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Case report

Trunnion Failure in Revision Total Knee Arthroplasty

Samir Chihab, MD [*], Bryan M. Grommersch, Greg A. Erens, MD, George N. Guild III, MD

Department of Orthopaedics, Emory University School of Medicine, Atlanta, GA, USA

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ABSTRACT

In revision total knee arthroplasty, joint kinematics must be maintained amid bone and ligamentous insufficiency. Current modular designs address defects while allowing for intraoperative prosthesis customization through a variety of stem extensions and constraints. Additional constraint improves knee stability while increasing stress at the implant-host interface and modular junction of the implant. This renders the prosthetic stem-condyle junction more prone to fatigue failure. We report 2 cases of prosthetic stem-condyle junction failure in in a varus-valgus constrained revision total knee arthroplasty.

Introduction

Primary and revision total knee arthroplasty (rTKA) cases are expected to increase six-fold between 2005 and 2030 [1]. rTKA Presents many challenges. Bone loss and ligamentous insufficiency must be addressed while maintaining joint kinematics. The use of stems in rTKA is often necessary to obtain fixation in deficient bone and allow for long-term fixation with increasing constraint [2-4]. Constrained implants improve the stability of the knee but increase stress at the implant-host interface and modular junction of the implant. As a result, the prosthetic stem-condyle junction becomes a potential area for fatigue failure [3,5]. Therefore, the benefit of constrained implants must be balanced against the risk of added construct stress. Several types of constraint are currently available to compensate for ligamentous insufficiencies [6]. In general, using the minimum necessary constraint when performing rTKA is recommended [7]. Failure of TKA implants at the prosthetic stem-condylar junction has been reported in the literature [8-10]. We report 2 cases of modular junction failure in posterior stabilized constrained rTKA.

Case histories

Case 1

An 80-year-old male patient with a BMI of 25 underwent primary right TKA in 2007 for symptomatic osteoarthritis at an outside facility. Unfortunately, his postoperative course was complicated by infection requiring two-stage revision. Over 10 years later, the patient developed worsening right knee pain and instability. His radiographs revealed gross mechanical failure at the junction of the femoral component and stem (Fig. 1). The infection workup was negative. He underwent rTKA because of mechanical failure of a posterior stabilized legacy constrained condylar knee (LCCK) prosthesis (ZimmerBiomet, Warsaw, IN).

Informed consent for the procedure and publication was obtained and documented. Upon entry into the knee, it was noted that the patient had thickened black-stained synovium (Figs. 2 and 3). The joint fluid appeared relatively normal. The LPS liner did not show any signs of excessive or focal wear. As revealed on the preoperative radiographs, the femoral component was grossly broken at the femoral stem-condyle junction. Because the broken femoral stem remained lodged within the femoral canal, osteotomes followed by a trephine were used. The femoral component was easily extracted, and the tibial plate was noted to be solidly fixed. The decision was made to keep the tibial base plate to avoid more proximal bone loss. The femoral component was revised to a posterior stabilized LCCK with a small cone while the tibial component remained in place (Fig. 4). Unfortunately, the initial revision was performed at an outside institution in 2008, and documentation of the implant sizes was not available. The implants used for the revision reported herein were femur size D with 13 $\times$ 100 cemented femoral stem and a porous tantalum cone size small 30 mm in height, as well as a 20-mm LCCK polyethylene liner. At 21-month follow-up, the patient had experienced no postoperative complications and demonstrated an active range of motion of 0-110° with excellent strength and stability.

* Corresponding author. Emory University School of Medicine, 59 Executive Park South NE, Suite 2000, Atlanta, GA, 30329, USA. Tel.: +1 404 778 3350.

E-mail address: samir.chihab2@emory.edu

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Figure 1. An anteroposterior radiograph of the right knee showing the broken stem.

Case 2

A 72-year-old morbidly obese male with a history of hypertension underwent bilateral TKA for osteoarthritis. The left TKA was performed in 2007 and has done well. The right TKA was performed in 2011 but became mechanically loose and required revision surgery in 2015 with a posterior stabilized LCCK prosthesis (ZimmerBiomet, Warsaw, IN). In 2019, the patient again began complaining of right knee pain. This pain acutely worsened after a fall in 2020. Radiographs performed at that time revealed a loose tibial component as well as mechanical failure at his tibial stem junction with breakage (Fig. 5).

Informed consent for the procedure and publication was obtained and documented. Upon entry into the joint, the fluid appeared normal with no signs of infection or metallosis. The

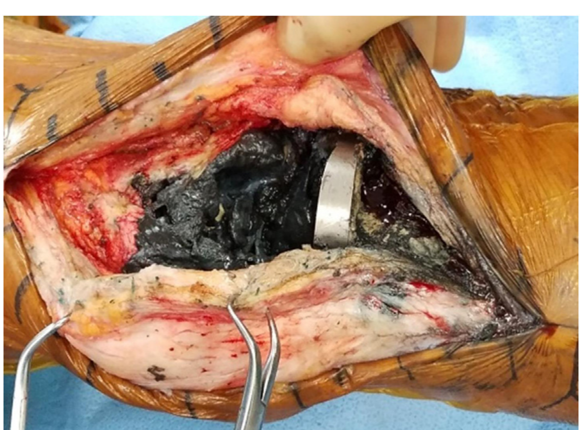

Figure 2. Metallosis of the right knee in a posterior stabilized LCCK prosthesis (ZimmerBiomet).

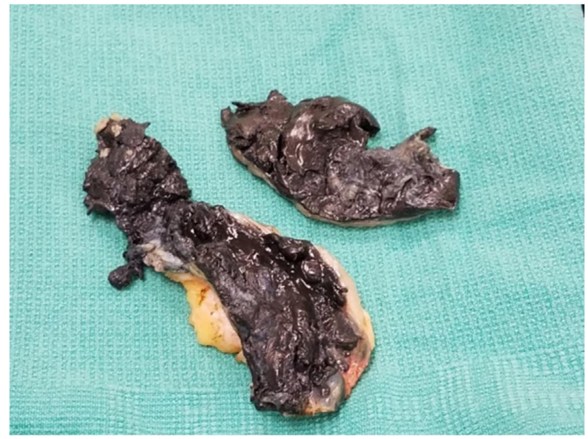

Figure 3. Thickened and stained synovium resected from the right knee.

polyethylene liner did not show any signs of excessive wear. As expected, the tibial base plate was grossly loose within the proximal tibia and was extracted (Fig. 6a). This allowed visualization of the stem, which remained within the canal. The stem had broken at the trunnion (Fig. 6b). After clearing out cement and debris around the stem, it was easily removed from the canal. A Persona Revision Total Knee System (ZimmerBiomet, Warsaw, IN) was used with cemented stem extensions and a tibial cone (Fig. 7). The implants revised were femur size F with 20 × 130 sharp fluted stem extension and 5-mm augments medially and laterally, wedged tibial plate size 5 with offset 13 × 155 stem extension, and a 12-mm liner. The implants used in the revision were femur size 9 with 20 × 135 smooth cemented stem, tibia size D with 12 × 135 smooth cemented stem extension, and a 22-mm LCCK polyethylene liner. At the 2-week postoperative visit, radiographs demonstrated a revision right total knee replacement without complication. His surgical staples were removed. The patient was able to ambulate short distances with a walker and was recovering without issue.

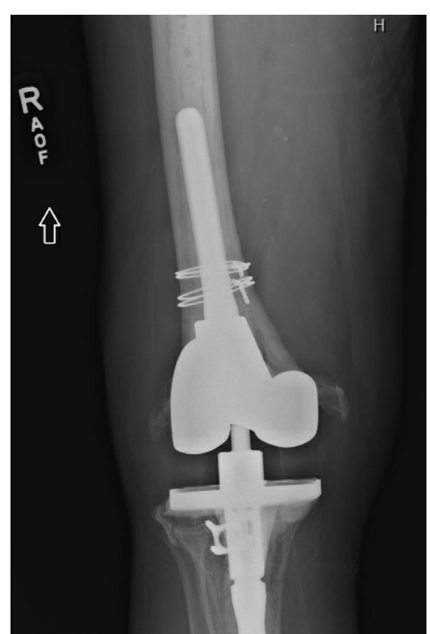

Figure 4. Postoperative anteroposterior radiograph of the right knee.

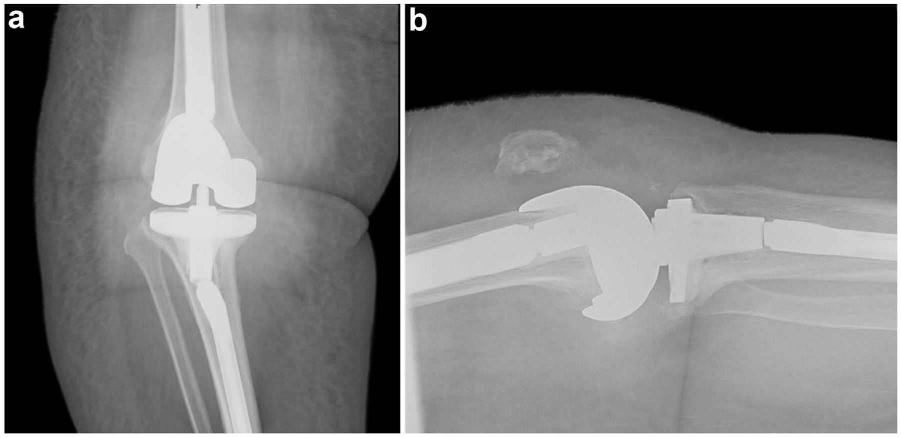

Figure 5. Anteroposterior (a) and lateral (b) right knee radiographs demonstrating tibial component loosening and mechanical failure with breakage at the tibial stem junction.

Unfortunately, the patient has not returned for additional follow-up amid the COVID-19 pandemic.

Discussion

Primary and rTKAs are increasingly prevalent in the United States [1]. As TKAs are performed in younger patients, surgeons will be faced with rising amounts of severe bone loss and ligamentous deficiencies in revision surgeries. In such cases, the surgeon must combat the many challenges associated with restoring original anatomy and function while maintaining stability. Suboptimal distal femoral or proximal tibial fixation and ligamentous insufficiency dictate the use of constrained stemmed components [9,11,12].

Stem-condyle junction failure remains a rare clinical event, with approximately a dozen cases previously reported in the literature. Lim et al. described 5 cases of stem dissociation from the condylar portion of Total Condylar III (TC3) prostheses (DePuy Johnson & Johnson, Warsaw, IN) secondary to locking screw failure 1-3 years after most recent revision [3]. Over a decade later, Butt et al. described another case of TC3 coupling failure occurring by a similar mechanism 3 years after most recent revision [13]. Two instances of Optetrak stemmed constrained condylar knee prosthesis (Exactech, Gainesville, FL) failure occurring 3 and 4 years after revision were reported by Issack et al. after fracture at the male portion of the taper lock between the femoral component and the stem extension [14]. Nikolopoulos et al. reported a case of failure at the junction of the modular intramedullary stem and holding screw of a P.F.C. Sigma TC3 (DePuy Johnson & Johnson) 2 years after most recent revision [15]. Howell and Rorabeck disclosed an incident of intraoperative femoral intramedullary stem disengagement, likely from an assembly error, that lead to night pain but no significant implant loosening at 3-year follow-up [16]. Boe et al. reported a similar dissociation of the femoral condylar component in a Triathlon TS prosthesis 7 years after most recent revision (Stryker, Kalamazoo, MI) [17]. Most recently, Kahan and Estes detailed failure at the femoral stem-extension condylar interface in a NexGen Rotating Hinge Knee 7 years after revision (ZimmerBiomet, Warsaw, IN) [18].

To our knowledge, the cases presented in this report are the first to identify stem-condyle junction failure in a posterior stabilized LCCK prosthesis.

Meta-diaphyseal stem fixation is required to share articular loads, augment suboptimal condylar fixation, and protect ligament deficiencies [19,20]. Although articular constraint provides knee stability, it increases stress at the bone-component interface and at the condylar-stem junction in case of a modular prosthesis [5,21]. As a general principle, the minimum necessary amount of constraint should be used when performing rTKA [7]. Modular design helps with fixation and stability by allowing for intraoperative customization. In the case of modular prostheses, the area of maximal stress concentration is at the stem-prosthesis junction and tip of the stem [2,5]. The stem extensions, however, are unable to resist the entire load when limited juxta-articular bone support is available. As the condylar portion of the femoral or tibial implant loosens, stresses at the stem junction increase, especially if the part of the stem further from the joint remains stable. The prosthetic stem-condyle junction may not be able to

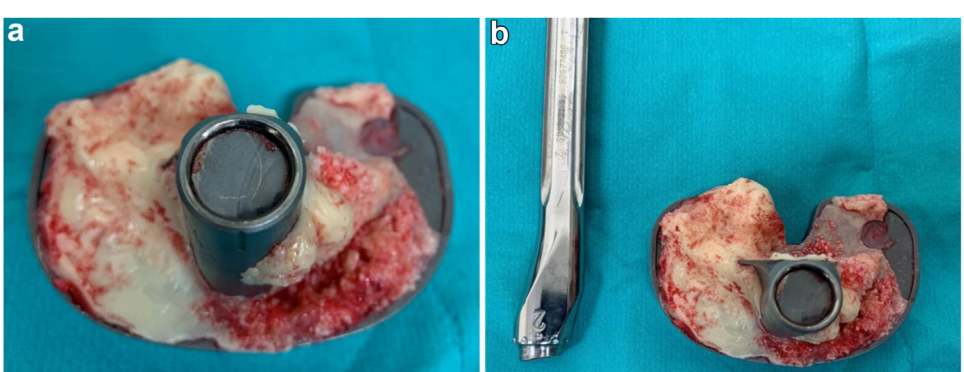

Figure 6. The extracted tibial base plate (a) and stem that had broken at the trunnion (b).

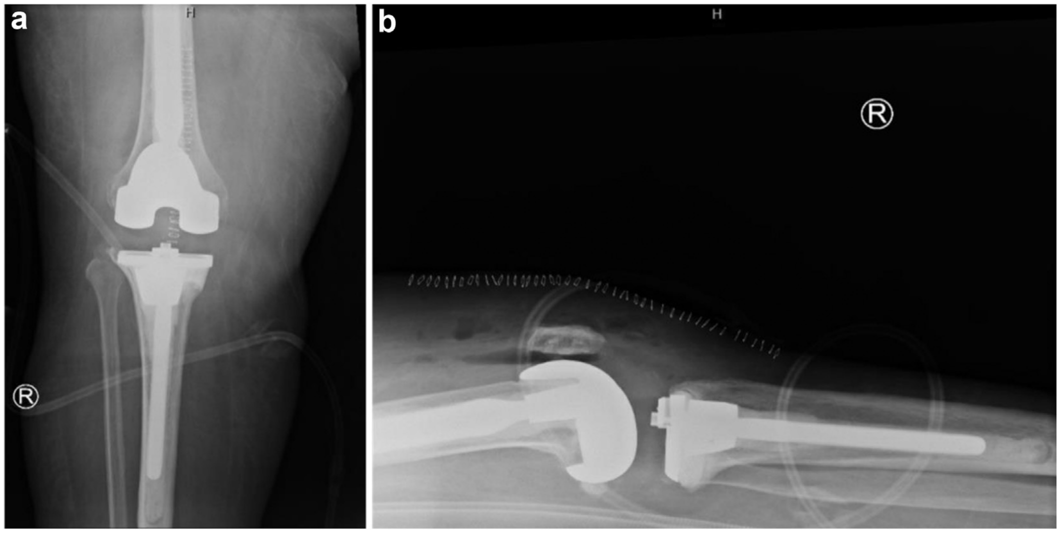

Figure 7. Postoperative anteroposterior (a) and lateral (b) radiographs.

withstand such concentrated forces and becomes an area susceptible to fatigue failure [5].

In our patients described in case 1 and case 2, there was radiographic evidence of osteolysis and bone loss at the distal femur and proximal tibia, respectively. This may have contributed to aseptic component loosening. In these cases, bone loss at the distal femur or proximal tibia may have been caused by stress-shielding of the respective cemented stemmed component [22,23]. It is likely that this component aseptic loosening increased stresses throughout the stem and the taper connection.

Summary

The benefits of the current modular knee systems are intraoperative customization and improved fixation and kinematics. However, there is a potential for failure at the modular junction. When increased constraint is required, the minimum necessary amount of constraint should be used, and special consideration should be given to the amount of stress that will be placed on the condyle-stem junction. Adequate distal bone support should be optimized with a variety of techniques (bone graft, augments, cone, sleeve) to avoid excessive stress on the femoral and tibial component-stem junctions.

Declaration of interests

The authors declare there are no conflicts of interest.

References

[1] Kurtz S, Ong K, Lau E. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89:780.
[2] Bertin K, Freeman M, Samuelson K, Ratcliffe S, Todd R. Stemmed revision arthroplasty for aseptic loosening of total knee replacement. J Bone Joint Surg Am 1985;67(2):242.
[3] Lim L-A, Trousdale RT, Berry DJ, Hanssen AD. Failure of the stem–condyle junction of a modular femoral stem in revision total knee arthroplasty: a report of five cases. J Arthroplasty 2001;16(1):128.
[4] Kim Y-H, Kim J-S. Revision total knee arthroplasty with use of a constrained condylar knee prosthesis. J Bone Joint Surg Am 2009;91(6):1440.
[5] Ahn J-M, Suh J-T. Detection of locking bolt loosening in the stem-condyle junction of a modular femoral stem in revision total knee arthroplasty. J Arthroplasty 2010;25(4):660. e11-13.
[6] Scuderi GR. Revision total knee arthroplasty: how much constraint is enough? Clin Orthop Relat Res 2001;392:300.
[7] Haas SB, Insall JN, Montgomery 3rd W, Windsor RE. Revision total knee arthroplasty with use of modular components with stems inserted without cement. J Bone Joint Surg Am 1995;77(11):1700.
[8] Murray PB, Rand JA, Hanssen AD. Cemented long-stem revision total knee arthroplasty. Clin Orthop Relat Res 1994;309:116.
[9] Sandiford NA, Phillips JR, Back DL, Toms AD. Three cases of femoral stem failure in rotating hinge revision total knee arthroplasty: causes and surgical considerations. Clin Orthop Surg 2018;10(2):260.
[10] Westrich GH, Hidaka C, Windsor RE. Disengagement of a locking screw from a modular stem in revision total knee arthroplasty. A report of three cases. J Bone Joint Surg Am 1997;79(2):254.
[11] Donaldson III WF, Sculco TP, Insall JN, Ranawat CS. Total condylar III knee prosthesis: long-term follow-up study. Clin Orthop Relat Res 1988;226:21.
[12] Peters CL, Erickson J, Kloepper RG, Mohr RA. Revision total knee arthroplasty with modular components inserted with metaphyseal cement and stems without cement. J Arthroplasty 2005;20(3):302.
[13] Butt AJ, Shaikh AH, Cameron HU. Coupling failure between stem and femoral component in a constrained revision total knee arthroplasty. J Coll Physicians Surg Pak 2013;23(2):162.
[14] Issack PS, Cottrell JM, Delgado S, Wright TM, Sculco TP, Su EP. Failure at the taper lock of a modular stemmed femoral implant in revision knee arthroplasty: a report of two cases and a retrieval analysis. J Bone Joint Surg Am 2007;89(10):2271.
[15] Nikolopoulos D, Polyzois I, Magnissalis E, Bernard P, Michos I. Fracture at the stem–condylar junction of a modular femoral prosthesis in a varus–valgus constrained total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2012;20(6):1071.
[16] Howell G, Rorabeck C. Femoral stem disengagement in modular total knee revision arthroplasty. Knee 1999;6(3):221.
[17] Boe CC, Fehring KA, Trousdale RT. Failure of the stem-condyle junction of a modular femoral stem in revision total knee arthroplasty. Am J Orthop 2015;44(10):E401.
[18] Kahan M, Estes C. Failure at the femoral stem extension-condylar interface in a rotating hinge knee without radiographic evidence of loosening. Arthroplasty Today 2020;6(1):36.
[19] Mow CS, Wiedel JD. Structural allografting in revision total knee arthroplasty. J Arthroplasty 1996;11(3):235.
[20] Rawlinson JJ, Peters LE, Campbell DA, Windsor R, Wright TM, Bartel DL. Cancellous bone strains indicate efficacy of stem augmentation in constrained condylar knees. Clin Orthop Relat Res 2005;440:107.
[21] Mabry TM, Vessely MB, Schleck CD, Harmsen WS, Berry DJ. Revision total knee arthroplasty with modular cemented stems: long-term follow-up. J Arthroplasty 2007;22(6):100.
[22] Completo A, Simões J, Fonseca F. Experimental evaluation of strain shielding in distal femur in revision TKA. Exp Mech 2008;48(6):817.
[23] van Loon C, Kyriazopoulos A, Verdonschot N, de Waal Malefijt M, Huiskes R, Buma P. The role of femoral stem extension in total knee arthroplasty. Clin Orthop Relat Res 2000;378:282.