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Case report

Tapered modular fluted titanium stems for femoral fixation in revision total knee arthroplasty

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ABSTRACT

Consensus regarding femoral stem fixation options in revision total knee arthroplasty remains controversial. Tapered, modular, fluted titanium (TMFT) stems have an excellent track record in total hip arthroplasty for their ability to provide axial and rotational stability in situations of compromised host bone. We present 3 successfully treated cases in which the Food & Drug Administration granted permission to use custom TMFT stems in situations of failed femoral fixation in multiple revised knees. These stems hold promise to achieve stable fixation in revision total knee arthroplasty where host metadiaphyseal bone is deficient. Implant manufactures should consider dedicating future resources to create adapters that can link existing successful TMFT stems currently used in hip arthroplasty to revision total knee components when host bone is severely compromised.

Introduction

As more patients undergo total knee arthroplasty (TKA), the demand for revision TKA has continued to rise [1]. The increasing incidence of aseptic failures brings about concerns with revision fixation strategies to preserve bone stock and maximize function [2]. Stems are an attractive adjunct due to their ability to provide a diaphyseal reference for length, bypass metaphyseal bone defects, and reduce interface stresses in damaged bone. Although stems have been used in revision TKA for decades, debates over fully cemented vs hybrid cementless fixation remain [3-5]. Long-term concerns of loosening with non–ingrowth surface designs exist in cases of substantial bone loss with highly constrained articulations.

Diaphyseal fixation in revision total hip arthroplasty has been improved by the introduction of tapered, modular, fluted titanium (TMFT) stems. Tapered fluted stems are now preferentially chosen given their excellent long-term survivorship with low reported rates of stem failure and high rates of bone fixation compared to cylindrical fully porous designs, particularly in compromised bone [6-9]. The versatility of such a design affords the surgeon the chance to obtain diaphyseal fixation when the periarticular bone stock is poor. Evidence further suggests that regeneration of proximal trabecular bone may be possible due to the transmission of forces produced by the conical design of the stem combined with titanium's lower modulus of elasticity [10,11].

Given the success of TMFT stems in revision hip arthroplasty, we adopted a similar fixation strategy in a series of revision TKAs where femoral bone stock was severely compromised and conventional stem fixation strategies had failed. This report focuses on the technique, outcomes, and application of TMFT stems as the possible future of fixation in revision TKA.

Case histories

We retrospectively identified 3 cases in which a custom TFMT stem design was utilized in revision TKA by the senior author (T. K. F.) between 2012 and 2015. Each patient provided informed consent to be included in this case report. All 3 subjects are at least

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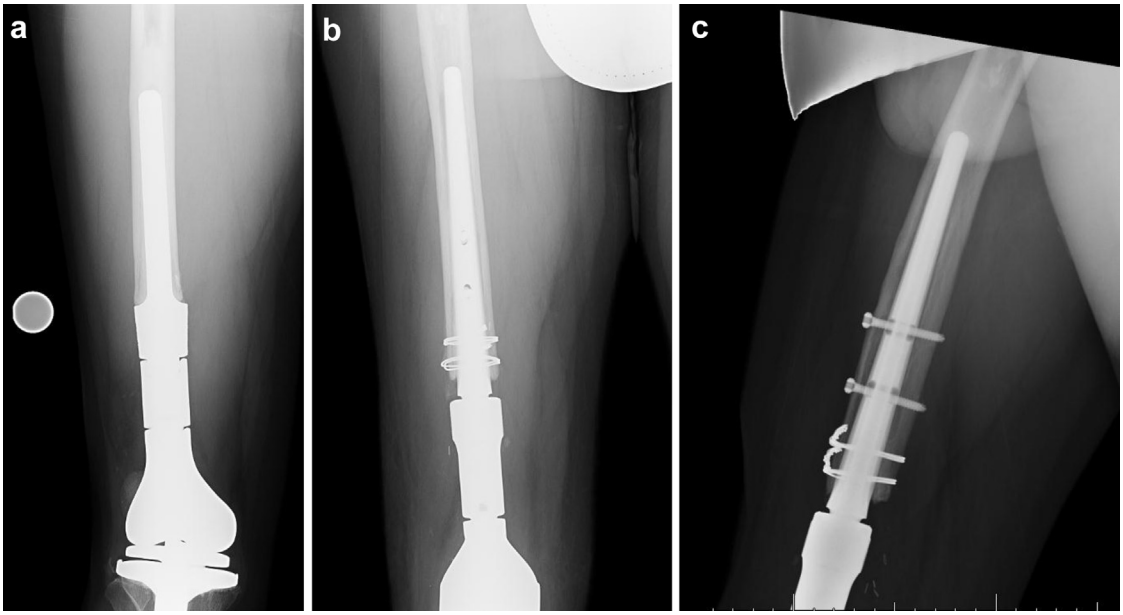

Figure 1. (a) Distal femur replacement with pre-existing cemented modular femoral endoprosthesis before explantation for infection. (b) Anteroposterior radiograph of custom Zimmer Biomet OSS fluted modular stem with 2 proximal locking screws. (c) Lateral radiograph of custom Zimmer Biomet OSS implant with fluted modular stem and 2 anterior-to-posterior femoral interlocking screws to backup axial support.

1 year out from surgery and none have required a return to the operating room or surgical complication.

Case 1

A 37-year-old male who underwent a right distal femoral replacement for osteosarcoma over 10 years ago was referred to the senior author (T. K. F.) for management of an acute hematogenous infection (Fig. 1a). He initially underwent irrigation and debridement with modular component exchange but subsequently required explantation with placement of a static antibiotic spacer. After appropriate antibiotic treatment, he underwent reimplantation. For the revision, given the patient's age, functional status, and sclerotic femoral diaphysis, the decision was made to proceed with a custom TMFT stem (Zimmer Biomet Inc., Warsaw, IN) linked to hinge components from their Orthopaedic Salvage System line. A preoperative computed tomography scan of the femur was obtained to accurately size the stem diameter and length ahead of time and sent to the manufacturer for assembly. For the surgery itself, a standard extensive revision knee exposure was utilized and pre-existing implants were meticulously removed and the remaining bone stock surveyed. Prophylactic wires were placed at the distal 3 cm of intact diaphysis of the distal femur prior to reaming to prevent propagation of nondisplaced cracks (Fig. 1b and c).

As in the revision hip setting, reaming the canal by hand or power until solid engagement of the reamer inside the bone is achieved is absolutely necessary to ensure proper sizing and to prevent subsidence of the final implant. We also advise inspecting the reamer to gain feedback on how much bone is being removed. For this custom design, interlocking screws were utilized for additional axial and rotational stability. As with any distal femoral replacement, we took great care to provide adequate external rotation of the stem to ensure proper patellar tracking. This was done at the onset of stem implantation as the flutes engage the endosteal cortical bone preventing late adjustments. On the tibial side, there was sufficient cancellous bone available to allow the use of a cemented stem along with metaphyseal cone fixation. At a follow-up of 27 months, the patient remains active with radiographic evidence of osseointegration of his custom implant.

Case 2

A 65-year-old female presented to the senior surgeon (T. K. F.) with a supracondylar femoral periprosthetic nonunion after attempted intramedullary fixation. Initially, she underwent distal femoral replacement with a cylindrical porous stem, which subsequently loosened over the course of 2 years (Fig. 2a and b). Because the remaining diaphyseal bone was sclerotic without an apparent cancellous bed to accept a cemented stem and a cementless porous stem had previously failed, the decision was made to utilize a custom TMFT stem (DePuy Synthes, Warsaw, IN) with an accompanying set of custom reamers. The stem diameter and length had to be templated and accurately sized ahead of time for fabrication with a preoperative CT scan. At the time of revision surgery, a cerclage wire was placed prophylactically during canal preparation to prevent fracture propagation of her already thin cortex. Once inserted, the female taper of the distal femoral component (Limb Preservation System [LPS]; DePuy Synthes) was impacted onto the custom male Morse taper fabricated specifically to mate with that LPS component. Final fixation of this implant called for one proximal interlocking screw to confer additional axial support. The postoperative protocol included touchdown weight bearing for approximately 6 weeks to allow for osseointegration and decrease the chance of stem subsidence. At a follow-up of 30 months, the patient walks without pain, and has stable fixation on serial radiographs (Fig. 3a and b).

Case 3

A 72-year-old patient was referred to the senior author (T. K. F.) with a failed distal, femoral, allograft prosthetic composite stem. This patient had a total of 32 previous surgeries in his left lower extremity, including at least 4 TKA revisions for recurrent aseptic femoral loosening. Initially, the failed allograft prosthetic composite was revised to a cemented hinge prosthesis, which subsequently

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