grade III in 5 cases. Focal periprosthetic bone-loss (osteolysis) was not observed in any acetabulum.

No radiolucent lines were seen on any of the follow-ups on the AP view in 23 hips and on the lateral view in 15 hips. In 9 of these cups, we found no radiolucent lines on either view. When present on the postoperative radiographs, the radiolucent lines usually progressed or remained stationary. In 3 cases, however, thin lines in region 1 disappeared after the first follow-up (before index operation, 1 case) or later on (Table 3).

Half of the radiolucent lines in the different regions were seen as early as on the postoperative radiographs after the primary arthroplasty. Four fifths were detected on the postoperative radiographs after the index operation and nine tenths after 1 year. No newly developed radiolucent lines that progressed to 100% were detected after the index operation (Table 4).

Radiolucent lines were usually seen on the periphery (regions 1, 3, 4 and 6). Progression to the dome of the cup (regions 2 or 5) occurred in only one case who had 33% radiolucency in regions 1 and 6 at the index operation and developed central and complete radiolucencies at the 15-year follow-up (one of the revised cases). At the latest follow-up, radiolucent lines were most frequent in region 1 in 18 (37%) cases, region 3 in 9 (18%),

Table 4. Time table illustrating when new radiolucent lines were detected. The history in cases with 100% radiolucent lines are indicated. Simultaneous detection of lines in 2 or 3 regions on the AP view did not occur

Radiolucent lines	Primary operation	Index operation	Follow-up						
			1	3	5	7	10	13	15
AP view									
First detected in 1 region	15	13	0	0	0	0	0	0	0
progress to 2 regions	1	1 [a]	–	–	–	–	–	–	–
progress to 3 regions	2 [b, c]	1 [d]	–	–	–	–	–	–	–
Lateral view									
First detected in 1 region	13	10	3	1	2	1	0	0	0
progress to 2 regions	5	1	2	1	1	–	–	–	–
progress to 3 regions	1 [b]	14	–	–	–	–	–	–	–
First detected in 2 regions	1	2 [c]	0	0	0	0	0	0	0
progress to 3 regions	0	0	–	–	–	–	–	–	–
First detected in 3 regions	0	1 [d]	0	0	0	0	0	0	0
Number of new lines	29	26	3	1	2	1	0	0	0
accumulated	29	55	58	59	61	62	62	62	62
Cups with new lines	21	16	1	0	1	1	0	0	0
accumulated	21	37	38	38	39	40	40	40	40

[a] Progressed to 66% at the 1-year follow–up. On lateral view, 100% lucency at index operation
[b] Progressed to 100% at index operation (after 1.7 years), revised 5.5 years after index operation
[c] Progressed to 100% at index operation (after 2.7 years), revised 8.9 years after index operation
[d] Progressed to 66% at 13-year and 100% at 15-year follow-up (revised)

region 4 in 22 (45%) and region 6 in 29 (59%). They were less frequent centrally (region 2 in 4 (8%), region 5 in 3 (6%)). Peripherally (regions 1, 3, 4 and 6), we found an overall increase in the extension of radiolucent lines between the follow-up examination and the index operation (p = 0.001–0.05). Thereafter, the lines continued to increase in regions 1, 4 and 6 (index operation to last follow-up, p = 0.05–0.003, Wilcoxon signed rank test), (Figure 2).

No significant increase was seen in the width of the radiolucent lines between the primary and index operation. Between the index operation and the latest follow-up, the width increased in region 4 (p = 0.02, Wilcoxon signed rank test). The mean widths at the latest follow-ups seen in region 1 were 0.4 (0.3–0.8) mm; region 2 0.9 (0.3–1.5); region 3 0.7 (0.7–1.3); region 4 0.7 (0.3–1.3); region 5 0.7 (0.5–1.0) and in region 6 0.5 (0.3–2.2) mm. In the 4 cups which became radiographically loose, we found no overall tendency to increased width of the lines between the primary and the index operation except in region 4, where increased width was noted in all cases (p = 0.07, Wilcoxon signed rank test). Between the index operation and last follow-up, no consistent increase was seen in width of any region in these 4 cups (p = 0.1–0.7).

No factors such as gender, weight, diagnosis (rheumatoid arthritis or not), activity level, cup design (flange or unflanged), quality or thickness of the cement mantle, and the extension of radiolucent lines at the primary operation had any obvious influence on the incidence of radiographic loosening (4 cases, Cox regression).

Complications

We found 4 intraoperative femoral fractures (1 calcar region-untreated, 2 trochanteric and 1 diaphyseal-treated with cerclage) during the index operation. The femoral diaphysis was penetrated in 5 cases (but not treated).

1 postoperative dislocation was treated with closed reduction. 2 hips became dislocated 1 and 5 years after the index operation. Both were treated with closed reduction. One of these patients and 4 others developed instability, 1 of whom had to be treated with cuprevision. 2 periprosthetic fractures occurred after 1 and 5 years, both of which were treated with AO plates without further complications. Trochanteric pain was reported in 6 hips, in 2 hips in association with trochanteric pseudoarthrosis. 1 superficial infection developed,

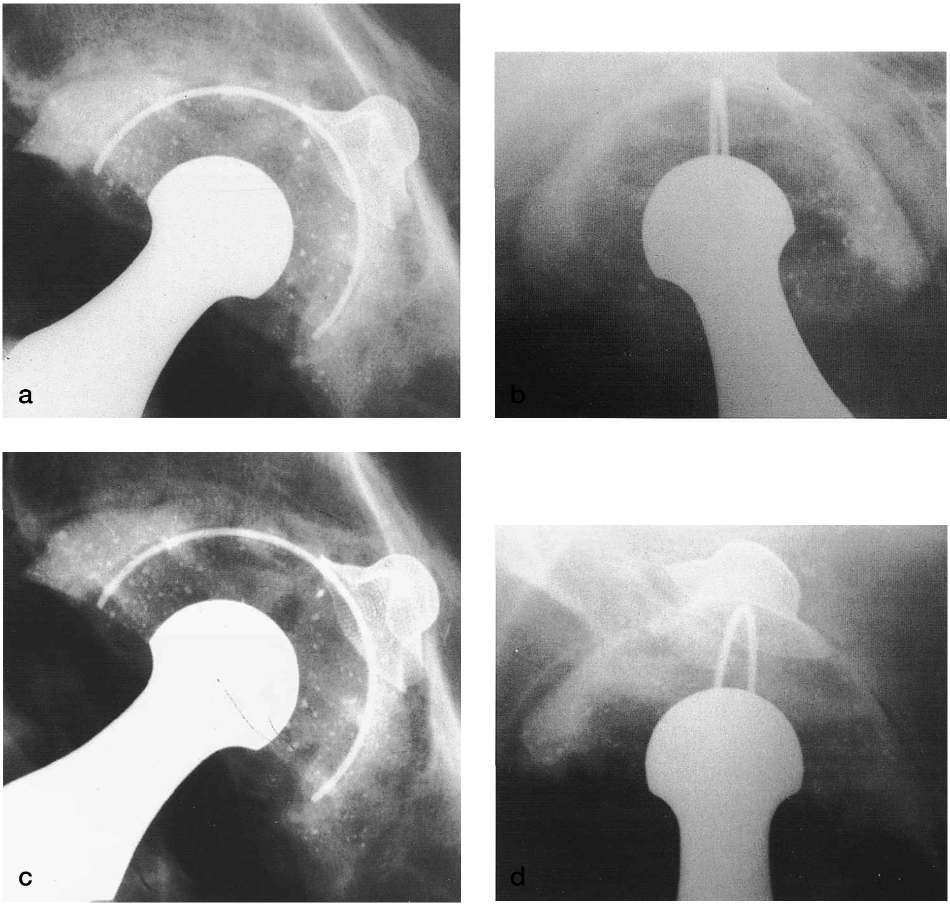

Figure 1. 70-year-old man primarily operated on in 1982. After surgery, we found a radiolucent line in region 1 (33%, a) and in regions 4 and 6 on the lateral view (66%, b).
At the index operation 2 years later, these lines had increased to 100% on both views. The width of these lines increased slightly up to 5.5 years after the index operation when both components had complete lines (c and d). At the second revision, both components were found to be loose.

which healed uneventfully (2 patients with a deep infection were excluded from this study). 1 patient had persistent sciatic sensory nerve dysfunction. General complications included pulmonary embolus (1 case), cardiac infarction (1 case), auricular fibrillation (1 case) gastric ulcer (1 case) and 3 cases of urinary tract infections.

Discussion

The decision whether to exchange or retain the acetabular component during revision of a loose femoral component is based on preoperative radiographic findings, intraoperative observations and patient-related factors. Only a few studies have evaluated the fate of retained cups (Callaghan et al. 1985, Kavanagh et al. 1985, Kershaw et al. 1991, Berger et al. 1999). The revision and mechanical failure rates varied between 1–8% and 15–25% after 4–8 years of follow-up after the index operation. Various criteria for failure (extension and width of radiolucent lines, limits of migration) have been used. In some of these studies, even the designs differed and primary and revision cases were combined. The only prospective study (Berger et al. 1999) reported 2 revisions and 4 mechanical failures, usually of revised cups (3 of 4), in 26 uninfected patients, after mean 8 years from the index operation.

Some authors have reported an increase in the loosening rate of cemented primary acetabular

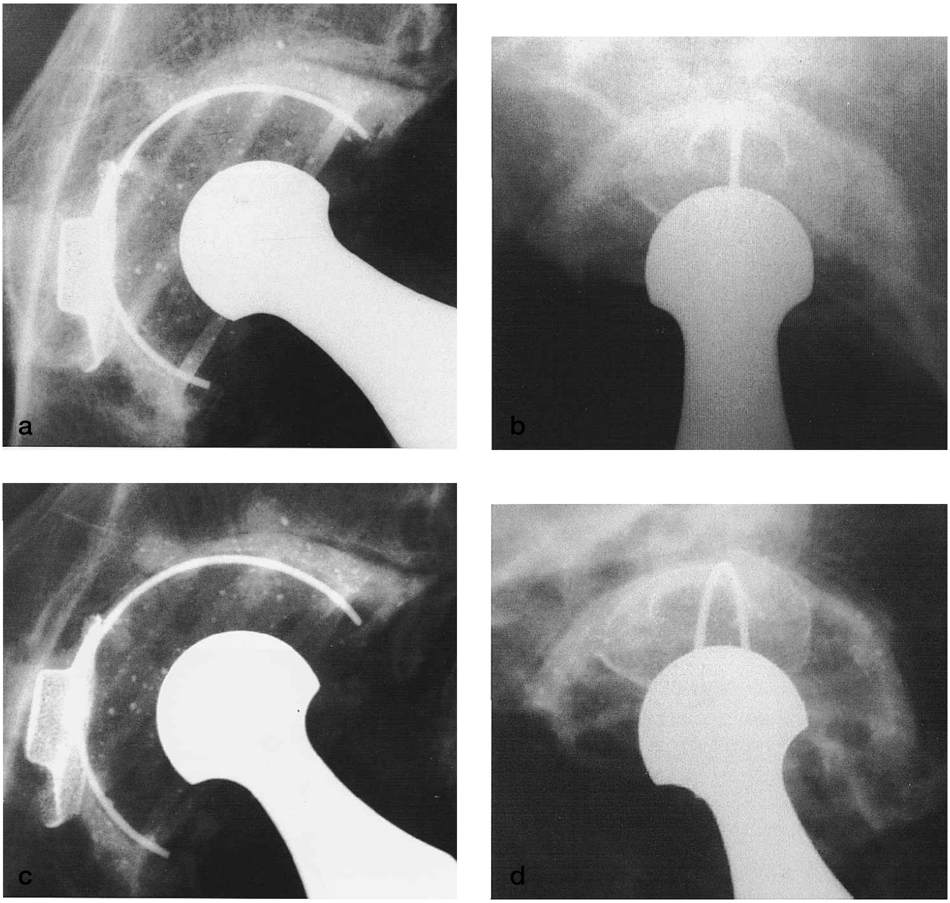

Figure 2. 76-year-old man operated on in 1983. After surgery, we found a radiolucency in region 1 (33%, a) and in regions 4 and 6 (66%, b).

At the index operation 4 years later, these lines were unchanged. At the latest follow-up 5 years later, the radiolucencies were unchanged (c and d). The patient walked regularly (> 1 km) with slight pain at the last follow-up. 2 years, later he died due to reasons not related to his operated hip.

components after the first 10 years (Charnley 1979, Stauffer 1982, Sutherland et al. 1982, Wroblewski 1985, Hodgkinson et al. 1988), but others have not confirmed this in primary (Carlsson et al. 1986, Mc Coy et al. 1988, Kavanagh et al. 1989, Ranawat et al. 1995) or revision THA (Marti et al. 1990). Berger et al. (1999) noted that a short interval between the primary and index operations indicated a poor prognosis. In their failed cases, the time interval was only 3.5 years, but the successful cases had not undergone revision of the stem until 7.4 years had elapsed. We found a similar tendency. Most of the radiolucent lines in our series were detected on the radiographs immediately after the index operation. Non of the lines that developed later progressed to 100%. We have observed a similar decreasing incidence of newly-detected radiolucent lines with time in cases revised with Charnley cups (Hultmark et al. 2001a).

These findings show that the preoperative radiographs should be carefully examined. 3 of 4 radiographic failures (100% radiolucency on 2 AP views and on 1 lateral) view were seen as early as on the radiographs taken before the index operation, including both AP and true lateral views of good quality. If these observations had been correctly interpreted at the index operation, the radiographic failure rate could have been reduced to 1 of 46 hips and mechanical failure rate to 2 of 46 hips. Callaghan et al. (1985) noted that cups with circumferential lucencies at follow-up had these lines even before the index operation. Contrary to our view, they stated that these lines progressed, but did gave no details. If these cups, which were radiographic failures before the revision of the stem, were excluded, they reported no mechanical failure after 2–5 years of follow-up.

On the basis of our data, no definite conclusions can be drawn regarding acceptable extension of radiolucent lines to retain the cup. However, cups with 33% peripheral lucency on the AP and/or 33% or 66% peripheral radiolucencies on the lateral view at the index operation can probably be retained (Figure 2). Our patients had an average age of 71 years, but in younger patients, these limits should perhaps be reduced.

The survival curves suggest the the retained cups do as well as primary THA for revision or mechanical failure. Cemented acetabular revisions have been associated with 9–30% radiographic loosening after 4–7 years of follow-up (Callaghan et al. 1985, Kavanagh et al. 1985, Pellicci et al. 1985, Engelbrecht et al. 1990, Strömberg et al. 1992). Loosening rates of 20–34% have been reported after 11–13 years (Garcia-Cimbrelo et al. 1995, Ash et al. 1996). Marti et al. (1990) carefully prepared the acetabulum. After 9 years, the revision and radiographic loosening rates were 5% and 17%. We used a similar technique in our study of cemented Charnley revisions (Hultmark 2001a) and had similar findings after the same period of time (6% and 15%). Thus, the results of retained cemented cups seem to be better. In addition, removal of a well-fixed cemented cup can increase the operative morbidity, bone loss and the costs.

In no case did the migration exceed our detection limit (> 5 mm), not even in the 4 radiographically-loose cups. Cups with complete lucency migrated 4 mm or less. These findings indicate that migration, judged by conventional radiographs, is not a satisfactory way to detect cup failure.

The wear rate in this material of retained cups was about the same as we had found previously in revision cases operated with Charnley cups (0.07 mm/year vs. 0.08 mm/year). The mean direction of the wear was superolateral in both studies (16° vs. 11°). One explanation could be that the cup has less mechanical support laterally for geometrical reasons. In a review of the literature, Murray and O'Connor (1998) found that the early direction of creep or cold flow was the same as the compressive joint contact force—i.e., superomedially. Penetration due to wear occurs later and is a function of activity and gait pattern. The direction of the wear was estimated to occur in the superior/lateral direction. This tendency to wear in the lateral direction became more evident with time (Hall et al. 1998).

To our knowledge, only Berger et al. (1999) studied the frequency of dislocation after stem revisions with retained cups and found no dislocations. Other authors have reported frequencies between 8–11% in mixed materials (Callaghan et al. 1985, Kavanagh et al. 1985, Kershaw et al. 1991). In our study 3 cases (6%) had one dislocation each. This is the same or less than that found by us in cases where a cemented Charnley cup was inserted at the revision (11%, 5/46) (Hultmark et al. 2001b). Thus, an increase in the risk of dislocation did not seem to be an argument to extract a well-fixed Charnley cup.

The width of the radiolucent lines did not increase significantly after the index operation. They rarely exceeded 1 mm even in the 4 cases classified as radiographic failures. This accords with our earlier observations (Hultmark et al. 2001a) that the cup can become completely surrounded by radiolucent lines even if they do not exceed 1 mm in width at any location. Therefore, we think that use of 1 mm as a lower limit for a definite radiolucent line is too narrow.

In conclusion Charnley cups without complete radiolucent lines and little, if any, wear can be retained without compromising the longevity of the implant. It should, however, be stressed that this conclusion is based on a patient population, in which four fifths of the patients at the index operation were 65 years of age or older.

Financial support was obtained from the Greta and Einar Asker Foundation, Hjalmar Sevensson Research Foundation, Neubergh Research Foundation and Göteborg Medical Association.

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