

Osteoblastic response to osteoarthritis of the hip does not predict outcome of cementless cup fixation

79 patients followed for 5–11 years

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ABSTRACT – We evaluated the influence of osteoblastic response to osteoarthritis of the hip on the outcome of cementless acetabular cup after 91 total hip replacements in 79 patients. Of the 91 hips, 23 were atrophic, 37 normotrophic, and 31 hypertrophic, according to Bombelli's criteria. There were no clinical or radiographic differences among the three groups at the final follow-up (average 7 (5–11) years), when stable bone growth had been achieved by all of the acetabular cups in patients with the atrophic type, 35/37 of the normotrophic type, and all the hypertrophic type. Revision of the acetabular cup was performed on 1 hip of the normotrophic type, in connection with severe polyethylene liner wear and progressive osteolysis. ■

Osteoblastic response by host bone to implant surface may be an important factor affecting longevity of total hip arthroplasty (THA). In patients with osteoarthritis (OA), the type of osteoblastic response, in terms of Bombelli's (1983) classification, has been reported to predict loosening of the cemented acetabular socket (Saito et al. 1987, Kobayashi et al. 1997). The atrophic OA type hips showed a higher incidence of unsatisfactory clinical results and radiographic loosening of the cemented cup than did the hypertrophic or normotrophic OA type hips. The influence of osteoblastic response on cementless THA has not been studied. We thought that cementless fixation may need a higher osteoblastic response to achieve good bone ingrowth or ongrowth fixation. Therefore we inves-

tigated whether there was any association between osteoblastic response and outcome in cementless THA, as previously reported in cemented THA.

Patients and methods

Between 1987 and 1993, a cementless THA, using the Spongiosa Metal Total Hip System (ESKA, Lübeck, Germany), was performed in a consecutive series of 100 hips for 87 patients with OA. All the cases were secondary to acetabular dysplasia or congenital subluxation or dislocation of the hip. No cases of primary osteoarthritis, or completely dislocated hip were included. The stem and metal socket of this system are made of cobalt chrome molybdenum alloy with the entire surface covered by a spongy metal structure similar to cancellous bone. The metal cup has a hemispherical shape with two spikes wedged into the anterior and posterior acetabular rims and one peg inserted into the ischium. The curved stem with a collar anatomically matches the medullary canal of the proximal femur. An interior polyethylene liner (ESKA, Lübeck, Germany) and a modular aluminum ceramic head, having a diameter of 28 mm (BioloX: Ceramtech, Plochingen, Germany), are used for the articulation. As a rule, the cup was placed in the anatomical position of the acetabulum, and a block bone graft from the resected femoral head was used in 14 hips and chip grafts in 23 hips to fill the superolateral bony defect in the acetabulum. Partial weight bearing was started at



Morphological types of osteoarthritis of the hip according to Bombelli's criteria: a) atrophic OA type, showing poor osteophyte formation and gradual reduction in size of the femoral head, b) normotrophic OA type, showing a moderately sized osteophyte formation, c) hypertrophic OA type, having large osteophytes on the margins and floor of the acetabulum as well as around the femoral head.

6 weeks and full weight bearing was allowed at 12 weeks after the operation. Clinical and radiographic assessments were done annually.

2 patients, accounting for 3 hips, died within 5 years after surgery due to causes unrelated to

the hip. Deep infection occurred in 1 hip 4 years postoperatively, and both the acetabular cup and stem were removed. 5 patients (5 hips) were lost to follow-up within 5 years after surgery, but they showed excellent clinical and radiographic results when last reviewed. The remaining 91 hips of 79 patients were the subjects for subsequently analyzed with a minimal follow-up of 5 years. The average age of the patients was 52 (29–67) years at the time of operation, and the average follow-up 7 (5–11) years.

The clinical assessments were based on the Merle d'Aubigné and Postel (1954) hip score, which allocates up to 6 points for each type of pain, mobility, and function, with a total of 18 points given to a normal hip. Osteoblastic response of the arthrotic hips was evaluated with Bombelli's (1983) criteria on preoperative radiographs (Figure). These radiographs were interpreted blindly by two of the authors without knowledge of the clinical and radiographic outcomes. Both observers had the same view about 78 hips, but came to an agreement about the remaining cases. 23 hips were classified as atrophic OA type (A-type), 37 as normotrophic OA type (N-type), and 31 as hypertrophic OA type (H-type). All patients were female, except 1 in the A-type group and 2 in the N-type group. The follow-up period was about the same in the three groups (mean months (SD): 85 (20) in the A-type group, 85 (19) in the N-type group, 87 (15) in the H-type group). The patients' ages at operation differed significantly: 56 years (SD 6) in the A-type group, 53 years (7) in the N-type group, 49 years (8) in the H-type group, the latter being younger than the A-type group ($p = 0.003$, Scheffe test).

At the annual postoperative follow-ups, anteroposterior and lateral radiographs were evaluated for evidence of radiolucent lines, implant fixation, and osteolysis by a zonal interface analysis of the acetabular cup with DeLee and Charnley's method (1976). Fixation of the cup was evaluated by a modified DeLee and Charnley classification (McPherson et al. 1995), according to which fixation by bone ingrowth (type 1) has three subtypes: 1A means the absence of radiolucent lines or migration of the cup, 1B has a radiolucent line in one zone, and 1C has a radiolucent line in two zones. Stable fibrous fixation (type 2) has a com-

Incidence of radiolucent lines around the acetabular cup and cup fixation at the final follow-up

Type of osteoarthritis	Radiolucent line				Cup fixation				
	Present in one or more zones	Zone 1	Zone 2	Zone 3	1A	1B	1C	2	3
Atrophic	2/2 (CI 0–0.22)	2/2	0	0	20/21	2/2	0	0	0
Normotrophic	7/7 (CI 0.06–0.35)	1/1	4/4	5/5	27/29	4/4	1/2	0	2/2 (CI 0–0.14)
Hypertrophic	3/3 (CI 0.02–0.24)	0	0	3/3	24/28	3/3	0	0	0

Values are number of patients/hips, CI = 95 % confidence interval of incidence ratios

plete radiolucent line less than 2 mm in width. Unstable fibrous fixation (type 3) has a complete radiolucent line equal to or greater than 2 mm in width, a progressive zone 3 radiolucent line, or cup migration by more than 2 mm.

Statistical analysis was performed with StatView software (version 5.0; SAS Institute, Cary, North Carolina) and a p-value less than 0.05 was considered significant.

Results

Clinical results

The mean Merle d’Aubigné and Postel hip score of all patients improved from 7.6 (pain 1.2, mobility 3.7, function 2.7) before operation, to 17 (pain 5.9, mobility 5.3, function 5.6) 2 years post-operatively, and to 17 (pain 5.9, mobility 5.3, function 5.5) at the final follow-up. All three groups achieved good hip score improvement from preoperative examinations to the final follow-up: from 8.0 points to 17 in the A-type group, from 7.7 to 17 in the N-type group, and from 7.2 to 17 in the H-type group. There was no statistically significant difference in the hip scores among the three groups at the final follow-up (one-way analysis of variance). The results were unsatisfactory, indicated by a total score of 14 or less, in 2 N-type hips due to stem fracture or disability from osteoarthritis of the contralateral hip, and in 1 H-type hip due to disability from lumbar spondyloarthritis.

Radiographic results

Radiolucent lines in one or more zones around the acetabular cup were seen in 2 patients in the A-type group, 7 patients in the N-type group, and 3 patients in the H-type group at the final follow-up (Table). When adjusted for other factors, including age, sex, follow-up period, and performance of block bone graft, osteoblastic response type showed no significant correlation with the occurrence of a radiolucent line (logistic regression analysis). Satisfactory fixation of the acetabular cup was achieved in all 3 groups at the final follow-up. All patients in A-type and H-type groups, and 32 patients in the N-type group showed bone ingrowth fixation (grades 1A, 1B, or 1C). Osteolysis around the acetabular cup was most marked in the N-type group (6 patients), while only 1 patient in the A-type group and none in the H-type group showed osteolysis.

Two revision operations were performed during the study: 1 hip in the N-type group underwent a revision of the acetabular cup due to unstable fibrous fixation, and 1 hip in the N-type group underwent revision of the femoral stem due to stem fracture without loosening of the cup.

Discussion

The morphological type of osteoarthritis is said to affect the outcome of cemented THA (Saito et al. 1987, Kobayashi et al. 1997): atrophic type hips had a high incidence of unsatisfactory clinical results and acetabular loosening. Histological

examinations showed that bone specimens from hypertrophic type hips had many osteoblasts with few osteoclasts on the surface of subchondral trabeculae, while bone specimens from atrophic type hips had many osteoclasts with fewer osteoblasts (Saito et al. 1987).

These findings suggest that the results with morphological types of osteoarthritis may be similar to those with acetabular cups after cementless THA. Hernández-Vaquero et al. (1996) compared the outcome of threaded acetabular cups after cementless THA among the atrophic, normotrophic, and hypertrophic types of hips at a mean follow-up of 6 years, and found that periprosthetic radiolucent lines and loosening of the acetabular cups occurred significantly oftener in the atrophic hips. Our study, however, showed no significant differences in clinical results, incidence of radiolucent lines or cup fixation after 7 years among the three groups. The discrepancy between the findings of Hernández-Vaquero et al. (1996) and ours may be due to the tendency of threaded cups to fail after a few years (Snorrason and Kärrholm 1990, Yahiro et al. 1995). Adequate bone ingrowth and long-term fixation of the acetabular cup can be achieved only by stable initial fixation into the acetabular bone. If stability is insufficient, minimal bone ingrowth can be expected because of weak osteoblastic activity in atrophic type hips. Here we used a press-fitting technique with underreaming to obtain stable fixation of the acetabular cup. The results half-way through the study using this technique for cup fixation were satisfactory (Morscher 1992, Dorr et al. 1998). Linder et al. (1988) showed that osseointegration with the implant surface was usually attained even in patients with compromised bone quality, such as osteoporosis and rheumatoid arthritis, and adequate initial stability with the acetabular cup we used should have resulted in adequate subsequent bone ingrowth fixation and a successful outcome, even in hips of the atrophic type.

Our study has certain limitations: almost all patients were female, and osteoarthritis secondary to dysplasia or congenital subluxation or dislocation of the hip was evaluated exclusively because these are the main causes of osteoarthritis in our country. This may have affected the relation between the outcome of the arthroplasty and the osteoblastic types of hip. We found no significant

difference among the three groups as regards clinical and radiographic outcomes. However, there may be a true difference among the groups (type II error), because of the limited sample size (Freedman and Bernstein 1999). Further studies in more patients including more males and various causes of osteoarthritis are needed to increase the reliability of the statistical analysis and extrapolate the findings to the usual type of osteoarthritis of the hip or a population with more males.

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