Due to their excellent tribology, ceramics are increasingly used for total hip arthroplasty (THA) in young patients. Fracture rates for contemporary ceramics range from 0% to 0.004%. Recently, ceramic liners are encased in a titanium sleeve to further decrease the chances of fracture. We encountered 1 case of a metal-encased acetabular liner fracture in a ceramic-on-ceramic articulation in a series of 764 hips. Our literature review revealed no reports of metal-encased ceramic liner fracture.

A 60-year-old woman presented 27 months after a bilateral ceramic-on-ceramic THA. She reported mechanical grinding and clicking from the left hip on extension. There was no history of trauma or fall. Examination revealed a nonantalgic gait and audible-palpable crepitations on the left hip. Range of motion of the left hip was intact with no subluxation. Radiographs revealed fractured ceramic insert and an excessively anteverted socket on the left side. Intraoperative findings revealed gross impingement in the form of indentation of the metal femoral neck against the elevated metal rim encasing the liner. Revision THA was performed using an uncemented polyethylene liner while retaining the well-fixed cup and stem. The Harris Hip Score at 4.5-year follow-up was 100, with no evidence of osteolysis or polyethylene wear.

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doi: 10.3928/01477447-20110826-30

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Figure: Intraoperative photograph showing gross evidence of impingement as scoring on the metal femoral neck (A) and on the elevated titanium rim encasing the liner (B).
The pursuit for an ideal bearing surface for total hip arthroplasty (THA) has evolved from metal-on-metal to metal-on-polyethylene and ceramic-on-ceramic articulations. Due to their excellent tribology, alumina ceramics have emerged as promising bearing surfaces, especially for young and active patients. However, the prime concern with ceramics is their brittleness and propensity to break instantly. The fracture rates of ceramics have greatly decreased with advancing ceramic generations. Contemporary third-generation ceramics (BIOLOX Forte; CeramTec, Plochingen, Germany) have a reported fracture rate of <0.004%. To further decrease the chances of third-generation ceramic insert breakage, the Trident Acetabular system (Stryker Orthopaedics, Mahwah, New Jersey) was introduced. We used this system in 764 hips from May 2003 to January 2006 using a posterolateral approach and encountered 1 case of liner fracture.

CASE REPORT
A 57-year-old woman diagnosed with bilateral hip osteoarthritis secondary to hip dysplasia underwent a bilateral THA in October 2004. The Food and Drug Administration-approved Trident Acetabular ceramic-on-ceramic bearing was used. She received a 50-mm acetabular shell with an alumina-bearing ceramic liner enclosed in a titanium sleeve, a 32-mm alumina ball head, and a size 7 Stryker secure-fit femoral stem on both sides. The liner was inserted using the silicone insert positioner tip and liner impactor following the manufacturer’s guidelines. Prosthetic impingement and liner malseating were ruled out intraoperatively. The acetabular component was at 38° inclination and 32° anteversion on the right and 42° inclination and 38° anteversion on the left.

The patient’s postoperative recovery was uneventful. Both hips did well until December 2006, when she presented with mechanical grinding and occasional clicking sounds in the left hip. There was no history of trauma or fall. On examination, she had nonantalgic gait, audible clicks, and palpable crepitations with a grinding sensation on left hip extension. There was no sign of subluxation. The right hip was symptom free, and examination detected no abnormalities. Hip radiographs showed the eccentric position of the head with a fractured ceramic liner in the excessively anteverted socket on the left side (Figure 1). A diagnosis of left ceramic liner fracture was made, and the patient underwent revision.

At arthrotomy, the titanium-encased ceramic liner was broken at its periphery. The alumina head showed areas of discoloration due to contact between broken fragments and the metal rim with the femoral head. Gross evidence of impingement was noted as scoring on the metal femoral neck (Figure 2A) and on the elevated metal rim encasing the liner (Figure 2B). The acetabular shell was in high anteversion but well fixed. The femoral stem was well positioned and fixed. A meticulous synovectomy followed by revision THA was successfully performed. The patient received a 32-mm cobalt chrome head and a 10° elevated, un cemented Trident X3 polyethylene liner (Stryker Orthopaedics) at revision.

At 4.5-year follow-up, the patient reported no hip pain. Range of motion of the left hip was 0° to 130° flexion, 50° external rotation, 20° internal rotation, 50° abduction, and 20° adduction. The Harris Hip Score was 100, and there were no signs of osteolysis or polyethylene wear (Figure 3).

DISCUSSION
The reasons for ceramic liner fracture can be broadly classified into 3 categories: ceramic-related issues (poor manufacturing techniques and inherent brittleness), patient-related issues (trauma, obesity, and habitual squatting), and surgical technique-related issues (poor implant positioning, intraoperative chipping, and liner malseating). In the past, ceramic-related issues were a major concern; however, manufacturing processes like hot isostatic pressing, laser marking, and reduced grain size (1.8 μm) have yielded higher density, improved quality third-generation ceramics. Contemporary ceramics are 100% proof
tested and undergo stress testing and sterilization before becoming available for use.11 Nonetheless, reported fracture rates range from 0% to 0.004%.2-4,12 The standard first-generation ceramic liner design was modified to place it in a titanium sleeve, presumably to prevent impingement and liner breakage.12 The assembly of the liner in the metal sleeve is done by the manufacturer, which ensures an optimum press-fit and secure locking of the liner. This has increased burst strength by 50% over nonsleevcd liners.5,12

Patient-related issues are identified as possible causes for liner fracture in a few reports. Fractures of ABC ceramic liners (Stryker Orthopaedics) have been attributed to habitual squatting and cross-legged sitting in the Asian population,3,7 as well as direct trauma and increased gym activity.4,10 Ceramic liner fractures in the sandwich cup design, where a polyethylene layer is used as a shock absorber between ceramic liner and metal shell, have also been reported. Improper placement of the prosthesis in slight retroversion and impingement were also identified as possible causes of stress concentration and consequent breakage of ceramic liners.9,13

Liner fracture in our patient was related to impingement and edge-loading on the ceramic bearing from the metal rim in addition to the excessive anteversion of the acetabular component. The excessive anteversion was due to the underlying acetabular dysplasia and magnified by the titanium sleeve encasing the ceramic insert; the elevation created by the metal rim decreased the available arc of motion prior to neck–socket impingement. Retrieval analysis confirmed that the liner fractured at the anterior edge, which was the site of maximum loading in extension. In retrospect, the patient experienced clicking sounds in the left hip while walking, which were explained by the impingement of the metal neck by the metal rim of the liner.

The management of ceramic liner fractures is debatable. Retained ceramic particles may trigger wear and osteolysis after revision with a different bearing surface (eg, metal–polyethylene).11 Hence, conceptually, revising the fractured ceramic liner with a new ceramic insert would be appropriate. However, in our case, the shell was well fixed but relatively anteverted. Replacing a ceramic liner in such a case may lead to a possible refraeture of the new ceramic. Attempts to remove the well-fixed cup would have led to excess bone compromise, especially in a dysplastic hip. Hence, we retained the cup and changed the bearing surface to a metal head-on-polyethylene liner. Meticulous synovectomy with thorough irrigation was performed before placing the new bearing. At 4.5-year follow-up, the patient was doing well with no radiologic signs of ceramic breakage or osteolysis on either hip.

**CONCLUSION**

Despite their excellent tribology, ceramic-on-ceramic articulations are subject to fracture. The hard-on-hard nature of this bearing surface makes it more unforgiving of malposition and edge loading. This particular acetabular insert has a metal rim designed to protect the ceramic from impingement; however, we found that the rim caused impingement and subsequent edge-loading in our patient. In view of the increasing use of ceramic-on-ceramic articulations, surgeons should be aware of the possibility that even metal-encased ceramic inserts may fracture with impingement and edge-loading.

**REFERENCES**


