

Fourth generation head fracture in ceramic-on-polyethylene bearing after hip revision surgery: a case report

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Summary. Fourth generation ceramic bearings (BIOLOX delta, CeramTec AG; Phlochingen, Germany) were developed to reduce wear debris and improve fracture resistance. A case of a fourth generation head fracture in ceramic-on-polyethylene (COP) coupling after hip revision surgery is reported. A 58-year-old man was admitted to our department for increasing hip pain following a direct trauma which occurred during skiing activity 4 months before. Six years earlier, he had undergone a right cementless revision surgery with a 36-mm BIOLOX delta femoral head on polyethylene liner for metallosis and foreign body reaction after primary total hip replacement for hip osteoarthritis. At admission, radiological evaluation revealed a fracture of ceramic femoral head requiring a new revision surgery. Extensive synovectomy, lavage and capsulectomy were performed. Both acetabular cup and femoral stem were well fixed with no damage of trunnion, and therefore they were retained. A 36-mm internal diameter polyethylene acetabular liner was inserted along a 36-mm BIOLOX delta head with a BioBall adapter XL. The postoperative course was uncomplicated. At 1-year follow-up, the patient had a complete functional recovery. To our knowledge, BIOLOX delta ceramic femoral head fracture after COP hip revision surgery has not been previously reported. (www.actabiomedica.it)

Key words: total hip arthroplasty, revision hip surgery, ceramic-on-polyethylene, BIOLOX delta ceramic head, fracture

Introduction

In the last two decades, use of ceramic bearings in THA has been increased thanks to improved mechanical properties. In 2003 BIOLOX delta ceramic bearings (BIOLOX delta, CeramTec AG; Phlochingen, Germany) were developed in total hip arthroplasty (THA). Addition of Zirconium, Chromium and Strontium that stabilizes composite alumina matrix has resulted in increased fracture resistance of BIOLOX delta compared with BIOLOX forte ceramic bearings introduced in 1994 (BIOLOX Forte CeramTec AG; Phlochingen, Germany) (1). However, breakage of the ceramic components is still a serious

concern requiring revision surgery. Ceramic fractures occur mainly because of defects in ceramic production, direct or continued trauma, or improper surgical technique (2). Femoral head breakage is likely to correlate more frequently with ceramic-on-ceramic (COC) than with ceramic-on-polyethylene (COP) bearings. BIOLOX delta femoral head fracture is a rare complication following THA (3-6), and fracture of BIOLOX delta head coupled with a polyethylene liner has been exceptionally described in primary THA (6). This case report describes a BIOLOX delta femoral head breakage which was observed after COP revision THA. To our knowledge, this occurrence in revision THA has not been previously reported.

Case report

A 58-year-old male patient was admitted to our department because of increasing right groin pain and functional impairment. He sustained a direct trauma to the area of the greater trochanter during skiing activity 4 months before with no hip disability. At the age of 44, he had undergone a primary cementless COC THA because of hip osteoarthritis. Six years ago, both prosthetic components were revised due to metallosis and foreign body reaction using a 54 mm acetabular cup (Pinnacle Acetabular Shell, DePuy Orthopaedics, Inc., Warsaw, Indiana) with a 36 mm polyethylene acetabular liner (Pinnacle Marathon cross-linked, DePuy Orthopaedics, Inc., Warsaw, Indiana), a modular femoral revision stem (S-ROM Total Hip System, DePuy Orthopaedics, Inc., Warsaw, Indiana), and a 36 mm BIOLOX delta alumina ceramic femoral head (CeramTec, Phlochingen, Germany), +9 neck length and 11/13 tapered cone head.

At first admission to our department, physical examination revealed groin pain and limited hip mobility with no clinical signs of infection. Plain radiograph

of the pelvis showed radiopaque fragments inferior to the ceramic femoral head and no signs of loosening (Figure 1). Multi-Slice Computed Tomography (CT) confirmed the breakage of the ceramic femoral head with two major fragments, showing acetabular inclination and anteversion of 44° and 32° , respectively (Figure 2). Revision surgery was performed with the patient in supine position through an anterolateral Watson-Jones approach under spinal anesthesia. Breakage of the ceramic head, which included two gaps at the opposite sites close to the stem neck (Figure 3), and acetabular polyethylene wear were found. The broken head, the two large fragments and most of the smaller fragments, and the acetabular liner were removed. Extensive synovectomy, lavage, capsulectomy and accurate debridement were performed to decrease residual ceramic fragments in the soft tissues. Both acetabular cup and femoral stem were well fixed with no damage of trunnion and therefore they were retained. A 36-mm internal diameter polyethylene acetabular liner with elevated rim and a 36-mm BIOLOX delta with a BioBall (Merete; Berlin, Germany) adapter XL (+7, 11/13 mm) were implanted. Immediately after surgery, the patient

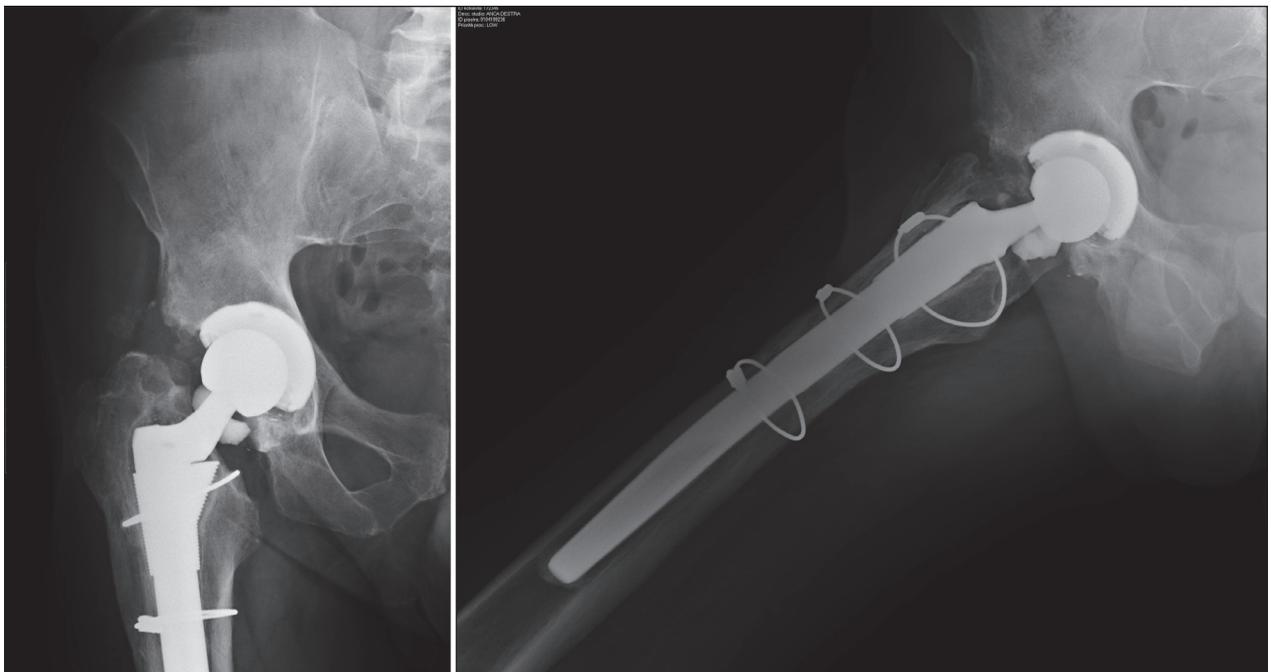


Figure 1. Anteroposterior (a) and lateral (b) radiographs at presentation revealing ceramic head fracture

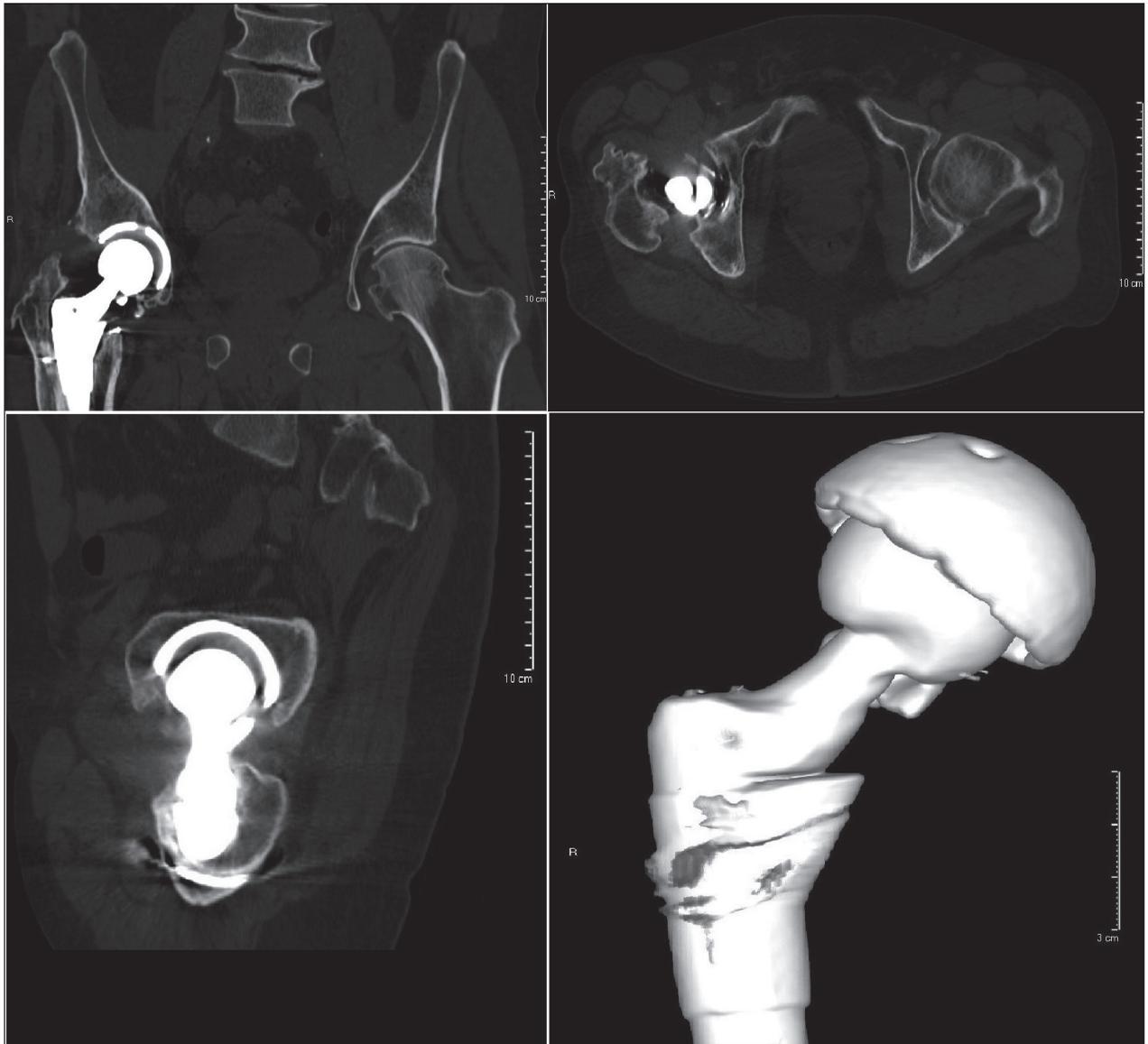


Figure 2. Computed Tomography scans demonstrating fragmentation of the ceramic femoral head

started rehabilitation with weight-bearing as tolerated with crutches for one month. At 1-year follow-up, the patient had a complete hip function recovery with no pain and satisfactory radiological result (Figure 4).

Discussion

Ceramic breakage is a serious complication following THA. Data obtained from CeramTec register show that the incidence of BIOLOX delta ceramic

femoral head fracture is about 0,001% (28 out of 2.78 millions) (7). As reported by Si et al. in a systematic review and meta-analysis of 13 randomized controlled trials, higher head fracture in COC group with a risk ratio of 6.02 when compared with COP bearing was found (8). Moreover, ceramic head fracture occurred only in short neck heads (1). As stated in table 1 (Table 1), only 3 cases of fracture of BIOLOX delta femoral head have been described after primary COP total hip replacement (4-6). In revision hip surgery, the breakage of a ceramic head is a rare occurrence, which

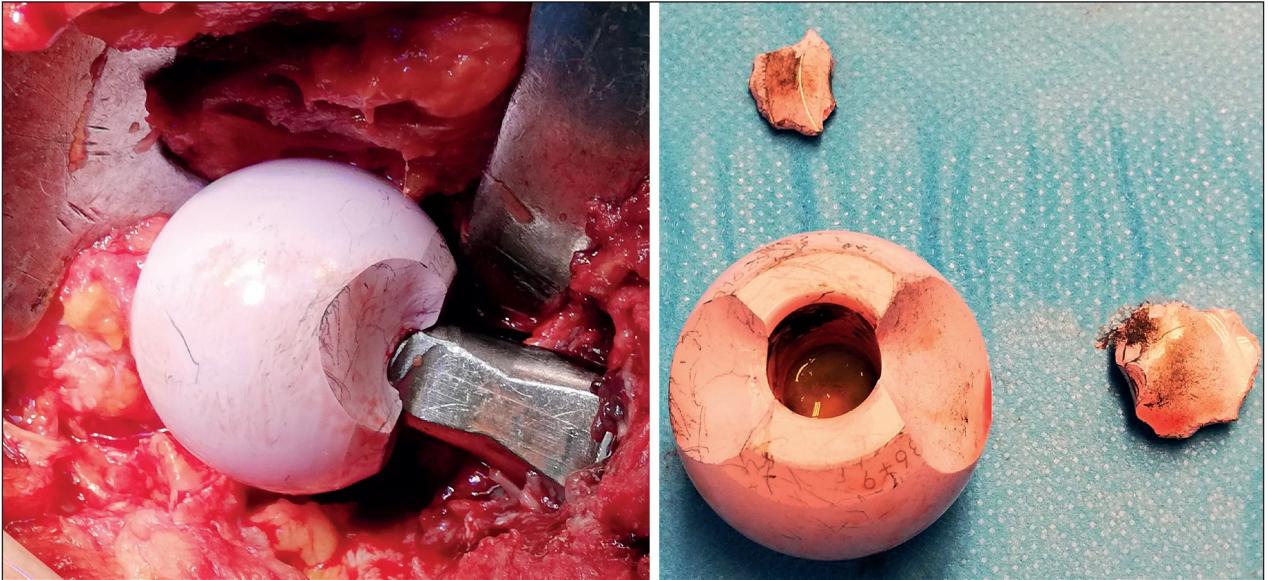


Figure 3. Intraoperative findings showing the broken ceramic head and two gaps at the opposite sites close to the stem neck (a), and two large fragments of the femoral head (b)

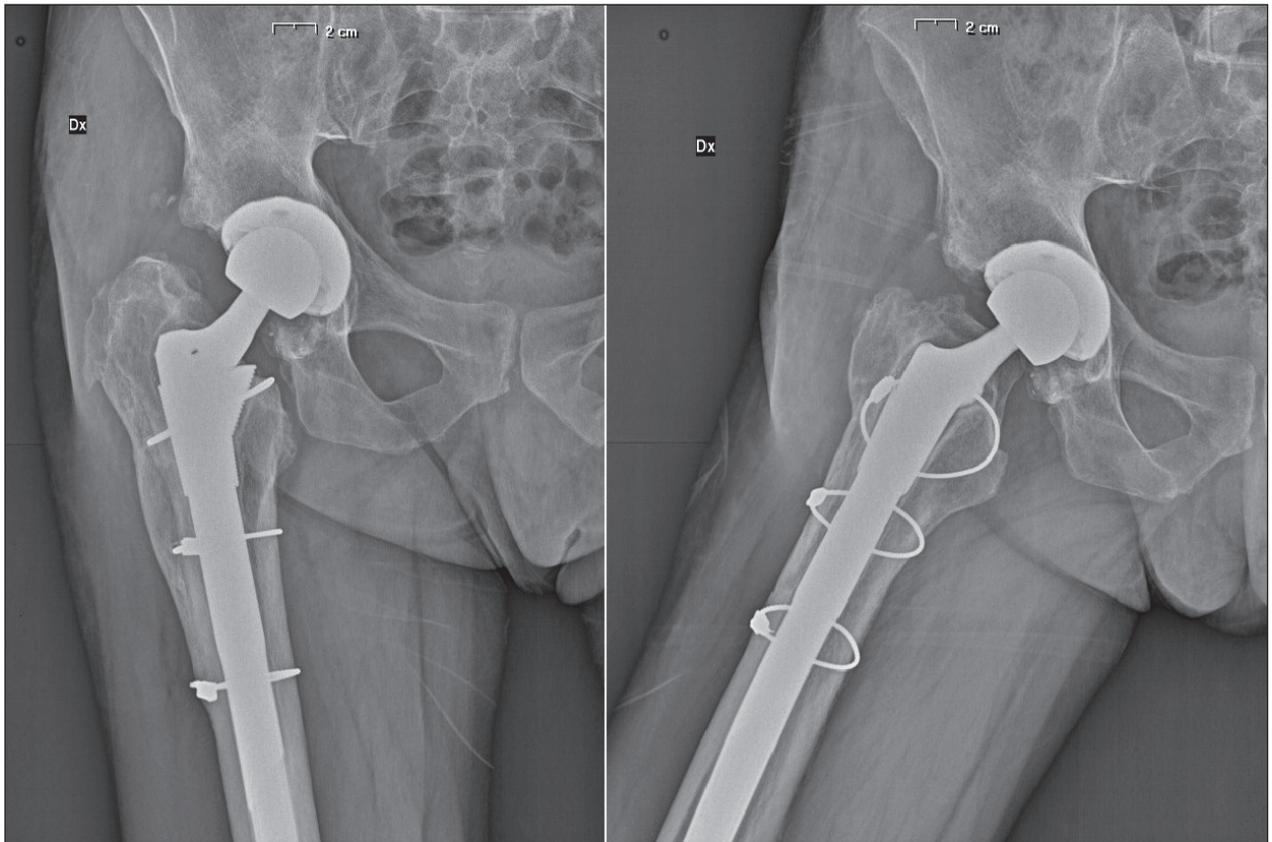


Figure 4. Postoperative x-ray after partial component hip revision, including replacement of the polyethylene acetabular liner and a BIOLOX delta femoral head with a BioBall adapter

Table 1. Cases of BIOLOX delta ceramic head fracture with ceramic-on-polyethylene coupling

Author	Year	Head Diameter	Cause
Heiner et al. [4]	2014	36 mm	Bicycle accident
Pomeroy et al. [5]	2015	32 mm	Atraumatic
Rankin et al. [6]	2019	32 mm	Slip and fall (symptomatic after 2 months)

was reported in 2014 by Tai et al. with a COC coupling (3). Although many studies previously described this dramatic complication, the incidence in hip revisions has never been detailed. The present study reports the breakage of a BIOLOX delta femoral head which occurred after revision THA with a COP bearing, and to our knowledge it has not been previously reported.

Ceramic fractures may occur acutely, but more frequently during normal activity, due to stress and fatigue on the implant (1). As reported by Rankin et al. in 2019, we believe in “slow crack growth”: a crack initiation in the surface of alumina matrix by repeated stress event on the implant that ultimately propagate to all the ceramic head until its fracture (6). Only this event may explain the delayed rupture that we observed.

Clinical signs are hip pain, limited range of motion and sometimes a creaking or squeaking sound; a duller clicking sound is indicative of rupture (1). X-rays are generally diagnostic because fragments of ceramic head are radiopaque. CT provides additional information of head fractures, debris wear and component positioning (9).

Treatment consists of early hip revision to prevent local and systemic complications. Surgery should include accurate debridement and extensive synovectomy to remove all ceramic debris and avoid dissemination of the sharpest fragments that can be abrasive for the taper (1). After removal of the femoral head and the acetabular liner, it is essential to check components stability and trunnion state. A marked damage of the trunnion is an indication to replace the femoral stem. Revision surgery may consider COC and COP bearings. In the presence of a breakage of the ceramic component, Garcia et al. advise caution with the use

of metal femoral head, as small ceramic fragments can cause 3rd-body wear with massive metal debris and severe local and general complications (10). As reported in our case, if femoral stem is well fixed with no damage to the trunnion, the use of a metal adapter is a good system to match the head on the 11/13 taper and to obtain optimum hip stability and elongation.

Conclusion

This case for the first time describes a fourth generation alumina ceramic femoral head breakage with a COP bearing after hip revision surgery. Fracture of ceramic head may result in mechanical and biological problems if mismatched. This case confirms the need to carefully evaluate the status of fourth generation alumina ceramic components in symptomatic patients, especially following traumatic events. Early revision surgery is essential to prevent local and systemic complications. During surgery, it is necessary to remove all fragments for preventing early failure induced by sharp debris.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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