During open reduction of an irreducible anterior dislocation of a total hip replacement with an Oxinium femoral head, it was observed that the head had been significantly damaged. Gross and scanning electron microscopic examination revealed cracking, gouging, and delamination of the surface. Because of the risk which this poses for damaging the polyethylene acetabular liner, it is strongly recommended that patients with this type of prosthetic head be carefully monitored after a dislocation.

Alternative bearing surfaces for total hip replacements (THRs) have become a popular means of minimising osteolysis and subsequent loosening.\(^2\) In the manufacture of the Oxinium femoral head (Smith & Nephew, Memphis, Tennessee) a zirconium bearing surface is selectively oxidised, resulting in the transformation of approximately the top 5 µm to zirconia.\(^3\) The purported advantages of Oxinium when compared with aluminium or zirconium are that the inner part of the ceramic head retains the characteristics of the metal, including resistance to fracture, there are more options for neck size, and less damage to the femoral taper if the head is removed. The surface has the characteristics of a fully ceramic femoral head, including increased hardness, excellent surface finish, and resistance to abrasion.

The ceramic-on-polyethylene articulation has been shown to have in vitro wear characteristics superior to those of metal-on-polyethylene,\(^4\) and there is clinical evidence to suggest that zirconia heads induce less polyethylene wear than do those at cobalt-chromium (CoCr).\(^5\) We present a patient who suffered dislocation of a THR with an Oxinium head. After many attempts at closed reduction, an open procedure was performed when the femoral head was noted to be extensively damaged. These findings have implications for the performance of THRs using the Oxinium femoral head which are complicated by dislocation.

Case report
A 47-year-old man with severe bilateral osteoarthritis of the hip underwent bilateral THR through a posterior approach. Size 14 high-offset porous Synergy (Smith & Nephew, Memphis, Tennessee) stems, 28 mm +0 millimetre neck length Oxinium femoral heads, 58 mm Reflection (Smith & Nephew) acetabular components, and cross-linked polyethylene liners with 20° augments (Smith & Nephew) were used on both sides. The femoral stem was placed in 15° of anteverision and the acetabular component in 45° of abduction and 20° of anteverision. Dynamic intra-operative range of motion testing showed no evidence of instability or impingement. There were no intra-operative or immediately post-operative complications.

At 15 days after operation he sustained an anterior dislocation on the right hip after a fall (Fig. 1). After many unsuccessful attempts at closed reduction under conscious sedation he was taken to the operating room. When closed reduction under general anaesthesia was also unsuccessful, an open reduction was performed. This repeat operation was 16 days after the initial surgery. It was found that the femoral head had button-holed through the anterior capsule, accounting for the inability to reduce the closed hip. Visual inspection of the femoral head revealed full-thickness surface scratches with apparent exposure of the zirconium substrate (Fig. 2). The head was removed and the femoral stem and acetabular component were found to be stable and in the appropriate orientation. There was no evidence of damage to the polyethylene. For the revision, another Oxinium femoral head was used.

The extent of damage to the femoral head was assessed further under scanning electron microscopy, which revealed separation and
cracking of the surface oxide layer with gouges into the metal substrate (Fig. 3). There was also metal transfer from the acetabular shell to the femoral head.

The patient had an uneventful post-operative course and was free of symptoms one year later.

Discussion
Several relatively new options for joint bearings potentially improve the longevity of the implant in relatively young and active patients. The initial procedure in this patient employed a ceramic-on-crosslinked polyethylene articulation. Once the femoral head was removed following dislocation, our options for revision were limited. The system which we used does not have an option on the acetabular side to remove the polyethylene and replace it with either a metal or ceramic liner. Therefore, conversion to a metal-on-metal or ceramic-on-ceramic bearing surface would have required the replacement of the acetabular component.

While the use of a traditional CoCr-on-crosslinked polyethylene articulation was also an acceptable option, we believe that a ceramic-on-polyethylene articulation offers greater resistance to wear. The use of a fully ceramic head to create a ceramic-on-polyethylene articulation was also a possibility for this patient. However, it is generally recom-
mended that ceramic heads are implanted on virgin tapers in order to minimise the risk of breakage of the ceramic.

One final consideration in this patient was whether to use a larger femoral head in order to decrease the risk of future dislocation. We took this into account, but increasing the femoral head size must be weighed against the potential for increased polyethylene wear.\textsuperscript{9,10} Although we still use Oxinium femoral heads, we avoid this material in patients whom we consider to be at an increased risk of instability.

The process of transforming the surface of a metallic femoral head into a ceramic was developed by Smith & Nephew to improve the wear characteristics of total joint replacement.\textsuperscript{3} Oxinium (zirconium oxide, OxZr), is produced by heating zirconium alloy (Zr-2.5\% Nb) to 500°C in air.\textsuperscript{11-13} Thermal oxidation results in transformation of the metal surface from zirconium to zirconium oxide (zirconia).

Several in vitro studies have indicated that Oxinium hip and knee implants have excellent wear resistance which is significantly greater than that of CoCr.\textsuperscript{8,14-17} Tests in a simulator comparing wear rates in polyethylene produced by Oxinium and CoCr femoral components of total knee replacements revealed 85\% less wear in the Oxinium group.\textsuperscript{14} In another simulator study comparing CoCr and Oxinium, the wear rate was 42\% less with Oxinium.\textsuperscript{15} A study by the manufacturer comparing wear rates of CoCr and Oxinium surfaces under abrasive conditions showed that Oxinium was less affected by the roughening procedure used than CoCr and that the wear of polyethylene by Oxinium was significantly less than by CoCr.\textsuperscript{16} Oxinium and CoCr femoral heads have also been compared under both smooth and roughened conditions in hip simulators; Oxinium heads exhibited lower wear rates.\textsuperscript{8} More recently, Bourne et al.,\textsuperscript{17} compared the in vitro wear rates of artificially-damaged Oxinium and CoCr femoral heads on polyethylene, and found that damaged Oxinium heads had wear rates similar to those of undamaged CoCr heads.

Ceramics can suffer damage secondary to impingement or localised impaction stresses when there is ceramic-on-ceramic or ceramic-on-metal contact.\textsuperscript{18} In the present case, the femoral head undoubtedly impinged against the metal acetabular shell during dislocation and subsequent attempts at closed reduction. The thin brittle ceramic layer on an elastic substrate was unable to resist the high contact stresses, resulting in cracking, which exposed a damaged substrate.

Damage to the femoral head will contribute to increased polyethylene wear. Kim, Ritchie and Hardaker\textsuperscript{19} have shown that metal transferred to ceramic heads during impingement by the shell during dislocation and reduction causes increased polyethylene wear. Bourne et al.\textsuperscript{17} also examined two retrieved Oxinium heads after dislocation and noted metal transfer and scratching similar to our findings. They found in simulator testing that this damage increased the wear rate to similar to that produced by CoCr heads.

Based on the work by Kim\textsuperscript{6} and Kim et al.\textsuperscript{19} we believe that the degree of damage to this femoral head would have placed the patient at risk for greater wear of the polyethylene component than that from an intact head. If dislocation occurs with an Oxinium head, the surgeon should be aware of possible damage and follow these patients closely for premature polyethylene wear.

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References