Alumina-on-Alumina Total Hip Arthroplasty

A Concise Follow-up, at a Minimum of Ten Years, of a Previous Report*

By Young-Kyun Lee, MD, Yong-Chan Ha, MD, Jeong Joon Yoo, MD, Kyung-Hoi Koo, MD, Kang Sup Yoon, MD, and Hee Joong Kim, MD

Investigation performed at the Department of Orthopaedic Surgery, Seoul National University College of Medicine, Seoul, South Korea

Abstract: We previously reported the five-to-six-year results of the use of third-generation alumina-on-alumina bearings in a consecutive series of 100 primary cementless total hip arthroplasties. This report presents the longer-term outcomes of these same bearings, at a minimum of ten years postoperatively. Eighty-six of eighty-eight hips available for the study retained the original bearings at the time of the latest follow-up. Thirteen hips were associated with noise, and six hips demonstrated fretting of the femoral neck on radiographs. Two hips required a change of the bearings because of a ceramic head fracture. The ten-year survival rate of the alumina-on-alumina total hip prostheses, with revision of any implant for any reason as the end point, was 99.0%. On the basis of those results, we concluded that the rate of survival of primary cementless total hip prostheses with third-generation alumina-on-alumina bearings is excellent at ten years. However, the risk of ceramic fracture, noise, and impingement between the metal neck and the ceramic liner should be a concern to surgeons, and patients should be informed of these risks before surgery.

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 minimum of five years following the implantation of third-generation alumina-on-alumina bearings (BIOLOX forte; CeramTec, Plochingen, Germany) in a consecutive series of 100 primary alumina-on-alumina cementless total hip arthroplasties performed in eighty-four patients by a single surgeon at our institution[1]. All of the bearings were made of hot isostatic pressed, laser-marked, and proof-tested third-generation BIOLOX forte alumina (CeramTec). The acetabular components were hemispherical titanium cups (Plasmacup SC; Aesculap, Tuttlingen, Germany) with an outer coating of plasma-sprayed pure titanium (Plasmapore; Aesculap). The cementless femoral components were slightly tapered, rectangular, collarless titanium-alloy implants (BiCONTACT; Aesculap). The proximal one-third of the stems was also coated with Plasmapore. The 28-mm modular alumina femoral heads were secured with a Morse taper, and the alumina acetabular inserts were secured with use of a self-securing conical fit.

The mean age of the eighty-four patients included in the previously reported cohort[1] was forty-one years (range, eighteen to sixty-five years) at the time of the index surgery. After a minimum of five years of follow-up, only one hip had undergone a reoperation, which was performed because of a ceramic fracture following a serious motor-vehicle collision. There was no detectable wear or periprosthetic osteolysis in the series. No hip demonstrated radiographic signs of loosening of any component or of hip dislocation. One periprosthetic femoral fracture occurred; it healed with nonoperative treatment. The goal of this update was to present the longer-term outcomes associated with these bearing couples.

Methods

The patients were evaluated prospectively, and data were reviewed retrospectively at a minimum of ten years postoperatively. Institutional review board approval was obtained for the study. Clinical evaluations were performed with use of the Harris hip score[2], the Western Ontario and McMaster

Original Publication

Yoo JJ, Kim YM, Yoon KS, Koo KH, Song WS, Kim HJ. Alumina-on-alumina total hip arthroplasty. A five-year minimum follow-up study. J Bone Joint Surg Am. 2005;87:530-5.

Disclosure: In support of their research for or preparation of this work, one or more of the authors received, in any one year, outside funding or grants of less than $10,000 from Seoul National University Hospital Research Fund (grant number 06-03-063). Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity.

Universities Osteoarthritis Index (WOMAC) score[3], and a questionnaire that included items regarding any noise during daily activity (the presence of noise; the nature, time of onset, and frequency of the noise as well as activities associated with the noise; awareness of the noise by other people; the intensity of the noise over time; associated pain; and the affect of the noise on the quality of life).

Radiographs were evaluated by two independent observers (Y.-K.L. and H.J.K.) with respect to component stability[4], radiolucent lines[1], calcar resorption[5], osteolysis[6], and loosening[7]. The zones described by Gruen et al.[8] and those described by DeLee and Charnley[9] were used to assess the location and extent of radiolucent lines and osteolysis. Osteolysis was defined as a periprosthetic cystic or scalloped lesion with a diameter exceeding 2 mm that had not been present on the immediate postoperative radiograph[6,10]. In addition, serial radiographs were reviewed for femoral neck fretting, which was interpreted as evidence of impingement of the metal neck on the ceramic liner[11].

Kaplan-Meier survival analysis[12] was performed with use of three end points: revision of any implant for any reason, a reoperation for any reason, and any reoperation or radiographic evidence of osteolysis or loosening.

Source of Funding

This study was funded internally by the Seoul National University Hospital Research Fund (grant number 06-03-063).

Results

At a minimum of ten years postoperatively, of the original eighty-four patients, four (with six total hip arthroplasties) had died and six (with six total hip arthroplasties) had been lost to follow-up, which left eighty-eight hips in seventy-four patients. Of these seventy-four patients, sixty-eight (eighty-one hips) had both clinical and radiographic evaluations and six (seven hips) underwent only a clinical evaluation conducted by telephone and with a questionnaire sent by mail (Table I). The latest clinical and radiographic evaluations were performed at a mean of 131 months (range, 120 to 142 months) and 130 months (range, 120 to 142 months), respectively, after the operation. The study group included forty-five men and twenty-nine women. The mean age of the patients at the time of the index arthroplasty was forty-one years (range, eighteen to sixty-five years), and the mean body mass index was 23.6 kg/m^2. The most common diagnosis, recorded for forty-four hips (50%), was osteonecrosis of the femoral head (Table II). A short-neck modular femoral head component was used in forty-seven hips; a medium-neck component, in thirty-two hips; and a long-neck component, in nine hips.

TABLE I Follow-up Data

	No. of Patients	No. of Hips
Initial cohort	84	100
Died without ten-year data	4	6
Lost to follow-up before ten years	6	6
Cohort with ten-year data	74	88
Clinical and radiographic data	68	81
Clinical data only	6	7

TABLE II Initial Diagnosis Leading to Total Hip Replacement

	No. of Hips (N = 88)
Osteonecrosis of femoral head	44
Primary coxarthrosis or coxarthrosis after hip dysplasia	15
Sequelae of hip-joint infection	9
Sequelae of Legg-Calvé-Perthes disease	8
Ankylosis of hip joint	4
Rheumatoid arthritis	2
Miscellaneous conditions	6

The mean preoperative Harris hip score for the entire series was 59 points (range, 30 to 84 points), and the mean postoperative score for the seventy-four patients followed for at least ten years was 96 points (range, 87 to 100 points). At the last follow-up evaluation, the mean WOMAC score was 12.9 points (range, 0 to 44 points). Twelve (14%) of the eighty-eight hips were associated with an intermittent clicking sound, and one hip had squeaking. None of the "clicking" hips were associated with pain or any modification of daily activities, and all clicking occurred when the patient was rising from a squatting position. With the numbers available, no significant associations were found between hip noise and patient-related or prosthesis-related factors, including age, sex, weight, height, body mass index, position of the implant, or neck length of the femoral component. A patient with bilateral total hip arthroplasty, who was twenty-six years old at the time of the index surgery, reported an audible squeak (several times per day) in the right hip, only during swaying to the side, that had begun seven years postoperatively. However, this noise was not reproducible during our outpatient evaluation. The remaining total hip prostheses were completely problem-free.

All of the eighty-one hips had radiographic evidence of bone ingrowth at the time of the most recent follow-up. Ten hips (11%) in the previous study[1] had a radiolucent line only in Gruen zone[8] 3, 4, or 5. No additional hip was found to have developed a radiolucent line around any implant at the time of the longer follow-up. Furthermore, the radiolucent lines in these ten hips had not changed from their previous appearance. None of the radiolucent lines measured >2 mm in width. Rounding off of the sharp medial edge of the resected femoral neck was a frequent finding (Fig. 1), but no calcar resorption was detected in any hip. No

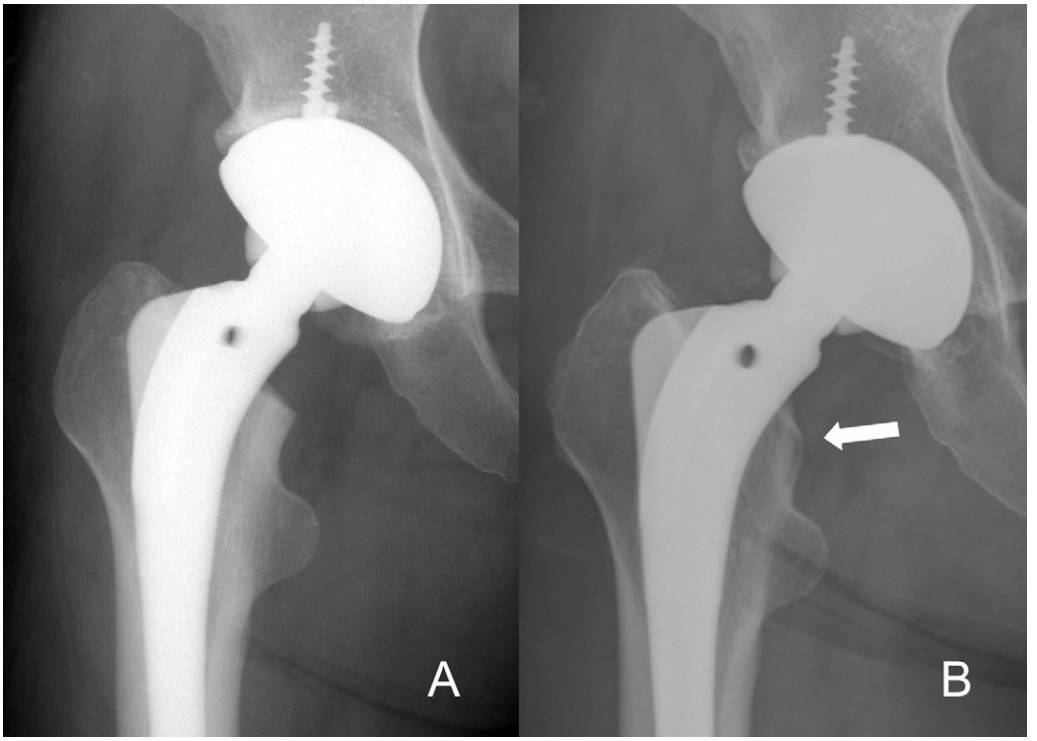

Fig. 1

Anteroposterior radiographs showing a sharp medial edge of the resected femoral neck immediately postoperatively (A) and rounding off of that edge at ten years after the total hip arthroplasty (arrow) (B).

hip demonstrated radiographic signs of loosening. Periprosthetic osteolysis was not detected around any cup or stem. Although no fracture of an alumina liner or notch-sensitive titanium stem occurred in this series, fretting of the femoral neck was observed on the translateral radiographs of six hips (7%) (Fig. 2). The mean interval from the index

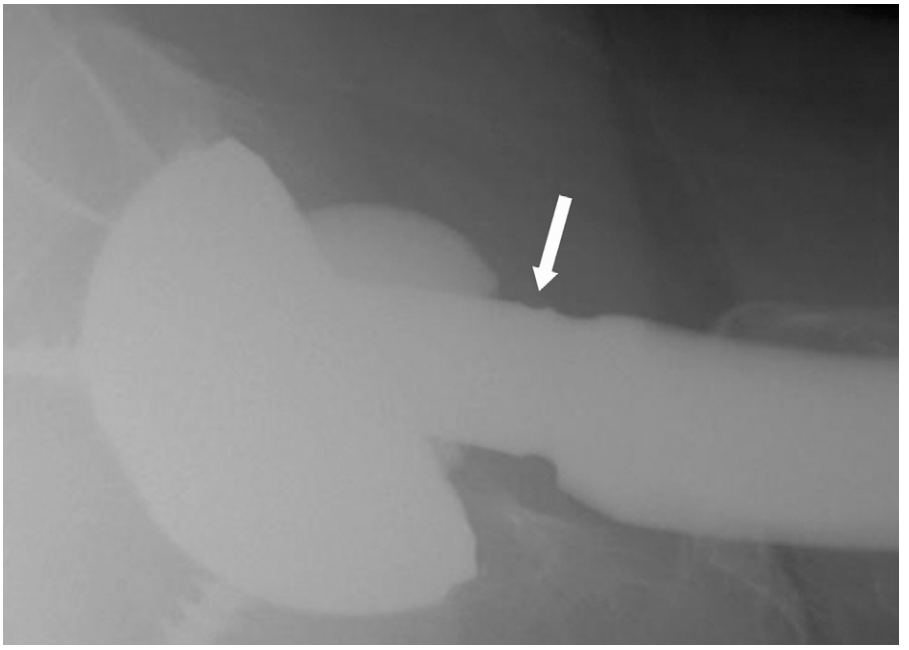

Fig. 2

Translateral radiograph of a hip, made 7.5 years after the total hip arthroplasty, showing fretting of the anterior aspect of the neck (arrow).

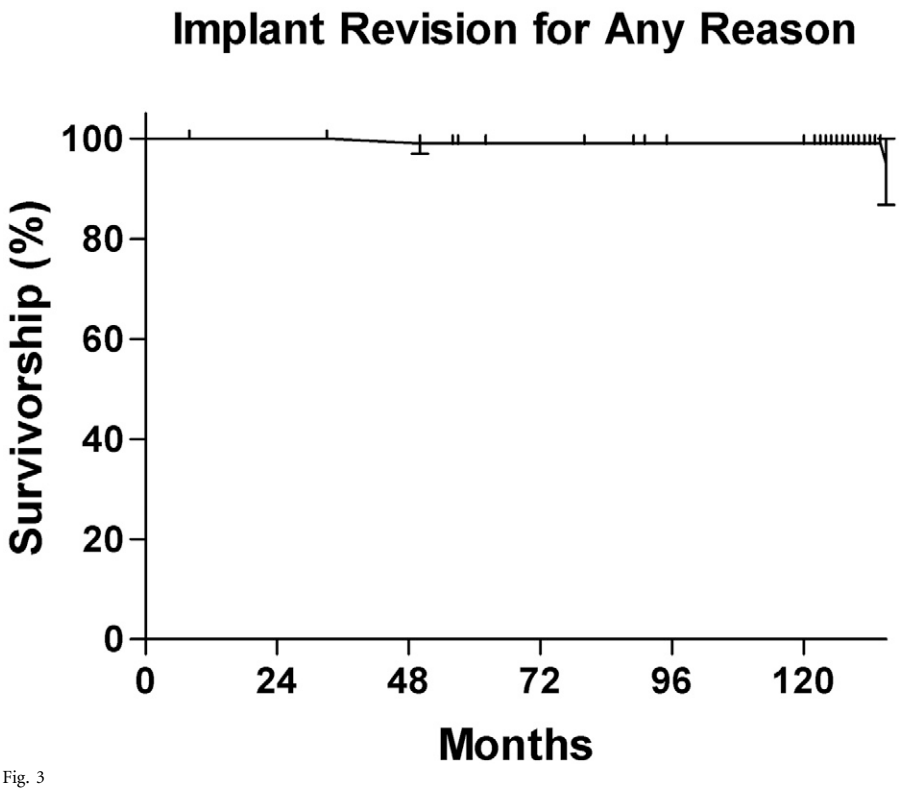

Fig. 3

Kaplan-Meier curve, with any implant revision for any reason as the end point. The tick marks indicate censored data. The I-bars indicate the 95% confidence intervals.

surgery to the appearance of fretting was 7.2 years (range, 4.7 to 10.3 years). All of the fretting was observed on the anterior portion of the neck. Only one neck had fretting before the five-year follow-up evaluation. With the numbers available, we found no significant associations between fretting and patient-related or prosthesis-related factors, including hip noise, age, sex, weight, height, body mass index, ability to sit in the so-called tailor position, duration that the prosthesis was in situ, position of the implant, or neck length of the femoral component.

Two ceramic femoral head fractures occurred in this series. Previously, we reported on a fracture sustained by a patient who was in a motor-vehicle collision[1] and, since that report, an additional ceramic femoral head fracture occurred. That fracture occurred without trauma, eleven years and three months after the surgery. The patient reported a crunching sensation when rising from the toilet, and two days later radiographs confirmed the fracture. The fractured alumina femoral component had a 28-mm short neck, which was reported by Koo et al. to be prone to fracture[13]. In this patient, we replaced the bearing surface with a cobalt-chromium femoral head and polyethylene insert and left the well-fixed stem and cup in place, as was done in our other patient[1]. At the time of writing, both patients remained under close observation for wear of the polyethylene liner[14].

During the period between the previous and the current report, an additional patient sustained a periprosthetic fracture, after falling from a height of 3 m. The fracture occurred around a well-fixed stem at six years and two months postoperatively. It was treated with open reduction and internal fixation with use of cable and wire, and subsequently it completely healed without an additional procedure.

Since the original report, only one hip has dislocated. This dislocation, of the right hip, occurred seven years and three months postoperatively in a patient who had undergone bilateral total hip arthroplasty. An open reduction was performed; the bearing was not exchanged, and the dislocation did not recur.

Overall, there were only four reoperations during the follow-up period. These included two implant revisions, each for a fracture of an alumina femoral head; one procedure for the treatment of a periprosthetic fracture; and one for the treatment of a dislocation.

Kaplan-Meier survivorship analysis based on eighty-eight hips at risk, with any implant revision for any reason as the end point, revealed a cumulative survival rate of 99.0% (95% confidence interval, 97.0% to 100%) at ten years (Fig. 3). With a reoperation for any reason as the end point, the ten-year survival rate was 96.9% (95% confidence interval, 93.4% to 100%). Survivorship analysis revealed that, at ten years, 96.9% of the hips were not associated with any reoperation or radiographic evidence of osteolysis or loosening.

Conclusions

The third-generation alumina-on-alumina bearings used for primary cementless total hip arthroplasty in this study were found to produce excellent clinical results and implant survival rates, with no detectable osteolysis at a minimum of ten years postoperatively. On the basis of these results, we believe that improved alumina-on-alumina bearing implants are a reasonable option for young, active patients, and we continue to use ceramic-on-ceramic bearing couples for the majority of primary total hip arthroplasties in this patient group. However, our findings suggest that surgeons should be aware of the potential risks of ceramic fracture, noise, and impingement between the metal neck and the ceramic liner when using an alumina-on-alumina articulation; accordingly, patients should be informed of these risks. Additional, longer-term follow-up is necessary to assess the potential adverse effects of these concerns on the longevity of this total hip prosthesis. ■

Young-Kyun Lee, MD
Yong-Chan Ha, MD
Jeong Joon Yoo, MD
Kyung-Hoi Koo, MD
Kang Sup Yoon, MD
Hee Joong Kim, MD
Department of Orthopaedic Surgery,
Seoul National University College of Medicine,
28 Yeongeon-dong, Jongno-gu,
Seoul 110-744,
South Korea.
E-mail address for H.J. Kim: oskim@snu.ac.kr

References

1. Yoo JJ, Kim YM, Yoon KS, Koo KH, Song WS, Kim HJ. Alumina-on-alumina total hip arthroplasty. A five-year minimum follow-up study. J Bone Joint Surg Am. 2005;87:530-5.

2. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am. 1969;51:737-55.

3. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol. 1988;15:1833-40.

4. Engh CA, Bobyn JD, Glassman AH. Porous-coated hip replacement. The factors governing bone ingrowth, stress shielding, and clinical results. J Bone Joint Surg Br. 1987;69:45-55.

5. Sarmiento A, Gruen TA. Radiographic analysis of a low-modulus titanium-alloy femoral total hip component. Two to six-year follow-up. J Bone Joint Surg Am. 1985;67:48-56.

6. Joshi RP, Eftekhar NS, McMahon DJ, Nercessian OA. Osteolysis after Charnley primary low-friction arthroplasty. A comparison of two matched paired groups. J Bone Joint Surg Br. 1998;80:585-90.

7. Martell JM, Pierson RH 3rd, Jacobs JJ, Rosenberg AG, Maley M, Galante JO. Primary total hip reconstruction with a titanium fiber-coated prosthesis inserted without cement. J Bone Joint Surg Am. 1993;75:554-71.

8. Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. Clin Orthop Relat Res. 1979;141:17-27.

9. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res. 1976;121:20-32.

10. Maloney WJ, Jasty M, Harris WH, Galante JO, Callaghan JJ. Endosteal erosion in association with stable uncemented femoral components. J Bone Joint Surg Am. 1990;72:1025-34.

11. Sugano N, Nishii T, Miki H, Yoshikawa H, Sato Y, Tamura S. Mid-term results of cementless total hip replacement using a ceramic-on-ceramic bearing with and without computer navigation. J Bone Joint Surg Br. 2007;89:455-60.

12. Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. J Am Stat Assoc. 1958;53:457-81.

13. Koo KH, Ha YC, Jung WH, Kim SR, Yoo JJ, Kim HJ. Isolated fracture of the ceramic head after third-generation alumina-on-alumina total hip arthroplasty. J Bone Joint Surg Am. 2008;90:329-36.

14. Allain J, Goutallier D, Voisin MC, Lemouel S. Failure of a stainless-steel femoral head of a revision total hip arthroplasty performed after a fracture of a ceramic femoral head. A case report. J Bone Joint Surg Am. 1998;80:1355-60.