

Revision Total Knee Arthroplasty for Catastrophic Tibial Post Failure: Rare Complication of Total Knee Replacement

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ABSTRACT

Tibial post failure is a rare but serious complication of posterior-stabilized total knee arthroplasty that requires revision surgery. Although tibial post fracture has previously been reported, this case involves an implant with a design feature that may predispose patients to the complication. The fracture also occurred later than observed in most other reports. A 72-year-old male who had undergone a posterior stabilized total knee arthroplasty seven years prior presented with knee pain and instability after a fall from standing. Although plain radiographs were not diagnostic, history and physical exam suggested failure of the tibial polyethylene post. This was confirmed during surgery when the fractured component was identified in the suprapatellar pouch. Given absence of malrotation or malalignment of the well-fixed femoral and tibial components, a polyethylene liner exchange was performed. Postoperatively, the patient had complete resolution of pain and instability with 0–120 degrees of stable ROM, which has persisted to latest follow-up at 6 months.

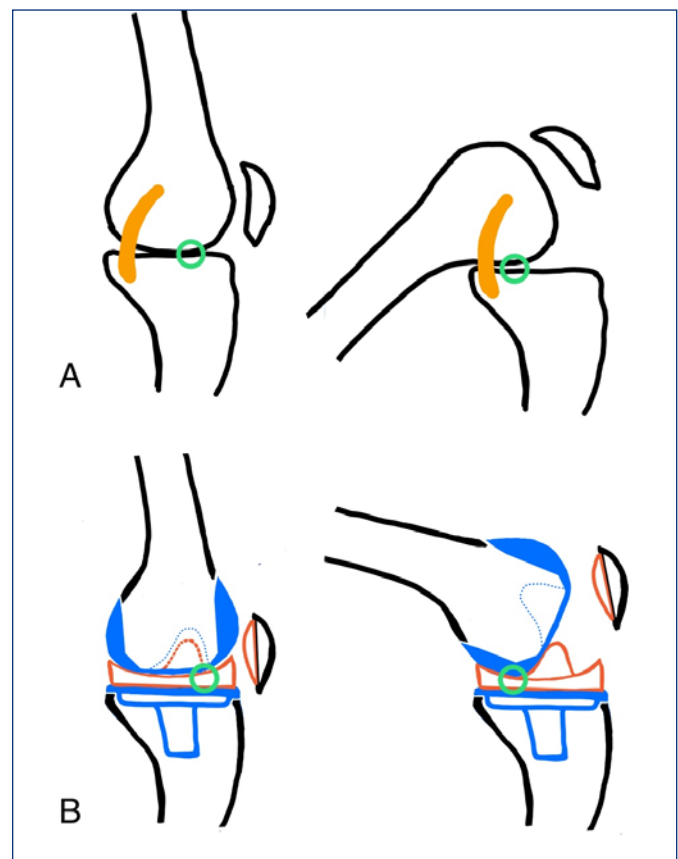
KEYWORDS: total knee revision arthroplasty, post fracture, polyethylene failure, posterior stabilized

INTRODUCTION

Activity-limiting knee pain is a frequent presentation to primary care physicians. Total knee arthroplasty (TKA) is one of the most common elective orthopedic procedures and an effective method of relieving pain and restoring function in patients with end-stage osteoarthritis.¹ The posterior cruciate ligament (PCL) permits deep knee flexion by limiting posterior subluxation of the tibia (**Figure 1A**). Frequently, however, excision of the cruciate ligaments during TKA may be required to allow for deformity correction and greater surgical exposure.² To compensate for an absent PCL, posterior stabilized (PS) TKA implants rely on a post incorporated in the tibial polyethylene liner that prevents posterior tibial subluxation and allows deep flexion (**Figure 1B**).^{3,4}

The tibial post resulted in increased functionality in PS TKA compared with previous total condylar prosthesis designs and demonstrated greater than 95% survivorship at ten years.^{2,5,6} However, it also created a new source of

Figure 1A,B. [A] Femoral rollback, posterior shift in femoral-tibial contact (green circle) that occurs during native knee flexion with PCL (orange). [B] Femoral rollback (green circle) in prosthetic knee facilitated by tibial post (orange hashed line) articulation with femoral component (blue dotted line).



complications at both the patellofemoral and the femoral-post articulations.^{7,8} We present a case of tibial post fracture occurring seven years after index TKA using Foundation-500 series PS components (DJO Surgical, Lewisville, TX). Although reports of both chronic wear and acute fracture of polyethylene tibial posts exist in the literature, this case involves an implant with a design feature that may predispose patients to the complication. Additionally, the tibial post fracture in this case occurred seven years after the index surgery, longer than the average elapsed time reported in other studies.

CASE HISTORY

A 72-year-old male with history of left total knee arthroplasty (TKA) in 2014 presented with left knee pain and instability after fall from standing. Of note, he had a periprosthetic infection found to be *Streptococcus mitis/oralis* approximately two months after the original surgery that was treated with open irrigation and debridement, polyethylene liner exchange and six weeks of intravenous vancomycin. Otherwise, he had been doing well clinically with no complaints regarding his prosthesis until this traumatic event. On exam, he had normal range of motion (ROM) but had significant anteroposterior subluxation with a positive posterior drawer test. Plain radiographs showed acceptable alignment of prior TKA with no evidence of hardware failure (Figure 2). Computed tomography (CT) scan showed a large joint effusion but stable arthroplasty components (Figure 3). His knee was aspirated with results not suspicious for infection. Because of his markedly abnormal physical exam findings, and severe limitations in ambulation due to feelings of instability, he was indicated for revision surgery. At the time of revision surgery, a large knee effusion was noted with significant detritic synovitis. The polyethylene bearing post was found to be sheared off and located in the suprapatellar pouch (Figure 4). The bearing was removed with evidence of severe delamination and oxidative degradation of the polyethylene. A new posterior-stabilized (PS) bearing with screw was placed. Due to his history of infection, he was discharged on a seven-day course of cefadroxil per previously published protocols.⁹ Post-operative radiographs showed well-aligned femoral and tibial components status post polyethylene exchange (Figure 5). Post-operatively the patient's inpatient course was uncomplicated and he was discharged home with services on post-operative day one. On latest office follow-up, at more than six months after

Figure 3. Representative coronal cut from pre-operative computed tomography (CT) imaging of the left knee showing stable tibial and femoral implant components.

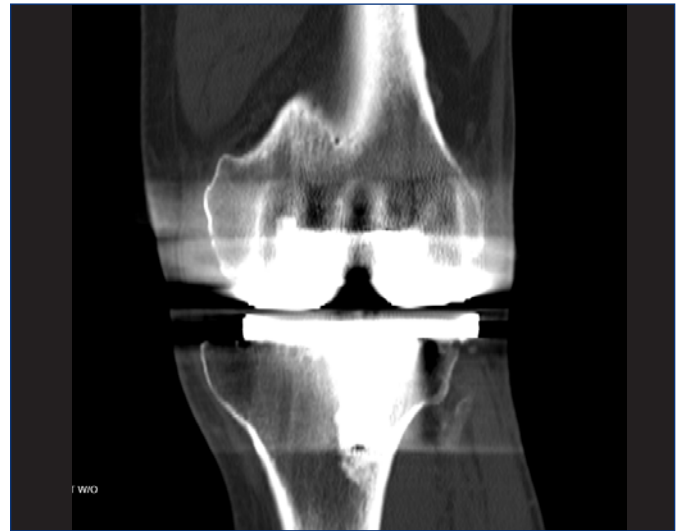


Figure 4. Intra-operative clinical photos showing the post of the polyethylene liner.



Figure 2. Pre-operative plain radiographs of the left knee including AP (left), lateral (right) views showing no acute fractures or evidence of hardware failure.

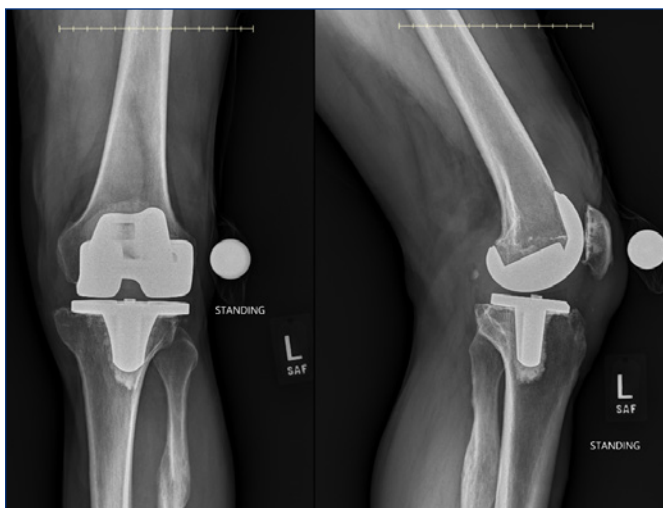
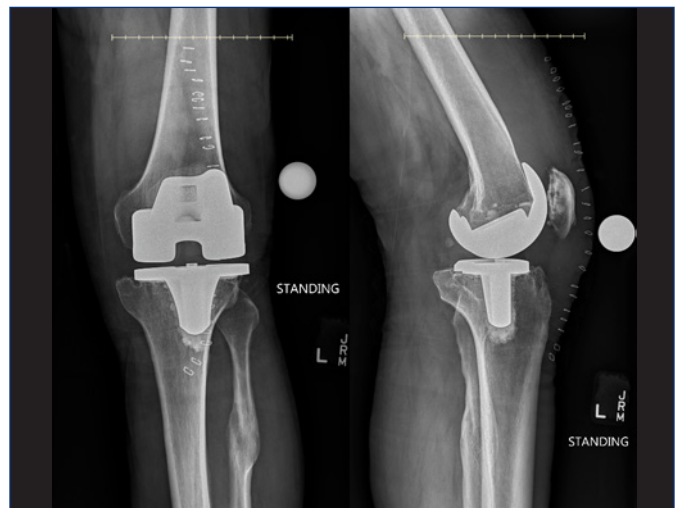


Figure 5 Post-operative plain radiographs of the left knee AP (left) and lateral (right) views showing stable alignment after polyethylene exchange.



revision, he presented with resolved symptoms of instability, with no complaints or episodes of femoro-tibial subluxation. He had no clinical signs or symptoms of infection. Radiographs demonstrated no signs of loosening or wear.

DISCUSSION

We present the case of a fractured polyethylene tibial post seven years after initial posterior-stabilized (PS) total knee arthroplasty (TKA) utilizing Foundation components (DJO Surgical Lewisville, TX). The limited literature on this complication contains only case series, the majority of which describe tibial post fractures occurring soon after index arthroplasty.^{3,7,8,10} Additionally, failure of the implant model used in this case has not been previously reported. The tibial post common to PS knee prostheses provides a substitute for the posterior cruciate ligament (PCL) that allows for increased knee flexion and more closely mimics native knee mechanics than previous prosthesis designs.^{2,5,6,10} However, the additional articulation in PS knee prosthesis creates a potential mechanism of implant failure – tibial post fracture, a serious complication of PS TKA that necessitates revision surgery.

Tibial post failure is an uncommon late complication of PS TKA. The majority of reported cases occurred between two to four years after the index arthroplasty.¹¹ The incidence of tibial post-fractures is reported to range from 0.5–1.2%. Some implant designs seem to be more prone to this complication however. A retrospective study of 564 patients performed by Bal et al in 2008 found 70 (12%) cases of tibial post fracture requiring revision surgery.^{11,12} Interestingly, all of the procedures in the study by Bal et al utilized Foundation-100 series Total Knee System (DJO Surgical Lewisville, TX), an earlier version of the components that fractured in our case.¹² The design of the tibial polyethylene in the Foundation-100 series features a screw hole in the center of the of the tibial post that was hypothesized to result in a stress riser and, thereby, increase risk of tibial post failure.^{7,12} Despite other updates to the implant, the Foundation-500 series continues to feature a screw hole in the center of the tibial post, which may have contributed to the fracture observed in our case. Other risk factors for tibial post fracture related to implant design include a taller tibial post, which leads to a longer lever arm during knee flexion when the femur exerts a tensile lift-off force on the post, and a highly conforming implant, in which the post also acts to provide medial and lateral constraint leading to greater experienced force.^{13–16} Implants with more anterior post placement have also demonstrated increased wear damage of the tibial post in retrieval studies.^{4,17} Sterilization during implant manufacturing may also play a role in tibial post fracture since historical γ irradiation in air can lead to oxidative degradation of the polyethylene implant during storage.¹⁸ The current practice of γ sterilization in an inert environment combined

with barrier packaging reduces pre-implantation degradation but still produces free radicals within the polymer that make it susceptible to in-vivo oxidation.¹⁸ Given that tibial post fractures have been reported in in γ inert sterilized components, further research is needed to determine the impact sterilization method has on tibial post failure.^{3,19,20}

In addition to implant characteristics, factors related to surgical technique and individual anatomy have also been implicated in elevated risk for tibial post failure. Surgical techniques that result in anterior tibial post impingement during knee extension, such as anterior positioning of the tibial tray or excessive femoral component flexion, have been found to result in increased tibial post damage.^{4,13,21–25} In terms of patient related factors, medial laxity post-operatively may increase risk for post-fracture as Hendel et al described five patients with noted to have mild medial laxity two to three years after the index arthroplasty who went on to have tibial post fractures.²² Patients with a large native anterior femoral bow may also be at risk for tibial post fracture due to the difficulty in properly positioning the intramedullary alignment guide so as to prevent femoral component flexion.^{4,10} For these patients, the use of an alternative system, such as a cruciate-retaining device may be a better option to avoid tibial post fracture.⁴

Knee pain has been estimated to affect 25% of adults, and results in 4 million primary visits annually.^{26,27,28} Although not all patients with knee pain require knee replacement, arthroplasty is one of the most common orthopedic procedures.¹ As the United States population ages, the demand for TKA is projected to approach 3.5 million procedures annually by 2030.²⁹ In some national registry studies, 10-year TKA implant survival without revision is over 95%, with risk of failure requiring revision decreasing with age of index surgery.³⁰ Despite the high success of TKA, from 2012 to 2019 over 500,000 revision surgeries were performed in the United States. Approximately 40% of revision TKA were performed for aseptic loosening and prosthetic joint infection with instability (11%) and bearing surface wear (2.3%) being less common indications.^{31,32} As the number of primary TKA increases, the number of revision TKA is also projected to surpass 200,000 annually by 2030.²⁹ As a result, primary care physicians and other non-orthopedic clinicians can be expected to increasingly be caring for patients who will need TKA, or have undergone either primary or revision TKA.

It is important for clinicians who care for patients with TKA to be aware of tibial post fractures as patients will often present to primary care physicians with intermittent and non-specific symptoms. Most commonly reported symptoms in post fractures are pain, swelling, and instability; however, patients can present with more objective mechanical symptoms such as “clunking” during range of motion, a palpable mass, or knee dislocation.^{3,7,8,11,22,33} Common mechanisms of failure include direct trauma to knee, standing from seated

position, or climbing stairs.^{12,34} In addition to a thorough history, it is important to evaluate posterior stability at varying degrees of flexion as any residual post may confer stability at flexion angles less than 90 degrees.¹² Although the use of arthroscopy and CT arthrography has been reported, the diagnosis of tibial post failure relies on a detailed clinical history and physical exam because radiographs, as in this case, are typically non-specific.^{11,35} High clinical suspicion should prompt evaluation by an arthroplasty specialist.

Standard treatment guidelines for tibial post fractures have not been established. In a 2011 review, Lachiewicz found the most common intervention performed was polyethylene liner exchange.¹¹ Only one (5%) of the patients treated with this method went on to require an additional revision surgery although limited follow up data was available. In our case, revision with a new posterior stabilized bearing of the same thickness as the initial implant provided optimal stability. The altered biomechanics of a knee with a fractured tibial post leads to increased wear and release of polyethylene debris which predisposes patients to osteolysis, aseptic loosening and reactive synovitis.¹³ As a result, different operative treatments may be required depending on timing of diagnosis and patient specific characteristics.^{22,36,37} Because delayed diagnosis can make revision more challenging, clinicians should maintain a high index of suspicion for tibial post fracture. In the absence of loss of implant fixation, ligamentous instability, or malalignment of the femoral or tibial components, polyethylene liner exchange is an appropriate initial intervention since it preserves bone stock and likely results in less patient risk, shorter operative times, faster rehabilitation, and lower cost.^{38,39}

In summary, we present a patient with a posterior stabilized total knee arthroplasty complicated by late tibial post fracture. We suggest that surgeons and primary care providers should maintain a high index of suspicion for this uncommon complication when faced with patients reporting similar histories and physical exam findings, especially those with implants which may have a track record of tibial post fracture. Polyethylene exchange utilizing an implant of the same thickness was a successful intervention in this case but we suggest that appropriate revision surgery should be dictated by the unique characteristics of the patient at the time of failure. The authors suggest an area to direct further research would be to determine the potential increased risk of catastrophic implant failure in total knee designs utilizing a fixation screw through the post compared to those without this design feature.

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