

Case report

Failure at the femoral stem extension-condylar interface in a rotating hinge knee without radiographic evidence of loosening

Michael Kahan, DO ^{a,*}, Christopher Estes, DO ^b^a Department of Orthopedic Surgery, UPMC Pinnacle, Harrisburg, PA, USA^b Department of Orthopedic Surgery, Adventist Health, Aspire Orthopedic Institute, Portland, OR, USA

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ABSTRACT

Modular stem extensions have become ubiquitous in revision total knee arthroplasty systems. Although stem extensions are valuable in addressing bone deficiencies and improving implant fixation, the stem extension-condylar interface may be a point of implant failure. We report a case of failure at the femoral stem extension-condylar interface in a Zimmer NexGen Rotating Hinge Knee (Zimmer, Warsaw, IN). Currently, several published case reports describe failure at the femoral stem extension-condylar interface but only 1 case describes loosening at a taper junction without evidence of set screw failure or taper fracture. Furthermore, no published cases describe this type of failure in the Zimmer NexGen Rotating Hinge Knee (Zimmer).

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Introduction

Revision total knee arthroplasty (TKA) presents many challenges, including maintaining normal joint kinematics, managing bone loss, and addressing ligamentous instability. Modular implants with stem extensions enhance implant fixation in the setting of periarticular bone defects. Additionally, varying degrees of constraint enhance stability in cases of ligamentous compromise [1]. However, the use of constrained implants can place added stress at modular junctions and implant-host interfaces. This additional stress increases the risk of mechanical failure or loosening at these respective interfaces [2,3]. Therefore, the benefit of constrained implants must be balanced with the risks of added stress placed on the construct. In general, it is recommended that the least amount of constraint required be used when performing revision TKA [4].

The Zimmer NexGen Rotating Hinge Knee (Zimmer, Warsaw, IN) is designed for both complex primary and revision TKAs,

incorporating constraint in the medial/lateral and anterior/posterior directions while maintaining the ability to flex/extend and rotate the knee. This design decreases the rotational stresses that were experienced in older nonrotating hinged knees [5]. This revision system, like all others, allows for the use of modular stem extensions to enhance implant fixation. The stemmed femoral component utilizes a 2-part combination locking mechanism between the femoral condylar component and the femoral stem extension that includes a Morse-type taper and 2 set screws. We report a case of aseptic loosening and failure at the femoral stem extension-condylar interface discovered intraoperatively. Our literature search returned only 1 case that describes failure at the modular junction between the femoral stem extension-condylar interface without radiographic evidence of fracture or loosening [6]. We found no published cases that describe this type of failure in the Zimmer NexGen Rotating Hinge Knee (Zimmer). The patient provided informed consent for publication of this case report.

Case history

A 71-year-old female with a body mass index of 34 and osteoarthritis of the right knee underwent primary right TKA 9 years prior to presentation. This was followed by numerous revision surgeries, including a failed debridement and implant retention for treatment of infection, successful 2-stage implant exchange, vastus

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* Corresponding author. Department of Orthopedic Surgery, UPMC Pinnacle, 4300 Londonderry Road, Harrisburg, PA 17109, USA. Tel.: +1 775 378 6337.

E-mail address: kahanmichael5@gmail.com

medialis advancement, and finally a revision to a hinged prosthesis that occurred 2 years after the patient's index TKA. The patient presented to our office 7 years after her last revision procedure with a 4-year history of progressive knee pain and a 1-year history of squeaking in the knee.

Physical examination revealed an antalgic gait favoring the right leg and use of a front-wheeled walker. Range of motion was from 10° to 80° of flexion with moderate laxity to varus/valgus stress testing through a full range of motion. There were no clinical signs of infection and serum erythrocyte sedimentation rate and C-reactive protein were normal. Knee aspirate yielded blue-green colored synovial fluid with a white blood cell count of 1160 cells/ μ L and 58% neutrophils. Synovial fluid culture was negative. Radiographs of the right knee (Fig. 1) revealed a hinged revision total knee with cemented femoral and tibial stems in satisfactory alignment with possible subtle asymmetry at the Morse taper junction on the anteroposterior (AP) radiograph. The tibial metaphysis and patella demonstrated significant osteolysis with minimal distal femoral metaphyseal bone. No significant osteolysis was adjacent to the femoral or tibial stem extensions.

With a high suspicion for metallosis revealed by the color of the aspirate, laxity on clinical examination, and lack of radiographic evidence of loosening of the femoral or tibial stem extensions, it was presumed that the hinge bushing had failed. The patient was therefore scheduled for revision of the modular components of the hinge mechanism.

Intraoperative inspection of the components revealed that the condylar portion of the femoral component was grossly loose and toggling at the Morse taper junction, leading to extensive metallosis throughout the knee (Fig. 2). The modular hinge mechanism was intact. The tibial component was not grossly loose; however, there was significant metaphyseal osteolysis consistent with the findings on the preoperative radiographs. There was a significant amount of patellar osteolysis, but the patella component was not grossly loose.

It was decided to proceed with revision of the femoral, tibial, and patellar components to address the above findings. A

backslapping device was attached to the well-fixed femoral stem which was removed from the cement mantle with minimal difficulty. The tibial component was likewise removed with minimal difficulty. After debridement of all avascular tissue and as much metallosis debris as possible, the patient was found to have severe metaphyseal bone defects of both the femur and tibia, consistent with Type III Anderson Orthopedic Research Institute defects [7]. A Zimmer NexGen Rotating Hinge Knee was implanted with the use of metaphyseal trabecular metal cones to reconstruct the metaphyseal bone defects. The patella was revised to a modular trabecular metal-backed component in order to address the severe osteolysis and prevent future loosening. Five intraoperative tissue cultures were obtained and found to be negative.

At 4 years of follow-up the patient had mild persistent knee pain, range of motion from 0° to 100°, and the knee was stable on examination. Radiographs remain stable and the implants appear well fixed (Fig. 3).

Discussion

The demand for revision TKA is growing at a rapid rate; current estimates anticipate a further increase of 601% by 2030 [8]. The use of modular revision total knee systems has been effective at addressing bone loss and ligamentous instability and will continue to be a staple in revision total knee surgery for the foreseeable future [1].

Approximately 14 cases of failure occurring at the stem extension-condylar interface have been described previously in the literature. Issack et al describes 2 cases of fracture at the male portion of the taper lock between the femoral condylar implant and the femoral stem extension using the Optetrak constrained condylar knee system (Exactech, Gainesville, FL). Nikolopoulos et al describe the same mechanism of failure in 1 patient using the P.F.C. Sigma TC3 constrained Knee system (DePuy Johnson & Johnson, Warsaw, IN) [9,10]. Lim et al and Butt et al describe a combined 9 cases of failure at the femoral stem extension-condylar interface due to locking screw fracture using the Insall-Burstein II Constrained Condylar knee

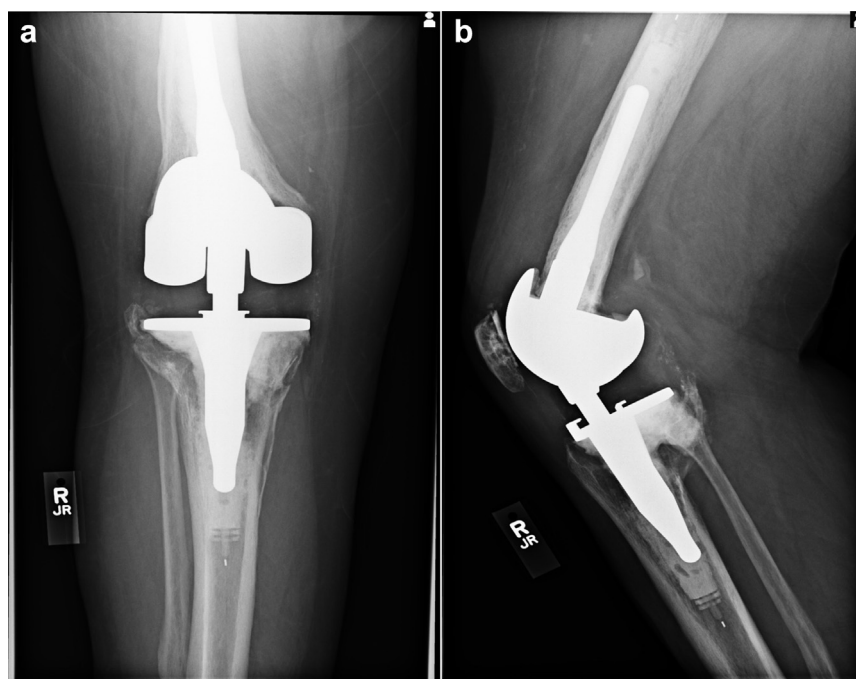


Figure 1. (a) AP and (b) lateral radiographs of the right knee acquired during initial presentation demonstrating Anderson Orthopedic Research Institute type III femoral and tibial bone defects with very subtle radiolucent asymmetry involving the stem extension-condylar interface and a well-fixed femoral stem extension.

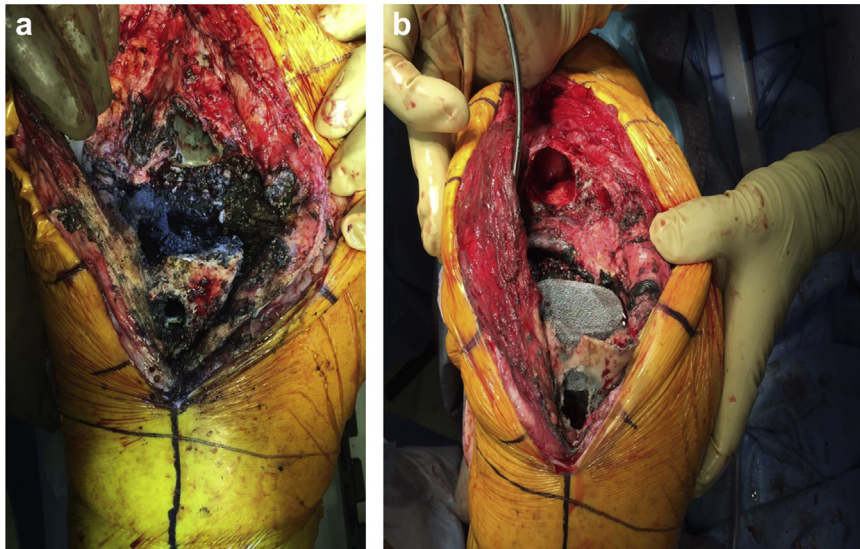


Figure 2. (a) Intraoperative photograph demonstrating uncontained bone defects within the distal femur and proximal tibia with associated metallosis. (b) Intraoperative photograph following tissue debridement and placement of a fully porous tantalum metaphyseal cone used for reconstruction.

prosthesis (Zimmer), Total condylar III prosthesis (DePuy Johnson & Johnson), and a constrained press-fit condylar TC3 implant (DePuy Johnson & Johnson) [3,11]. Howell and Rorabeck [12] describe a case of femoral stem extension-condylar interface disengagement that

was recognized on immediate postoperative radiographs and was likely a result of technical error during assembly of the modular implants. Only Boe et al have described a similar case of failure at the modular junction of the Triathlon TS revision knee system (Stryker,

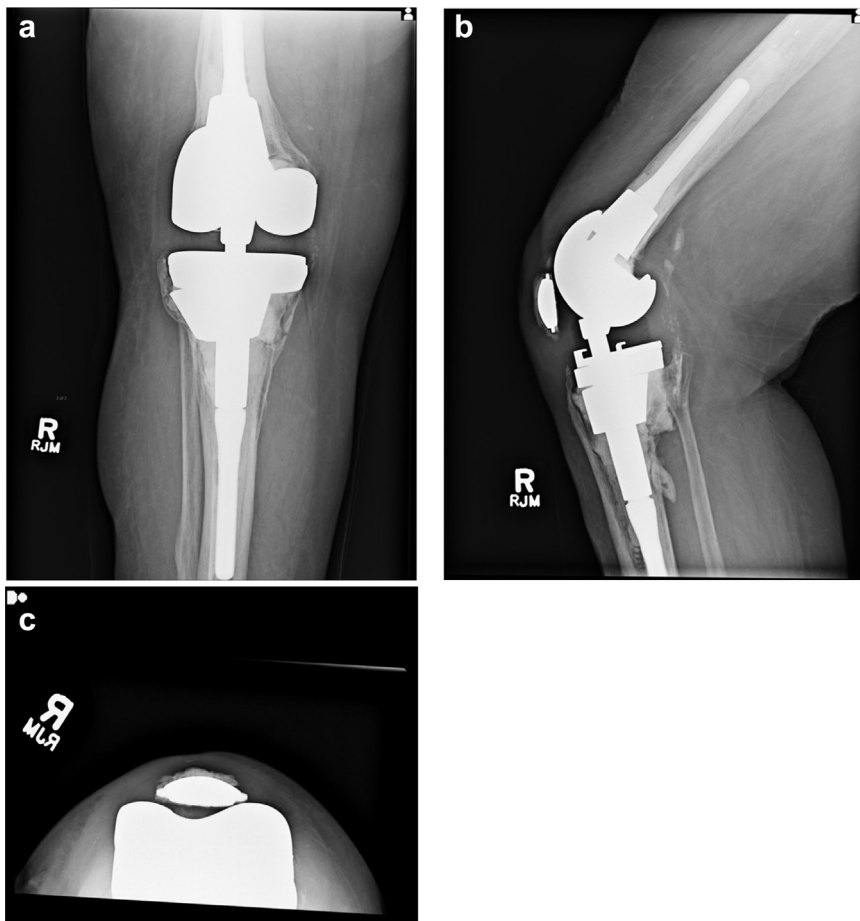


Figure 3. (a) AP, (b) lateral, and (c) merchant postoperative radiographs obtained at 4-y follow-up demonstrating the Zimmer NexGen Rotating Hinge Knee with associated metaphyseal cones and tantalum patella augment in maintained alignment without evidence of complication.

Kalamazoo, MI), without preoperative radiographic evidence of component fracture or loosening.

To our knowledge, the case presented here is the first case of loosening at a Morse-type taper junction involving the Zimmer NexGen Rotating Hinge Knee.

In this specific system, the locking mechanism between the femoral stem extension and the condylar component involves both a Morse-type taper and 2 set screws. Several causes of Morse-type taper failure have been hypothesized including fluid/cement interposition at the time of taper impaction, applying inadequate or excessive torque to the set screws, corrosion, and fatigue failure due to excessive stress experienced at the modular junction from inadequate bony support at the stem extension or condylar component [13–16]. Furthermore, previous literature has described that the disassembly strength of Morse-type tapers is directly correlated with the strongest impaction force delivered during taper seating [17]. Unfortunately, we are unable to comment on the surgical technique used during the initial surgery that may have led to the Morse-type taper failure. Upon inspection of the components intraoperatively there was no evidence of set screw fracture or hinge bushing failure. In this case, the most probable cause of failure of the Morse-type taper was loosening of the femoral condylar component within deficient distal femoral metaphysis, which placed increased stress on the condylar component over a prolonged period and ultimately lead to gross loosening at the taper junction. Furthermore, it is possible that mechanically assisted crevice corrosion was also involved in the process prior to gross mechanical failure. The chronic motion that occurred as the femoral condyle toggled on the well-fixed stem extension lead to severe metallosis and subsequent osteolysis. Regarding the patella revision, there was preoperative radiographic evidence of osteolysis behind the component and it was felt that eventual loosening was imminent. The patella was removed with minimal force and large cavitory defects were discovered in the remaining bone.

Reconstruction of Anderson Orthopedic Research Institute type III defects is recommended in order to achieve stable fixation and prevent significant stress concentration at modular junctions. Options such as bone graft, metal augments, and distal femoral and proximal tibial replacements have all been previously described as reconstruction options [18]. Recently, highly porous metaphyseal cones have shown promising results for reconstruction of a variety of defect types [19]. An in-depth review of fixation methods is outside the scope of this case report; however, the revision surgeon must be familiar with these techniques to optimize fixation and long-term survivorship of the implant.

Accurate preoperative diagnosis of the mechanism of failure of a total joint prior to revision surgery is paramount to success. The preoperative workup for this case lacked radiographic evidence of loosening. The Knee Society radiographic scoring system attempts to determine implant stability based on the aggregate thickness of radiolucent lines at different zones along the cement-prosthesis interface of the tibial and femoral components respectively [20]. In our case, the preoperative radiographs did not demonstrate any radiolucent lines surrounding the femoral stem extension and only a very subtle asymmetry at the Morse taper junction on the AP view. However, careful attention should be given to the assessment of overall implant alignment on preoperative radiographs as the presence of asymmetry at the modular junctions may indicate implant failure. It is important to note that assessing the bone-implant interface of the condylar portion of the implant on plain radiographs is difficult, if not impossible, due to the high profile of the femoral box on the lateral view. Advanced imaging such as a computed tomography scan may have proven useful in this case to further evaluate the component-cement and cement-bone interfaces. Also, in cases involving excessive AP translation, modular

junction asymmetry, or varus-valgus laxity in the setting of a hinged implant, stress radiographs may be valuable in determining the mechanism of failure. These studies were not performed in this case.

When workup of a painful TKA with modular stems reveals evidence of metallosis, a broad differential should be considered including loosening at the Morse-type taper junction. An emphasis should be placed on obtaining a definitive preoperative diagnosis in order to be prepared for the revision surgery. In this case, had the hinge bushing failed one would expect laxity on clinical examination that may or may not be associated with squeaking as the hinge post extension could theoretically rub on the tibial base plate or femoral condyles. On radiographic examination, subluxation or asymmetry at the hinge mechanism may also be present. Regardless of the specific mechanism of failure, the revision surgeon needs to be prepared to revise any and all components of the damaged prosthesis when different scenarios are encountered intraoperatively.

Summary

Awareness of the different mechanisms of implant failure and respective clinical presentations is important. In cases with modular stemmed implants with a clinical history of squeaking, evidence of metallosis, and/or excessive laxity in the setting of constrained devices, it is important to consider the possibility of mechanical failure at the taper junction and the need for full component revision. Making the appropriate preoperative diagnosis and having full revision systems available at the time of surgery is imperative and will allow the surgeon to revise any and all components if necessary.

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