Contemporary Total Hip Arthroplasty with and without Cement in Patients with Osteonecrosis of the Femoral Head

A Concise Follow-up, at an Average of Seventeen Years, of a Previous Report*

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Abstract: We previously evaluated ninety-eight consecutive patients (148 hips) at mean of 9.3 years after total hip arthroplasty; the mean age at the time of the index surgical procedure was 47.3 years. Fifty patients (100 hips) had simultaneous bilateral arthroplasty with a cemented stem in one hip and a cementless stem in the contralateral hip. Forty-eight patients (forty-eight hips) had unilateral hip arthroplasty with a cementless stem. All patients had a cementless acetabular component. In our first report, we found no difference in clinical results, as measured with the Harris hip score and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), between the cementless and cemented stems. One hip (2%) in the hybrid group (a cementless cup and a cemented stem) had revision because of infection and two hips (2%) in the fully cementless group had revision of the femoral component because of a periprosthetic fracture. Between the time of follow-up in that study (at a mean of 9.3 years) and the time of follow-up in the present study (at a mean of 17.3 years), twenty-two revisions of acetabular components were performed, with eight in the hybrid group and fourteen in the fully cementless group. There was no difference in clinical results, as measured with the Harris hip score and the WOMAC, between the hybrid and fully cementless groups. At the time of the present review, forty (83%) of forty-eight acetabular components in the hybrid group and eighty (85%) of ninety-four acetabular components in the fully cementless group were intact. Most of the femoral components (98%) in both groups were intact. Wear and periacetabular osteolysis were the causes of failure in the hips requiring revision.

Level of Evidence: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Background

We previously reported the results at a mean 9.3 years (range, eight to ten years) following the implantation of a femoral stem with or without cement in a consecutive series of 148 primary total hip arthroplasties performed by a single surgeon (Y.-H.K.) at our institution in ninety-eight patients (mean age at the time of the index operation, 47.3 years; range, twenty-six to fifty-eight years) with osteonecrosis of the femoral head[1]. A cementless acetabular component (Duraloc 100 or 1200 series; DePuy, Warsaw, Indiana) made of titanium was used in all hips. In fifty patients, an Elite or Elite-Plus cemented stem (DePuy, Leeds, United Kingdom) was implanted in one hip and a Profile cementless stem (DePuy, Leeds, United Kingdom) was implanted in the contralateral hip during the same operation. In addition, a Profile cementless stem (with the cementless cup) was implanted in forty-eight patients who had a unilateral total hip arthroplasty. The cement technique was so-called third-generation with an intramedullary plug, pulsatile lavage, vacuum-mixed cement inserted with a cement gun and a proximal rubber seal, and a distal centralizer on the stem.

The purpose of this study was to analyze the long-term results associated with these contemporary cemented and

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cementless total hip replacements, with an emphasis on the rates of osteolysis and revision, in patients with osteonecrosis of the femoral head who were followed for a minimum of sixteen years.

Methods

Data were collected prospectively and reviewed retrospectively at a mean of 17.3 years (range, sixteen to eighteen years) postoperatively. Institutional review board approval was obtained for the study. Clinical evaluations were performed with use of the Harris hip score[2] and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[3].

Radiographs were evaluated by one independent observer for component stability[4,5], radiolucent lines, bone-remodeling[5], osteolysis[1], and loosening[1]. The zones described by Gruen et al.[6] and those described by DeLee and Charnley[7] were used to assess the location and extent of radiolucent lines and osteolysis. Osteolysis was defined as a radiolucent lesion that was a minimum of 0.5 cm^2 in size, with loss of the trabecular pattern, that had not been present on the immediate postoperative anteroposterior radiograph of the pelvis[8]. Statistical analysis was performed with the use of the chi-square test with the Yates correction, Student two-tailed t tests, and analysis of variance. The level of significance was set at $p < 0.05$. Kaplan-Meier survival analysis was performed with a reoperation for any reason as the end point[9].

Source of Funding

No external funds were received for this study.

Results

The original study cohort included ninety-eight patients (148 hips). At the time of this review, at a mean of 17.3 years (range, sixteen to eighteen years), four patients (six hips) had been lost to follow-up. Ninety-four patients (142 hips) with a mean age of 64.6 years (range, fifty-one to seventy-eight years) were still living. All patients had clinical and radiographic evaluations at the time of the latest follow-up. Of the fifty original patients treated with bilateral arthroplasty, forty-eight (forty-two men and six women) were available for this latest follow-up evaluation; of the forty-eight original patients treated with unilateral, fully cementless arthroplasty, forty-six (thirty-four men and twelve women) were available. The mean body-mass index was 29 kg/m^2 (range, 22 to 35 kg/m^2).

The Harris hip and WOMAC scores at the earlier and later follow-up times (at a mean of 9.3 and 17.3 years) are summarized in a table in the Appendix; no differences between groups were observed at either time point. The mean polyethylene linear wear per year (and standard deviation) was 0.22 ± 0.12 mm at a mean of 9.3 years and 0.26 ± 0.09 mm at a mean of 17.3 years in the hybrid group (a cementless cup and a cemented stem) and 0.14 ± 0.12 mm at a mean of 9.3 years and 0.19 ± 0.11 mm at a mean of 17.3 years in the fully cementless group. We found the degree of polyethylene wear to have a significant relationship with the age of the patient and the inclination of the acetabular component, but not with weight, sex, hip score, range of motion, anteversion of the cup, center of rotation, femoral offset, abductor moment arm, femoral neck length, or limb length discrepancy (Table I).

Acetabular osteolysis was present in 8% (four) of the fifty hips in the hybrid group at a mean of 9.3 years and in 23% (eleven) of the forty-eight hips in that group at a mean of 17.3

TABLE I Comparison of Patients with Wear of <0.1 mm/yr with Patients with Wear of >0.1 mm/yr

	<0.1 mm/yr (N = 59)	>0.1 mm/yr (N = 35)	P Value
Age under 40 yr *(no. of patients)*	21 (36%)	31 (89%)	<0.0001*
Weight† *(kg)*	66.3 (45-86)	67.8 (52-84)	0.63*
Sex (M:F) *(no. of patients)*	49:10	29:6	0.17‡
Hip score† *(points)*			
Preoperative	44 (5-51)	48 (7-55)	0.83*
Postoperative	96 (75-100)	97 (80-100)	0.91*
Range of motion§ *(deg)*	301.1 (280-318)	300.5 (215-350)	0.74*
Inclination# *(deg)*	40 ± 5	50 ± 5	0.01*
Cup anteversion# *(deg)*	20 ± 3	23 ± 5	0.61*
Center of rotation of hip† *(mm)*			
Horizontal	38.4 (35-41)	38.1 (32-40)	0.17*
Vertical	16.1 (12-20)	15.9 (9-23)	0.16*
Femoral offset† *(mm)*	41.4 (34-49)	39.9 (29-48)	0.812*
Abductor moment arm† *(mm)*	45.1 (38-52)	44.3 (37-51)	0.19*
Femoral neck length† *(mm)*	34.9 (30-43)	35.1 (30-38)	0.78*
Limb length discrepancy# *(cm)*	0.6 ± 0.2 (−1.1-2.1)	0.7 ± 0.6 (−1.3-2.8)	0.71*

*Student t test (two-tailed). †The values are given as the mean with the range in parentheses. ‡Chi-square test 2 × 2. §Total flexion, abduction, adduction, and external and internal rotation. #The values are given as the mean and standard deviation.

years; the rate of acetabular osteolysis in the fully cementless group was 9% (nine of ninety-eight) at a mean of 9.3 years and 24% (twenty-three of ninety-four) at a mean of 17.3 years. There was no difference in the rates of acetabular osteolysis between the patients with bilateral arthroplasty and those with unilateral arthroplasty. The rate of the osteolysis adjacent to the femoral component was 16% (eight of fifty) in the hybrid group at a mean of 9.3 years and 17% (eight of forty-eight) in that group at a mean of 17.3 years; in the fully cementless group, the osteolysis rate was 24% (twenty-four of ninety-eight) at a mean of 9.3 years and 21% (twenty of ninety-four) at a mean of 17.3 years. There was no difference in femoral osteolysis between the bilateral and unilateral arthroplasties.

At a mean of 9.3 years postoperatively, one hip (2%) in the hybrid group had had both components revised because of infection and two hips (2%) in the fully cementless group had had revision of the femoral stem only because of a periprosthetic fracture. No hip in either group had had aseptic loosening of the acetabular metal shell or femoral stem at either the 9.3 or the 17.3-year follow-up interval. We removed twenty-two (15%) of 148 well-fixed acetabular shells because of liner wear and osteolysis. Eight acetabular components (17%) in the hybrid group and fourteen (15%) in the fully cementless group were revised to a ceramic-on-ceramic bearing with a larger-diameter femoral head (Figs. 1-A and 1-B). Therefore, at the time of this review, forty (83%) of the hips in the hybrid group and eighty (85%) of those in the fully cementless group had had an intact acetabular component since the index arthroplasty. Forty-seven (98%) of forty-eight hips in the hybrid group and ninety-two (98%) of ninety-four hips in the fully cementless group had had an intact femoral component at the time of final follow-up.

At eighteen years, with revision considered the end point for failure, the Kaplan-Meier survivorship analysis showed that the rate of survival of the femoral components was 98% (95% confidence interval, 0.91 to 0.99) in both groups and the rate of survival of the acetabular component was 83% (95% confidence interval, 0.77 to 0.86) in the hybrid group and 85% (95% confidence interval, 0.78 to 0.88) in the fully cementless group.

Conclusions

The average long-term wear rate of Charnley acetabular cups has been reported to be 0.07 to 0.15 mm/yr[10-13]. In our series, we noted excessive wear of the polyethylene liner in the hybrid and fully cementless groups. We believe that several factors contributed to this: young age (less than forty years old), excessive inclination of the acetabular component (>50°), and use of a 22-mm femoral head. It has been reported that younger patients have an increased prevalence of polyethylene wear[10-13], and we confirmed that finding in our patients, whose average age was 47.3 years. Inclination of the acetabular component of >50° may produce edge loading and excessive wear of polyethylene. It has been reported that, with approximately equivalent linear wear rates, the volumetric wear rate for 22-mm components was significantly less than that for 28 or 32-mm components[14-16]. In our series, all patients had acetabular components larger than 50 mm. Although

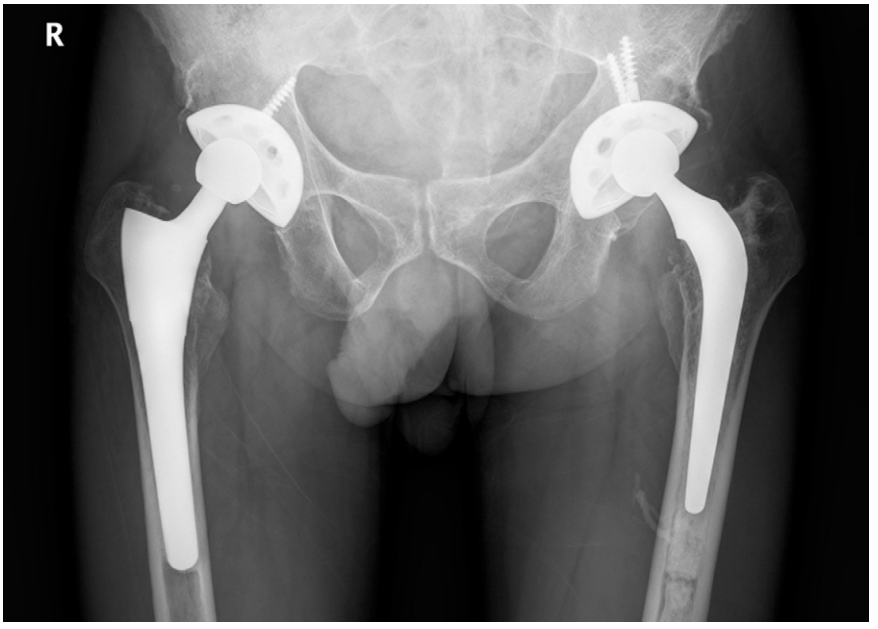

Fig. 1-A

Figs. 1-A and 1-B Anteroposterior radiographs of a man who underwent primary total hip arthroplasty for osteonecrosis of both femoral heads when he was thirty-two years old. **Fig. 1-A** Radiograph obtained fifteen years after surgery reveals that the acetabular and femoral components are embedded satisfactorily. The femoral heads are located eccentrically (migrated 3 mm vertically) within the acetabular components in both hips, suggesting wear of the polyethylene liner. Acetabular osteolysis (2 × 1 cm in size) in zones I and II is seen in both hips. There is no femoral osteolysis.

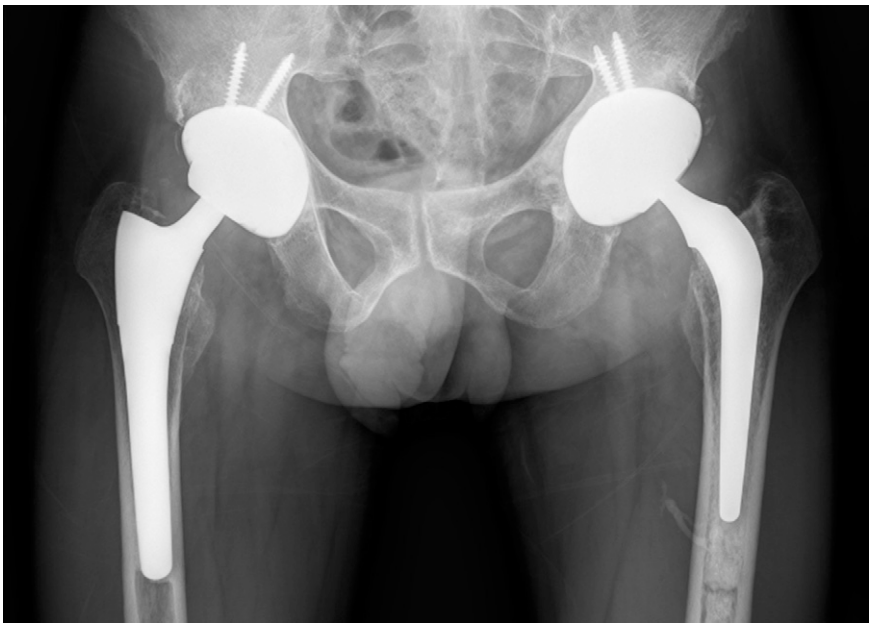

Fig. 1-B

Radiograph obtained three months after revision of both cups with a 36-mm Biolox Delta-on-Biolox Delta (CeramTec, Plochingen, Germany) articulation shows both revised cups fixed in a satisfactory position.

22-mm femoral heads undergo less volumetric wear, this small head could contribute to impingement and lead to excessive wear of the polyethylene.

There was a strikingly high prevalence of acetabular osteolysis in our series, in both the hybrid and the fully cementless group, and this was correlated with the youth of the patients and the amount of polyethylene wear. The sex and weight of the patients did not correlate with the finding of osteolysis. Twenty-two acetabular components (15%) were revised because of periacetabular osteolysis. The reason for not leaving the acetabular components in situ and exchanging the polyethylene was that the acetabular component that was used in this study would not accept a new highly cross-linked polyethylene or alumina Delta ceramic liner. Therefore, both the acetabular metallic shell and the polyethylene liner were revised so that we could use an alumina-on-alumina ceramic bearing to potentially minimize periacetabular osteolysis. There are other options besides revision of the whole cup. A cup in good position can be revised by cementing a highly cross-linked polyethylene liner into the cup. In patients older than seventy years, the conventional, non-highly cross-linked polyethylene liner can be used if the cup is in a good position.

The revision rate associated with total hip arthroplasty with cement in young patients has been reported to range from 5% to 49% over follow-up periods of sixteen to twenty-three years[17-19]. Femoral revision rates at fifteen years following fully cementless total hip arthroplasties have been reported to be 1% to 4%[20,21]. The reported rates of revision of acetabular components in young patients have ranged from 1% to 40% at fifteen years postoperatively[17-19]. Aseptic loosening has been the most common cause of revision of both cemented and cementless total hip replacements. In our series, aseptic loosening of the acetabular or femoral component was very rare. We believe that better cementing technique (grades A, B, and C_1[22]), solid fixation of cementless femoral and acetabular components, and the strong trabecular bone in young patients were factors contributing to the low prevalence of aseptic loosening of the components.

On the basis of our results in young patients with osteonecrosis of the femoral head, we concluded that contemporary cementless cups and cemented or cementless stems provide durable long-term fixation and substantial pain relief well into the second decade after the operation. Although the long-term fixation of the acetabular metallic shell and cemented or cementless femoral stem was outstanding, wear and periacetabular osteolysis constitute the major challenge associated with these contemporary total hip arthroplasties with or without cement in young patients with osteonecrosis of the femoral head.

Appendix

eA A table showing Harris hip scores and WOMAC scores for the mean follow-up time of 9.3 years and 17.3 years is available with the online version of this article as a data supplement at jbjs.org. ■

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