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Fracture of the Alumina-bearing Couple Delta Ceramic Liner

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abstract

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The fracture rate of third-generation ceramic liners is greatly reduced compared with first- and second-generation liners because of improvements in the design and manufacturing process. Fractures of the alumina-bearing couple are rare for the same reason.

This article describes a case of a fracture of an alumina-bearing couple delta ceramic liner without trauma history that was treated with ceramic-on-polyethylene revision total hip arthroplasty. A 57-year-old man was admitted to the hip ward because of an alumina-bearing couple delta ceramic liner fracture. He underwent hip replacement by anterior approach 18 months previously in the same center because of left hip primary osteoarthritis. He received a 54×36-mm modular press-fit cup ceramic alumina-bearing couple delta insert. Probable causes of such fractures are manufacture production failure and edge loading based on cup inclination, but in our patient, inacceptable range of motion, failure of the locking mechanism during implantation insertion, or cracking were possible causes of fracture.

Although the fracture rate of third-generation alumina-bearing couples is low, we believe that it may not be possible to eliminate the actual risk of alumina head fracture. Patients should be informed about the potential for this complication before receiving an alumina-bearing couple.

Figure: Fractured alumina-bearing couple delta ceramic liner.

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Traditional total hip arthroplasty (THA) using metal-on-polyethylene bearings is a reliable procedure.[1] Alumina-bearing couples (ABCs) are an alternative for THA and have been used for >20 years. Interest in alumina ceramic-on-ceramic bearings is largely due to good wear characteristics and relatively low biological reactivity of the wear particles. Retrievals have shown linear wear rates 4000-fold less than conventional metal-on-polyethylene bearings of the same era[2] and have consistently shown low wear rates in clinical and laboratory studies.[3]

Compared with other articular surfaces, ABCs are denser, more resistant to scratches, and more hydrophilic. Use of these bearings results in a decrease of erosion and reduction of particle pressure into surrounding tissue and does not have the risk of metal ion release.[4] Because of these advantages, these articular surfaces are preferred for young, active patients.[5] First- and second-generation ceramics had a fracture rate of 5% to 13%, respectively.[6]

The current (third-generation) ceramic manufacturing, which uses hot isostatic pressing, produces a highly pure, fully dense ceramic with a small grain size. The grain size in first-generation ceramics was 4.2 μm, compared with 3.2 μm in second-generation and 1.8 μm in third-generation ceramics.[5] The current generation has improved in stability compared with previous models, and the fracture rate is approximately 0% to 0.004%.[7] After approximately 5 years of clinical investigations, the use of ABCs for THA in the United States was approved by the Food and Drug Administration in February 2003.[4]

This article describes a rare fracture of an alumina-bearing couple (ABC) delta ceramic liner, which was located in the intra-acetabular cup (modular press-fit cup) and Stolzalpe-Buchner-Graf stem (Smith & Nephew, Memphis, Tennessee) by an anterior surgical approach of the Stolzalpe technique, which was accrued 18 months postoperatively with no trauma.

Case Report

A 57-year-old man was admitted to the hip ward of Stolzalpe Hospital in Austria because of an ABC delta ceramic liner fracture. He had undergone THA by anterior approach 18 months prior in the same center because of left hip primary osteoarthritis and received a 54×36-mm modular press-fit cup and ABC delta ceramic insert. The acetabular component was set in 450° of abduction and 150° of anteversion.

The patient had a safe postoperative period. At 18 months postoperatively, he had tenderness and a clicking sound in his left hip. On physical examination, no findings except hip tenderness during walking and at the end of his hip range of motion were found. A ceramic liner fracture was detected on radiographs. During revision surgery, the surgeon discovered that the ABC delta ceramic liner was fractured into multiple particles. The femoral and acetabular components were fixed well, and the ceramic head was intact (Figures 1, 2). Extensive sinovectomy was performed to remove multiple ceramic particles, and polyethylene and a new ceramic head were inserted. The had no postoperative tenderness or a limp.

Figure 1: Radiograph showing a failed ceramic hip arthroplasty.

Figure 2: Fractured alumina-bearing couple delta ceramic liner.

Discussion

Early generations of ABCs were often associated with mechanical loosening of the socket and ceramic implant fracture, and sporadic cases of excessive wear of the bearing surfaces occurred. These problems were attributed to suboptimal implant design, poor quality control, and the intrinsic brittle nature of ceramic materials.[8-10]

Optimum density and a fine microstructure are necessary to provide good mechanical strength. The ABC, now in its third generation, has significantly improved in terms of its mechanical properties, including purity, grain microstructure, and burst strength, through the evolution of design features and manufacturing processes over the past 3 decades and through the introduction of proof testing.[5,7,11]

Alumina-bearing couples have several theoretical advantages. Ceramics are hard, which makes them wear- and scratch-resistant. In hip simulator testing, ABCs produced linear wear rates of <1 micron per year, compared with 200 microns per year for a traditional cobalt chrome-on-polyethylene bearing surface.[12]

D'Antonio et al[13] performed a prospective, randomized study, in which 514 hips were implanted. All patients (mean age, 53 years) received the same press-fit hydroxyapatite-coated femoral stem; two-thirds (345 hips) received ABCs, and one-third (169 hips) received a cobalt chrome-on-polyethylene bearing. At a mean follow-up of 35.2 months (range, 24-48 months), no significant difference existed in clinical performance between the cohorts. No ceramic fracture or ABC failure occurred in their study.

Min et al[14] studied 147 patients after THA. They reported that delayed ceramic liner fractures occurred in 3 (1.7%) hips, all in men, with no trauma. The ages of the patients at the time of fracture were 33, 46, and 28 years. The mean age, height, and weight of these patients did not differ significantly from those of the overall group. The mean time between implantation and ceramic liner fracture was 9 months. All hips underwent revision surgery, and the retrieved implants and surrounding soft tissues were examined macroscopically and microscopically. All hips had radiographic evidence of bone integration at the final follow-up examination. No acetabular cups or femoral stems were revised due to aseptic loosening. Head fracture occurred in 2 (1.1%) hips. Another ABC delta ceramic liner was chipped during insertion because of eccentric seating of the liner.

In a study by Murphy,[15] 60 of 261 THAs were seen at a minimum of 2 years and a mean of 40 months postoperatively (range, 26-72 months). The group of 261 hips had a mean follow-up of 14.5 months. Three revision surgeries were necessary due to failure of osseointegration of a femoral component in a necrotic proximal femur (n=1), malseating of an acetabular liner treated by proper reinsertion of the liner (n=1), and an acetabular component that was displaced intraoperatively and recognized in the postanesthesia care unit, which required prompt revision (n=1). Reoperations other than revision included irrigation and debridement for acute infection (n=1), irrigation and debridement with no infection (n=1), open reduction and internal fixation of a postoperative greater trochanteric fracture (n=1), and open reduction and internal fixation of a greater trochanteric nonunion (n=2). No dislocations or bearing fractures occurred, and no radiographic evidence of wear or lyses was present.

Misalignment of the acetabular shell, which results in pressure on the edges in vertical insertion and impingement between the liner and neck in horizontal insertion of the cup, may be a cause of fracture. Impingement may be the result of an insufficient oscillation angle, which is related to the head diameter and geometry of the femoral neck and acetabulum component. However, the component in our patient was in the proper position. Therefore, impingement was not probable as the cause of the fracture.[16]

Fracture can occur due to manufacture production failure and edge loading based on cup inclination, but in our patient, unacceptable range of motion, failure of the locking mechanism during insert implantation, or cracking during implantation was the cause.

Although fracture of third-generation ABCs is uncommon, it may not be possible to eliminate the risk of alumina head fracture. Patients should be informed about the potential for this complication before receiving an alumina-on-alumina bearing couple.

REFERENCES

1. D'Antonio J, Capello W, Manley M. Alumina ceramic bearings for total hip arthroplasty. *Orthopedics*. 2003; 26(1):39-46.
2. Murphy SB, Ecker TM, Tannast M. Two-to 9-year clinical results of alumina ceramic-on-ceramic THA. *Clin Orthop Relat Res*. 2006; 453:97-102.
3. Garino JP. Modern ceramic-on-ceramic total hip systems in the United States: early results. *Clin Orthop Relat Res*. 2000; (379):41-47.
4. Capello WN, Dantonio JA, Feinberg JR, Manley MT. Alternative bearing surfaces: alumina ceramic bearings for total hip arthroplasty. *Instr Course Lect*. 2005; 54:171-176.
5. Bierbaum BE, Nairus J, Kuesis D, Morrison JC, Ward D. Ceramic-on-ceramic bearings in total hip arthroplasty. *Clin Orthop Relat Res*. 2002; (405):158-163.
6. Tateiwa T, Clarke IC, Williams PA, et al. Ceramic total hip arthroplasty in the United States: safety and risk issues revisited. *Am J Orthop (Belle Mead NJ)*. 2008; 37(2):E26-E31.
7. Willmann G. Ceramic femoral head retrieval data. *Clin Orthop Relat Res*. 2000; (379):22-28.
8. Mahoney OM, Dimon JH III. Unsatisfactory results with a ceramic total hip prosthesis. *J Bone Joint Surg Am*. 1990; 72(5):663-671.
9. Boehler M, Knahr K, Plenk H Jr, Walter A, Salzer M, Schreiber V. Long-term results of uncemented alumina acetabular implants. *J Bone Joint Surg Br*. 1994; 76(1):53-59.
10. Hamadouche M, Boutin P, Daussange J, Bolander ME, Sedel L. Alumina-on-alumina total hip arthroplasty: a minimum 18.5-year follow-up study. *J Bone Joint Surg Am*. 2002; 84(1):69-77.
11. Skinner HB. Ceramic bearing surfaces. *Clin Orthop Relat Res*. 1999; (369):83-91.
12. Taylor SK, Serekian P, Manley M. Wear performance of a contemporary alumina: alumina bearing couple under hip joint simulation. In: Transactions of the 44th Annual Meeting, Orthopaedic Research Society; 1998; New Orleans, LA.
13. D'Antonio J, Capello W, Manley M, Bierbaum B. New experience with alumina-on-alumina ceramic bearings for total hip arthroplasty. *J Arthroplasty*. 2002; 17(4):390-397.
14. Min BW, Song KS, Kang CH, Bae KC, Won YY, Lee KY. Delayed fracture of a ceramic insert with modern ceramic total hip replacement [published online ahead of print June 21, 2006]. *J Arthroplasty*. 2007; 22(1):136-139.
15. Murphy SB. Alumina ceramic-ceramic total hip arthroplasty using computer-assisted surgical navigation and a new minimally invasive technique. In: Lazennec J, Dietrich, M, eds. *Bioceramics in Joint Arthroplasty.* Darmstadt, Germany: Steinkopff Verlag, 2004:61-64.
16. O' Brien DA, Rorabeck CH. Managing bone loss in revision total hip arthroplasty: the acetabulum. *Instr Course Lect*. 2006; 55:263-277.