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Migration of the acetabular component after revision with impacted morselized allografts

A radiostereometric 2-year follow-up analysis of 21 cases

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In a consecutive series of hip revisions due to mechanical loosening, using impacted morselized allografts and cement, we followed 21 acetabular components by radiostereometric analysis (RSA) during 2 years. All but 1 acetabular component migrated in the proximal direction (median 2.1 (0.5–6.4) mm). 6 components migrated in the medial direction (median 0.8 (0.4–1.2) mm) and 6 in the lateral (median 0.8 (0.4–2.0) mm). 14 components migrated in the posterior direction (median 0.8 (0.3–2.3) mm) and 1 in the anterior 0.6 mm. The migration rate gradually decreased in all directions, but 7 acetabular components still migrated in at least 1 direction (median 0.3–0.6 mm) between 1.5 and 2 years postoperatively.

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Revision of the acetabular component in hips with loss of bone stock is a major problem. A high risk of radiographic reloosening (Engelbrecht et al. 1990, Strömberg et al. 1992) has been reported when using traditional cementing technique. Operation with impacted morselized allografts and cement has instead been advocated (Slooff et al. 1993). However, little is known about the motion-over-time of the acetabular components in revisions of this type. Due to difficulties in determining the presence and the degree of radiolucency (Brand et al. 1985, Bobyn et al. 1988) and migration of the acetabular component below 4–6 mm (Malchau et al. 1995), conventional radiography cannot detect prosthetic loosening at an early stage. Radiostereometric analysis (RSA) (Selvik 1989), however, can detect minor migration of the acetabular component down to 0.2 mm (Mjöberg et al. 1986, Snorrason and Kärrholm 1990, Önsten and Carlsson 1994).

We recorded by RSA the migration of acetabular components during the first 2 years postoperatively in a consecutive series of hip revisions with impacted morselized allografts and cement.

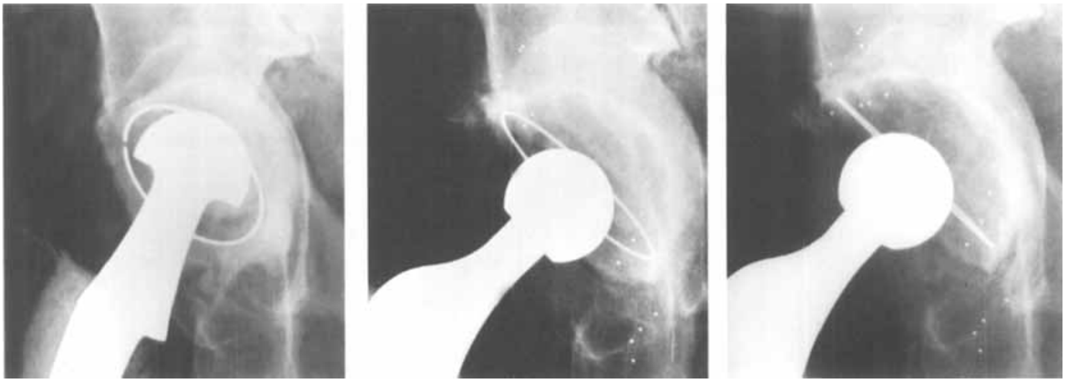
Patients and methods

Patients

During a 2-year period (1994–1995), we revised the acetabular components in 25 consecutive hips, primarily operated on with cemented total hip prosthesis due to arthrosis. All hips were revised for the first time because of aseptic mechanical loosening (Figure). 2 patients with 1 hip revision each died before the 2-year follow-up and in 2 hips, the tantalum balls could not be imaged. Thus, 21 acetabular components in 10 women (1 revised bilaterally) and 10 men aged 74 (56–87) years remained for RSA follow-up. Preoperative bone stock deficiency in the acetabulum was classified according to Gustilo and Pasternak (1988). 6 hips were classified as type I, 6 as type II and 9 as type III. None was classified as type IV.

Surgical technique

The operations were performed by 2 surgeons through a posterolateral incision, without trochanteric osteotomy. In the acetabulum, the subchondral bone was preserved when possible. Fresh frozen femoral heads were thawed in warm (55°–60°C) saline solution for about 20 minutes and



Mechanical loosening of an acetabular component with bone stock deficiency type III, according to Gustilo and Pasternak (1988).

After revision with allografts and before mobilization.

2 years postoperatively.

were then morselized using a Tracer™ Bone Mill with the middle cutter size and a hand-crank. This method produces bone chips with an average size of 3 mm. For delipidization, the bone chips were compressed in a cotton cloth. The whole bottom of the acetabulum including varying bone defects was filled with the allografts and then impacted with bone packers of metal having the same shape as the prostheses, but a 2–4 mm larger diameter. Impaction was achieved by gentle blows with a metal hammer. To anchor the acetabular component, vacuum-mixed prechilled Palacos bone cement containing gentamycin was introduced with a cement gun after 2 minutes and then compressed for 2 minutes with a pressurizer. The standard Exeter low-profile acetabular component was used. In 19 cases, the femoral component was revised with impacted morselized allografts. In 3 cases, a reconstruction plate reinforced the acetabular rim. Prophylactic systemic cloxacillin and low molecular heparin were given. Weight bearing was restricted for 3 months postoperatively.

Radiostereometric analysis (RSA)

To permit RSA evaluation of the prosthetic migration, 0.8 mm tantalum balls were implanted in the acetabular component, tuber ischii and the acetabular roof at surgery (Figure). RSA was performed before mobilization and at 1.5, 3, 6, 12, 18 and 24 months postoperatively.

The technical accuracy of this RSA method was calculated by repeat examinations of 17 patients at the initial RSA. The migration of the acetabular component between these double examinations, expected to be zero within pairs, and the standard deviation ($SD = \frac{\sum d^2}{(n-1)}$) for each migratory direction were calculated. By using the Student's t-distribution, the 99% confidence limits for the smallest significant migrations of the acetabular component in the proximal/distal direction, the medial/lateral direction and the posterior/anterior direction were calculated.

Results

Accuracy of RSA

The standard deviations for the errors of measurement between the repeat examinations were 0.051 mm in the proximal/distal direction, 0.097 mm in the medial/lateral direction and 0.105 mm in the posterior/anterior direction. These values correspond to the smallest significant movement of 0.131 mm, 0.250 mm and 0.270 mm, respectively. Measured migrations of the acetabular component were considered significant, being at least 0.2, 0.3 and 0.3 mm in these directions and numerical values below these levels were classified as having no migration.

Migration

All but 1 of the 21 acetabular components had migrated in the proximal direction, median 2.1 (0.5–6.4) mm at 2 years, 6 in the medial direction, me-

Data on 21 socket revisions with morselized allografts and cement

Months after revision					1.5	3	6	12	18	24	1.5	3	6	12	18	24	1.5	3	6	12	18	24			
A	B	C	D	E	Proximal migration, mm						Medial or Lateral migration, mm						Posterior or Anterior migration, mm						F	G	H
1	m	r	III	No	0.8	1.1	1.3	1.4	1.4	1.5	0.5	0.6	0.7	0.7	0.7	0.8 M	–	0.5	0.6	0.6	0.7	0.8 P	No	No	No
2	f	l	III	No	0.3	0.3	0.5	0.6	0.9	0.9	–	0.3	0.4	1.0	0.7	1.1 M	–	–	–	–	–	–	No	0.4	–
3	f	r	III	No	1.4	*	2.1	2.5	2.6	2.8	0.4	*	1.1	1.1	0.8	1.2 M	0.4	*	0.7	0.9	1.1	1.0 P	No	0.4	No
4	m	l	III	Yes	0.5	0.8	1.1	1.2	1.5	1.4	0.4	0.5	0.6	0.4	0.5	0.4 L	–	0.3	–	0.4	0.5	0.6 P	No	No	No
5	f	r	III	No	1.4	2.0	2.5	2.7	2.7	2.7	–	–	–	–	–	–	0.5	0.6	0.9	1.0	0.9	1.0 P	No	–	No
6	m	l	II	Yes	0.6	1.1	1.5	2.7	2.8	2.9	–	–	–	0.4	0.5	0.8 L	–	0,3	0.5	0.8	0.9	1.1 P	No	No	No
7	m	l	III	No	1.6	1.9	2.7	3.0	3.0	3.1	1.4	1.6	1.9	2.0	2.1	2.0 L	0.8	1.1	1.7	2.0	2.1	2.1 P	No	No	No
8	f	r	III	No	1.8	2.5	3.0	3.3	3.9	4.3	0.9	1.1	1.1	1.1	1.2	0.9 M	0.7	0.8	1.4	1.7	2.0	2.2 P	0.4	0.3	No
9	f	l	II	No	1.0	1.4	1.7	2.0	2.1	2.2	–	–	–	–	–	–	0.3	0.3	–	0.5	–	0.4 P	No	–	0.4
10	f	l	II	No	1.1	1.5	1.7	1.9	2.0	1.9	0.5	–	–	–	–	– L	0.3	0.4	0.4	0.4	0.4	0.5 P	No	No	No
11	m	r	II	No	0.8	1.1	1.9	2.1	2.3	2.3	–	–	–	0.3	0.5	0.4 M	–	0.3	0.7	0.7	0.7	0.5 P	No	No	No
12	f	l	I	No	1.2	1.8	2.3	2.8	2.8	3.1	–	–	–	–	–	–	–	–	0.6	0.7	0.6	0.9 P	0.3	–	No
13	f	r	I	No	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	m	r	I	No	0.4	0.6	0.7	0.8	0.8	0.9	–	0.3	0.4	0.6	0.5	0.4 M	–	–	–	–	–	–	No	No	–
15	m	r	I	No	0.4	0.5	0.6	0.6	0.6	0.6	–	–	–	–	–	–	–	–	–	–	–	–	No	–	–
16	m	r	I	No	0.2	0.3	0.4	0.5	0.5	0.5	–	–	–	–	–	–	–	–	–	–	–	–	No	–	–
17	m	l	III	No	0.5	0.7	0.8	1.1	1.1	1.0	–	–	–	–	–	0.4 L	–	–	0.3	0.3	0.4	0.6 A	No	0.4	No
18	f	r	I	No	0.5	0.8	0.7	0.8	0.8	0.8	–	–	–	–	–	–	–	0.4	–	0.4	0.3	0.3 P	No	–	No
19	f	r	III	Yes	0.7	0.9	1.1	1.2	*	1.2	–	–	0.3	0.6	*	0.9 L	0.3	0.4	0.4	0.4	*	0.6 P	No	No	No
20	f	r	II	No	2.2	3.5	4.3	5.2	*	6.4	0.3	–	–	–	*	– L	0.8	1.2	1.5	1.9	*	2.3 P	0.6	No	No
21	m	r	II	No	2.0	2.9	3.8	4.1	4.2	4.2	0.4	0.5	0.6	0.7	1.0	1.0 L	–	–	–	–	–	–	No	No	–

A Patient number
B Gender
C Side
D Bone stock deficiency according to Gustilo and Pasternak (1988)
E Reconstruction plate used (Yes or No)
F Proximal migration between 1.5 and 2 years (No or mm)
G Medial or lateral migration between 1.5 and 2 years (No or mm)
H Posterior or anterior migration between 1.5 and 2 years (No or mm)
* Missed RSA
– No migration

dian 0.8 (0.4–1.2) mm, 6 in the lateral direction, median 0.8 (0.4–2.0) mm, 14 in the posterior direction, median 0.8 (0.3–2.3) mm and 1 acetabular component migrated 0.6 mm in the anterior direction. The migration rate gradually decreased in all directions during the observation period, but 7 components still migrated between 1.5 and 2 years.

5 components in hips with bone stock deficiency type I migrated in the proximal direction, median 0.8 (0.5–3.1) mm, 1 migrated 0.4 mm in the medial direction and 2 components migrated in the posterior direction 0.3 mm and 0.9 mm, respectively. Between 1.5 and 2 years, 1 component still migrated 0.3 mm in the proximal direction.

All 6 acetabular components in hips with bone stock deficiency type II migrated in the proximal direction, median 2.6 (1.9–6.4) mm, 1 migrated 0.4 mm in the medial, 2 in the lateral direction 0.8 mm and 1.0 mm, respectively, and 5 components migrated in the posterior direction, median 0.5 (0.4–2.3) mm. Between 1.5 and 2 years, 2 components still migrated. 1 component migrated 0.6 mm in the proximal direction and 1 component 0.4 mm in the posterior.

All 9 acetabular components in hips with bone stock deficiency type III migrated in the proximal direction, median 1.5 (0.9–4.3) mm, 4 in the medial direction, median 1.0 (0.8–1.2) mm, 4 in the lateral direction, median 0.7 (0.4–2.0) mm, 7 in the posterior direction, median 1.0 (0.6–2.2) mm and 1 component migrated 0.6 mm in the anterior direction. Between 1.5 and 2 years, 4 components still migrated. 2 components migrated 0.4 mm each in the medial direction, 1 migrated 0.4 mm in the lateral and 1 component 0.4 mm in the proximal direction and 0.3 mm in the medial.

Of the 3 patients who had the acetabular ream reinforced by a reconstruction plate, 1 had a bone stock deficiency type II and 2 type III. All 3 acetabular components migrated in the proximal direction, median 1.4 (1.2–2.9) mm, in the lateral direction, median 0.8 (0.4–0.9) mm and in the posterior direction, median 0.6 (0.6–1.1) mm.

Discussion

Poor bone stock in conventionally-cemented hip revisions entails an increased risk of reloosening (Engelbrecht et al. 1990, Strömberg et al. 1992). Krismer et al. (1996) showed that migration of cemented acetabular component by 1 mm or more within 2 years after surgery reduced the prosthetic survival rate.

RSA (Selvik 1989), used in revision studies, revealed early migration of almost all prosthetic components (Snorrason and Kärrholm 1990, Franzén et al. 1993).

In our series of 21 acetabular revisions, using impacted morselized allografts and cement evaluated by RSA, all but 1 component migrated between 0.5 and 6.4 mm in the proximal direction during the initial 2 years. This migration was larger than in a previous RSA study of a combined series of conventionally-cemented revisions in 10 cases and cement and allografts in 7 cases (Franzén et al. 1993). In another RSA study of conventionally-cemented revisions with an acetabular bone stock deficiency type I in 7 cases, and type II in 8, according to Gustilo and Pasternak (1988), 14 of the 15 acetabular components had migrated at the 2-year follow-up (Snorrason and Kärrholm 1990). Compared to this series, our 6 cases with bone stock deficiency type II had a larger mean migration in the proximal direction. This might be explained by the use of allografts in all our cases, possibly yielding less initial stabilization than when using cement alone. Good long-term results, however, can be achieved after graft incorporation (Slooff et al. 1996), a finding which is supported by histological evidence in dogs and man (Roffman et al. 1983, Schreurs et al. 1994, Buma et al. 1996, Lamerigts et al. 1997). Further RSA follow-up is needed to clarify whether the 7 acetabular components that still migrated between 1.5 and 2 years will come to a standstill and whether the apparent fixed components will remain stable.

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