

# Acute Posttraumatic Catastrophic Failure of a Second-generation, Highly Cross-linked Ultra-high-molecular-weight Polyethylene Patellar Component

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## abstract

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A 74-year-old man underwent total knee arthroplasty in 1996 and subsequent revision total knee arthroplasty for aseptic loosening in 2005. During revision, an all-polyethylene, 7-mm, second-generation, highly cross-linked ultra-high-molecular-weight polyethylene patellar component (Durasul; Zimmer, Warsaw, Indiana) was used. The patient recovered well, but he presented with severe acute pain after a popping feeling was detected during a game of golf in postoperative year 4. Radiographs demonstrated a fracture of the patellar component. At re-revision surgery, polyethylene fragments were encountered without visual evidence of wear. Appropriate rotational and axial alignment of the components was confirmed. Patellar revision was performed.

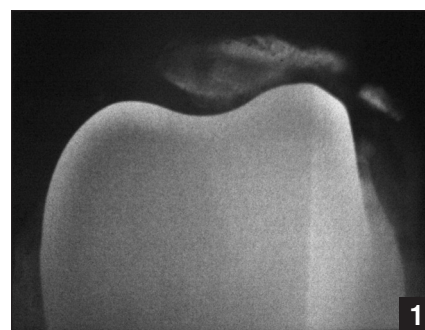
To the authors' knowledge, this is the first report of an acute posttraumatic catastrophic fracture of a second-generation, highly cross-linked ultra-high-molecular-weight polyethylene patellar component. Although no malposition of the components was noted, abnormal tensile forces across the patellar component can be transmitted by altered patellofemoral kinematics. This combination could lead to a small surface crack that propagates deeper into the component with continued impaction and an eventual acute fracture of the entire component. The patellar component failed in a piecemeal fashion following acute trauma. Although many advantages exist to the enhancement of polyethylene patellar components, including the potential for improved wear characteristics, cross-linking has reduced resistance to crack initiation and propagation. Therefore, fracture risk should be considered when using second-generation, highly cross-linked ultra-high-molecular-weight polyethylene.

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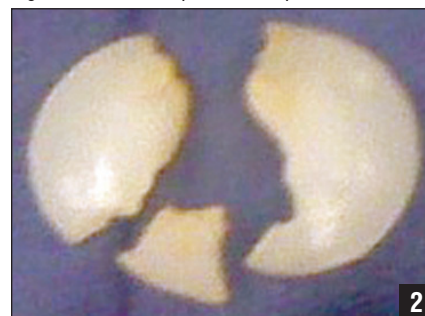
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**Figure 1:** Preoperative Merchant radiograph showing a fracture of the patellar component.



**Figure 2:** Photograph of the retrieved gross surgical specimen of the fractured second-generation, highly cross-linked ultra-high-molecular-weight polyethylene patellar component.



**Figure 3:** Photograph of the patellar surface at revision surgery showing no evidence of avascular necrosis or fracture.

Patellofemoral dysfunction has been implicated as the indication for up to 45% of revision total knee arthroplasties (TKAs).<sup>1</sup> More recent data from the Nationwide Inpatient Sample database demonstrated that 5.2% of revision TKAs in the United States are patellar component revisions.<sup>2</sup> These complications were first identified as early as 1979, when Mochizuki and Schurman<sup>3</sup> reported patellar component maltracking and dislocation and localized and generalized wear. Moreover, subsequent isolated patellar component revision has been associated with a 33% complication rate.<sup>4</sup>

In 1999, second-generation, highly cross-linked ultra-high-molecular-weight polyethylene (UHMWPE) was successfully introduced in acetabular components for total hip arthroplasty. Cases of rare acute fractures of these acetabular liners were later reported in 2009 and 2012.<sup>5,6</sup> In 2001, second-generation UHMWPE was introduced as an alternative in cemented all-polyethylene patellar components with the expectation of potential improvements in wear and durability.

To the authors' knowledge, this is the first report in the literature of an acute post-traumatic, catastrophic failure of a second-generation, highly cross-linked UHMWPE patellar component in a golfer after revision TKA.

## CASE REPORT

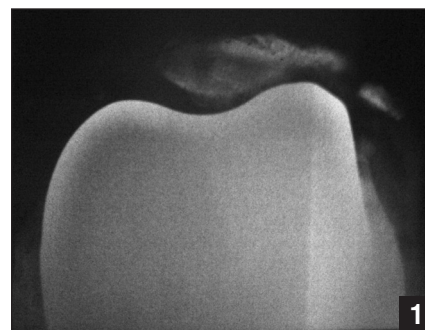
A 74-year-old, left-hand-dominant man (height, 5'8"; weight, 190 lb) with a past medical history of benign prostatic hypertrophy, hypercholesterolemia, and gout underwent staged primary cementless bilateral TKAs for posttraumatic arthritis in 1996 at another hospital.

In 2004, the patient presented to the senior author (F.R.D.) reporting chronic pain and signs and symptoms of instability. Sequential radiographs demonstrated cementless tibial component loosening and migration with tibial osteolysis. The patella was not resurfaced during the index procedure. An infection workup, in-

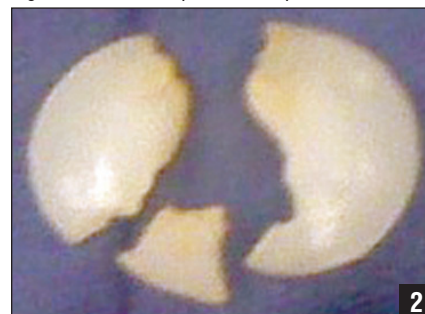
cluding blood work and indium bone scan, were negative, and indications for revision surgery were proposed. In February 2005, the patient underwent a cemented revision TKA for aseptic loosening and osteolysis without complication. The Natural Knee II (Zimmer, Warsaw, Indiana) revision TKA system was used: +4-mm size 3 revision tibial component with 90 mm of stem extension; size 4 revision femoral component with 18.5×125-mm stem of extension and 4-mm distal and posterior augments; size 2, three-pegged, all-polyethylene, 7-mm, second-generation highly cross-linked UHMWPE (Durasul; Zimmer) patellar component; and 11-mm posterior-stabilized tibial insert. The 7-mm patellar component, as opposed to the 10-mm option in this system, was chosen to maintain an overall composite thickness of 20 to 22 mm and avoid overstuffing the patellofemoral joint.

The patient did well and returned to his normal level of activity. Yearly evaluations were performed. During the fourth postoperative year, the patient presented to the senior author (F.R.D.) reporting severe acute pain after an unusual popping feeling was detected while playing a round of golf. The patient reported acute pain and buckling while driving a golf ball. Radiographs showed a fracture of the patellar component with no evidence of femoral or tibial component loosening (Figure 1). A preoperative workup revealed no signs of infection, and the patient underwent re-revision surgery in August 2009.

On entry into the joint, fragments of polyethylene were encountered (Figure 2). The remaining patella showed no evidence of damage or avascular necrosis (Figure 3). Further inspection revealed a fracture of the second-generation, highly cross-linked UHMWPE patellar component without visual evidence of wear. Appropriate rotational and axial alignment of the femoral and tibial components was confirmed. Revision was performed with a size 2, three-pegged, 7-mm patellar component (Sulene;



**Figure 1:** Preoperative Merchant radiograph showing a fracture of the patellar component.



**Figure 2:** Photograph of the retrieved gross surgical specimen of the fractured second-generation, highly cross-linked ultra-high-molecular-weight polyethylene patellar component.



**Figure 3:** Photograph of the patellar surface at revision surgery showing no evidence of avascular necrosis or fracture.

Zimmer). The component was sent to pathology for gross examination. The final pathology report is shown in the Table. As per hospital protocol, the patellar component was discarded shortly following submission by the pathology department; therefore, no further analysis was completed.

## DISCUSSION

To the authors' knowledge, this is the first report of an acute posttraumatic, catastrophic fracture of a second-generation, highly cross-linked UHMWPE patellar

component. No specific cause for the failure could be identified intra- or postoperatively; however, several factors may have contributed to the failure.

As reported by Maheshwari et al,<sup>7</sup> patella-related complications can arise from component wear, loosening, impingement, overstuffing, patellar fracture, avascular necrosis, extensor mechanism ruptures, and patellar tracking leading to instability (from the lateral placement of the component or a tight retinaculum).

It is feasible that lateral maltracking of the patellar component in the trochlea could lead to patellar impaction. In the current patient, a lateral release had been performed during the index revision surgery, and 4 years postoperatively, the patient reported no subjective patellofemoral complaints or clinical findings consistent with patellar maltracking. Furthermore, no intraoperative evidence existed of malrotation of the femoral or tibial components.

A more likely scenario is patellar component impaction on the anterior portion of the tibial component. Despite the manufacturer's design attempts to recess the anterior profile of the tibial polyethylene components, patellar-tibial impingement during knee flexion can occur; this is more likely in revision surgeries, where joint-line reconstruction can be difficult and patella baja is present.<sup>8</sup> In the current case, intraoperative patellar baja or tibial impingement could not be identified.<sup>9</sup>

Lastly, acute polyethylene fracture must be considered. The findings of a truly catastrophic failure, in which the patellar component failed in a piecemeal fashion following acute trauma, sheds light on an important consideration in the use of second-generation, highly cross-linked UHMWPE. Although many advantages exist to the enhancement of polyethylene patellar components, including the potential for improved wear characteristics, cross-linking has been shown to reduce resistance to crack initiation and propagation.<sup>10</sup> Although no malposition of the compo-

Table	
Final Pathology Report from the Retrieved Specimen	
<b>Final Diagnosis</b>	
A. Patellar component, right knee, removal	Patellar component; gross examination
B. Bone and soft tissue, right knee, revision arthroplasty	Osteoarthritis Fibrous tissue with histiocytic and giant cell reaction to foreign particles No evidence of acute inflammation
C. Specimen(s) submitted	a. Patellar component, right knee b. Tissue, right knee
D. Gross description	a. Received 3 fragments of hard, white material measuring 4×3.2×0.5 cm in aggregate. The surfaces are smooth with focally roughened areas. No sections submitted. Gross diagnosis only. Orthopedic hardware. b. Received in formalin are multiple portions of soft-to-bony, pink-tan tissue. The hard tissue fragments measure 5×5×1 cm in aggregate, and the soft tissue fragments measure 8×4×1 cm in aggregate. The surfaces are roughened. Representative sections are submitted in 2 cassettes.

nents was noted, abnormal tensile forces across the patella component could have been transmitted by altered patellofemoral kinematics. This combination could lead to the initiation of a small surface crack that propagates deeper into the component with continued impaction and an eventual acute fracture of the entire UHMWPE component.<sup>11</sup> ■

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