Case Report

Fracture of a Cross-Linked Polyethylene Liner Due to Impingement

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Abstract: We report a case of fracture at 2 years after implantation of a 50-kGy moderately cross-linked ultrahigh molecular weight polyethylene liner with an extended lip (Marathon, DePuy, Warsaw, IN). The extended lip section had fractured. The liner showed no oxidation. The articular surface was grossly deformed, likely due to wear, creep, and/or plastic deformation, and the liner showed no recovery of machining marks upon melting, indicating that some wear had occurred. Electron microscopy revealed fatigue striations on the fracture surface. The likely cause of failure was femoral neck impingement–induced wear and fatigue on the liner. **Key words:** highly cross-linked polyethylene, total hip arthroplasty, impingement, early failure, fatigue failure.
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Case Report

An 83-year-old woman presented with severe left hip pain secondary to advanced left hip arthritis. She underwent an uneventful primary hybrid total hip arthroplasty in November 2003. The components used were a 46-mm multihole Pinnacle (DePuy, Warsaw, IN) acetabular component held in place with 2 screws. The liner was Marathon cross-linked polyethylene (DePuy) with an inner diameter of 28 mm, a 10° buildup (extended lip liner), and a 4-mm offset. The femoral head was 28 mm in diameter with 8.5-mm neck length. The femoral component was a cemented Summit (DePuy) stem size 3 with a high offset neck.

A standard posterolateral approach was used for the surgery, and the patient had an uneventful postoperative course. At 1 year, the patient was doing very well clinically with no complaints.

Unfortunately in October 2005, 2 years after her surgery, she heard a loud clunking sound from her hip and presented to the office with pain and crepitation from her hip with ambulation. Radiographs revealed a dramatic superior migration of the femoral head, a significant change from her previous radiographs (Fig. 1).

Revision arthroplasty was performed. During surgery, the polyethylene liner was found to be fractured at the rim near the 10° buildup. Using a similar trial component, the mechanism of impingement was clearly reproduced. In full extension and external rotation, the femoral neck abutted the edge of the polyethylene liner. With a neutral liner, this impingement was avoided; therefore, because the femoral and acetabular components were well fixed, a neutral Marathon liner was placed with a new 28-mm femoral head with 8.5-mm neck length to prevent the impingement.

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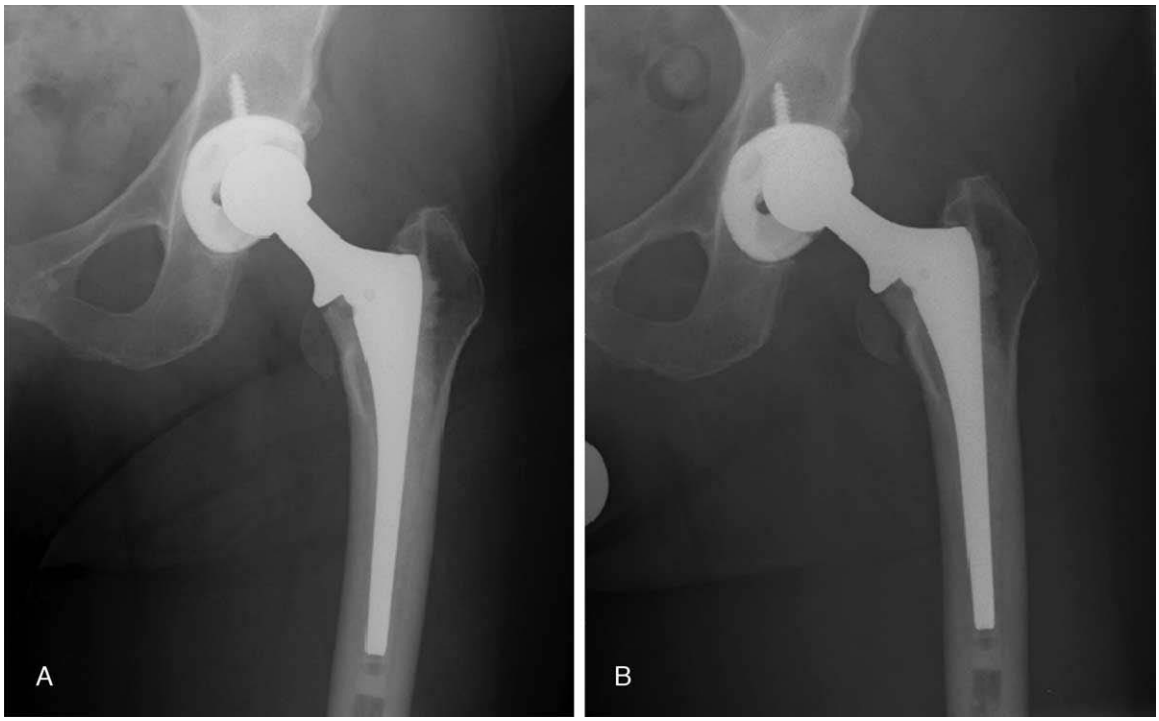

Fig. 1. Radiographs before (A) and after (B) the patient heard the loud "clunking" sound from her hip and began to experience pain and crepitation. The radiographs are approximately 7 months apart.

The patient did well postoperatively and had no further complications.

Clinically, the cause of the failure appeared to be impingement of the femoral neck in extension and external rotation leading to wear of the elevated rim causing fracture of the rim and failure of the locking mechanism through fatigue.

Laboratory Analysis

Upon receiving the explanted component in the laboratory (Fig. 2), we disinfected it by soaking for 24 hours in a 95% ethanol/5% water solution. The component was subsequently stored in an inert environment until analysis.

A section of the liner near the rim and another section near the dome was removed and microtomed (LKG Sledge, Sweden) into 150-μm-thin films. Some of the thin films were then refluxed in boiling hexanes for 16 hours to extract absorbed esterified fatty acids. The extracted and unextracted thin films were analyzed using Fourier Transform Infrared Spectroscopy (FTIR, Bio-Rad FTS2000/UMA500, Natick, MA) as a function of depth from a nonarticular surface into the component. Oxidation index values were calculated by normalizing the carbonyl absorbance over 1680 cm^{-1} to 1780 cm^{-1} to the absorbance over 1370 cm^{-1} to 1390 cm^{-1}, per ASTM Standard F2102. The trans-vinylene index values were calculated by normalizing the absorbance over 950 cm^{-1} to 980 cm^{-1} to the polyethylene skeletal absorbance over 1850 cm^{-1} to 1985 cm^{-1}.

Samples cut from the rim of the explanted acetabular liner were also used for differential scanning calorimetry (DSC). Differential scanning

Fig. 2. The Marathon UHMWPE explanted acetabular liner, along with pieces of its broken rim and its femoral head.

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