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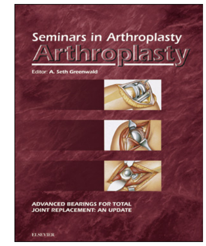

Modular tapered fluted stems: An accommodating option in the setting of femoral bone deficiency

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ABSTRACT

Tapered, fluted, modular, titanium stems are being used more frequently for revision total hip arthroplasty to address femoral bone deficiencies. Mid- and long-term survivorship studies demonstrate that these stems are a durable implant design, while outcome studies show that they provide favorable patient satisfaction and function. Subsidence, implant fracture, and stress shielding are frequently encountered complications, which can be minimized through the use of meticulous preoperative templating, direct visualization of the femoral stem using mini C-arm fluoroscopy, and through the use of a kinked femoral implant. By using these techniques, a canal-filling implantation technique can be achieved.
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Introduction

Over the past several decades, the number of revision total hip arthroplasty procedures being performed has continued to increase [1,2]. As this burden grows, so do the operative and clinical challenges faced by arthroplasty surgeons. Obstacles to restore clinical function in revision surgery include general debility, compromised soft-tissue envelope, muscle dysfunction, angular deformity, and bone loss. Achieving stable, well-fixed implants is fundamental to providing functional restoration. Revision total hip in the setting of femoral bone loss poses specific challenges in achieving adequate femoral fixation. In this review, we present our experience in dealing with femoral bone deficiency in the revision setting with the use of a modular tapered fluted stem implant as well as describe challenges commonly seen with these designs.

Implant options

Extensively porous-coated, monolithic, cylindrical cobalt-chrome stems have traditionally been the implant of choice to address femoral bone loss [3–18]. However, issues in regard to femoral version, torsional remodeling, metaphyseal–diaphyseal mismatch, leg length, and postoperative stability make these monoblock constructs more challenging [13]. Sporer and Paprosky [19] have reported that femoral fixation is less reliably achieved with these stems, with a mechanical failure rate of 18–38% for type 3B and 4 femoral bony deficiencies.

More recently, tapered, fluted, modular, titanium (TFMT) stems have been successfully utilized in the setting of bone deficiency [11–18]. These constructs allow decoupling of proximal and distal stem segments and bypass proximal femoral bone deficiencies by engaging into the diaphysis. When compared to non-modular cylindrical stems, TFMT stems have demonstrated better patient satisfaction, quality of life measures, lower incidence of intraoperative fracture, as well as better restoration of proximal bone stock [20,21]. Short term and mid-term results of TFMT stem constructs have been favorable. Mid-term survivorship of stems of similar design have been reported from 87% to 95% [11–18]. Our 10-year survivorship of 88.7% demonstrates continued durability of this implant design. Our reported Harris Hip Scores are also similar to reported short and mid-term functional outcome scores [8]. With the introduction of modularity of femoral implants over the past several decades, patient function and satisfaction scores have been improved [20].

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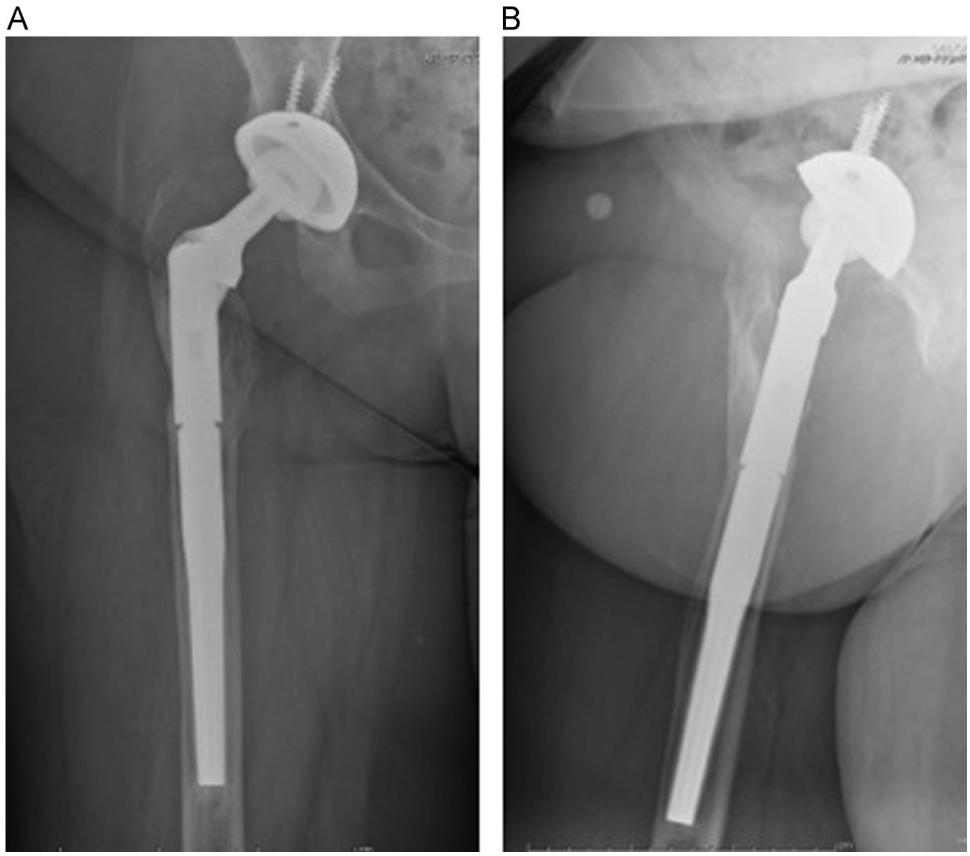

Figure – (A and B) The 13-year follow-up anteroposterior and lateral radiographs of a hip that was re-implanted following periprosthetic infection in a 50-year-old woman. Evidence of osteointegration and remodeling following an extended trochanteric osteotomy are evident.

The Link MP reconstruction femoral prosthesis (Waldemar Link, Hamburg, Germany) has been utilized extensively at our center. This modular, non-cemented, tapered, titanium stem is angled 3 degrees to accommodate femoral bowing. The stem is fluted distally to provide rotational stability and has a 2° taper angle. The surface of the stem is corundum-blasted to a roughness average of 70 μm to improve fixation and promote bone on-growth. The stem component is available in a variety of lengths and widths, while variable proximal bodies and spacers can be used for length adjustment and metaphyseal fill.

Stem subsidence

A frequently reported complication of TFMT stems is subsidence. Bohm and Bischel [22] reported subsidence of greater than 5 mm in 34% of cases. McInnis et al. [23] reported an average of 10 mm of subsidence in 84% of cases. Subsidence of greater than 10 mm occurred in 20% of cases in a study by Gutierrez et al. [24]. In all of these studies, under-sizing of the femoral diaphyseal component was indicated as the likely predisposing factor, and a learning curve for surgeon implant sizing has been suggested [25,26]. The femoral implants used in these studies were straight tapered stems that depend on 3-point fixation within the femoral canal to achieve stability [22,24]. As such, an implant that inadequately engages the femoral cortices would be predisposed for subsidence. Straight stems also impinge on the anterior cortex in 16.7% of cases with an average loss of cortical thickness of 40% (20–80%) [24].

Park et al. [14] reported a lower subsidence rate of 11% of their 62 hip revisions. Additionally, they found decreased subsidence rate in the patients who underwent an extended trochanteric osteotomy compared to those who did not. An extended trochanteric osteotomy removes any potential conflict with the proximal femur, and thusly gives direct visualization and access to the femoral canal. By extension, this also allows for larger diameter stems to be inserted into the femoral diaphysis. The implant design used in these cases also had a 4° stem angle. A kinked stem accommodates for femoral bow allowing a larger stem to be advanced before engaging the diaphyseal bone (Fig. A and B). We hypothesize that this canal-filling technique and the absence of proximal femoral bone conflict influencing implant choice may explain their decreased subsidence rate.

We reported a subsidence rate of 3% in our experience, which is less than previously reported rates [8]. We hypothesize that our low subsidence rate was achieved by creating a similar canal-filling construct through the combination of comprehensive preoperative templating, direct visualization of the femoral stem using a mini C-arm fluoroscopy, and the use of a 3° femoral implant kink. The Link MP reconstruction stem features high surface roughness (70 μm), which may also have contributed to our decreased subsidence rate.

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