Impingement of Metal Neck on a Ceramic Liner in Ceramic-on-Ceramic THA
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INTRODUCTION
Low friction and low wear contemporary ceramic-on-ceramic bearing surfaces are an attractive alternative to conventional metal-on-polyethylene articulation in terms of eliminating or reducing the problems related to polyethylene wear debris and offer a promising option for young active patients [1, 2]. However, the possibility of ceramic failure is still major concerns associated with contemporary ceramic bearings in total hip arthroplasty (THA) [3, 4].

Especially, it has been postulated that impingement of the metal neck on a ceramic liner can lead to early failure of liner in ceramic-on-ceramic THA [5]. Nevertheless, to our knowledge, there was no report demonstrating the evidence that repeated metal-on-ceramic impingement can induce crack propagation into the ceramic liner which results in impending ceramic fracture in vivo.

Here, our retrieval study demonstrates the evidence that impingement between ceramic liner and the metal neck cause crack formation leading to ceramic liner failure.

MATERIALS AND METHODS
Between November 1999 and April 2008, we performed reoperations in 17 patients who had received contemporary ceramic-on-ceramic THAs. All bearings were hot isostatic pressed, laser-marked, and proof-tested third-generation BIOLOX Forte alumina (CeramTec, Plochingen, Germany). The causes of reoperations were ceramic head fracture in 4 hips, ceramic liner fracture in 3, acetabular component loosening in 3, implant malposition in 3, infection in 2, dislocation in one, and osteolysis in one. The mean time interval between index arthroplasty and reoperation was 46 months (range, 2-99 months).

Among them, the evidence of impingement of the metal neck on a ceramic liner was observed in 3 hips (18%). Excluding one hip in which a ceramic bearing had been revised for a head fracture at other hospital previously, scanning electron microscopic (SEM; SM-500, Topcon, Tokyo, Japan) analysis of retrieved ceramic bearings were performed in remaining 2 hips. This study was approved by our Institutional Review Board.

RESULTS
For 3 hips where the evidence of impingement was observed, the causes of reoperation were an infection, a ceramic head fracture, and an acetabular component loosening. All patients could sit in the so-called tailor’s position. No squeaking sound was heard in either hip. Reoperations were performed at 99, 37, and 70 months after the index arthroplasty, respectively.

In all hips, V-shaped indented wear scar was found on the postero-superior aspect of the metal neck (Figure 1). In addition, the outer edge of the bearing surface on the ceramic liner was stained black in its postero-superior portion in 2 hips where the liner was available for an evaluation (Figure 2).

SEM analysis of the black stained area of ceramic liner demonstrated disruptive wear in these 2 hips. An intergranular fracture with multiple craters (<1 μm to 5 μm in size) had caused loss of surface integrity. Moreover, in one hip, cross-sectional SEM evaluation of the black stained area showed a crack propagating into the deep portion of the ceramic liner (Figure 3).

DISCUSSION
Impingement is not uncommon finding in THA. Recent retrieval study demonstrated that more than half (56%) showed evidence of impingement with conventional polyethylene bearing [6]. Impingement can damage the acetabular liner, create polyethylene wear, and cause dislocation. Impingement may be more problematic in ceramic-on-ceramic THA. Recent reports seem to indicate an increased risk of fracture of the ceramic-on-ceramic couple related to impingement [3, 5].

Our observations suggest that impingement between ceramic liner and the metal neck can cause metal transfer, liner surface damage, and finally, crack formation leading to ceramic liner failure in vivo. These findings indicate that contemporary ceramic liner fracture related to impingement is not a potential, but remains a real danger.

We think that proper implant selection and meticulous surgical techniques are required to minimize the possibility of impingement in ceramic-on-ceramic THA.

Figure 1. The postero-superior side of the metal neck shows a V-shaped indented wear scar (indicated by a Bovie tip).

Figure 2. The postero-superior portion of the bearing surface on the ceramic liner is stained black.

Figure 3. SEM finding of the cross-sectional surface of the black stained area of retrieved alumina liner. A crack propagating into the deep portion of the ceramic liner is shown (arrows) (original magnification, ×1000).

REFERENCES