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Original Article

"Top-Out" Removal of Well-Fixed Dual-Taper Femoral Stems: Surgical Technique and Radiographic Risk Factors

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A B S T R A C T

Background: Contemporary "dual-taper" modular femoral neck-stem designs have been associated with taper corrosion–related adverse local tissue reaction (ALTR) requiring revision surgery and stem removal. Extended trochanteric osteotomy is recognized as the workhorse procedure for revision hip surgery. The aim of our study is to describe our "top-out" stem removal surgical technique and identify preoperative radiographic risk factors associated with periprosthetic fractures when using this technique.
Methods: This is a single-center, single-surgeon, retrospective case series. Operative and clinic records were reviewed for patients with dual-taper modular femoral neck-stem junction who underwent revision surgery for taper tribocorrosion–related ALTR.
Results: Eighty-three patients (36 men and 47 women; mean age, 61.8 ± 10.3; body mass index, 30.2 ± 8.6) were revised using the top-out technique. Significant improvements in postoperative Harris hip score ($P = .004$), EuroQol 5-dimension questionnaire (EQ-5D; $P < .001$), and EQ-5D US-adjusted scores ($P < .001$) were observed at 19-months follow-up. Our study reports periprosthetic fracture incidence of 14% and reoperation rate of 7%. Periprosthetic fractures were positively correlated with radiographic parameters such as overhang distance (R = 0.376; $P = .002$) and overhang ratio (R = 0.312; $P = .01$) and negatively correlated with radiographic implant medial calcar prominence (R = −0.299; $P = .01$).
Conclusion: Removal of well-fixed femoral components can be challenging, and the burden of revision surgery for taper tribocorrosion–related ALTR of these femoral stems is likely to rise. A top-out technique with systematic preoperative planning with radiographs provides a viable, alternative surgical option to remove well-fixed femoral component while preserving the femoral bony envelope.

Modularity in total hip arthroplasty (THA) allows for intraoperative optimization and restoration of patient anatomy [1]. Traditionally, modularity has existed at the head-neck junction of femoral implants. Newer dual-taper modular neck femoral THA implants have an additional modularity at the neck-stem junction. The additional modularity at the neck-stem junction has the potential to allow for easier adjustment of mechanical parameters including offset, version, and length, independent of femoral stem position [2]. However, the use of contemporary dual-taper modular neck femoral stems has led to mechanically assisted crevice corrosion, fretting, femoral neck fractures [3-6], elevated serum metal ion levels as well as the occurrence of adverse local tissue reaction (ALTR) [7-10]. This has led to the voluntary recall of 2 femoral stem designs from a manufacturer, with an increasing burden of revision surgery of these implants [7,11-15]. It is estimated that more than 30,000 patients have been implanted with these recalled modular neck stems.

Revision surgery for dual-taper femoral stems in the setting of ALTR is a challenging endeavor that requires a systematic preoperative evaluation [16] and careful surgical planning for stem removal [17]. Removal of a well-fixed cementless femoral stem classically requires an extended trochanteric osteotomy (ETO) [18-20]. ETO has been used to extract well-fixed femoral stems in

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modular neck THA fractures [3-6]. Cooper et al [7] reported on 12 hips with ALTR secondary to taper corrosion at the modular neck-stem junction who underwent revision surgery. All femoral components were well fixed and required explant. Nine hips were approached with an ETO and the 3 revisions attempted without ETO resulted in a proximal femoral fracture requiring additional surgery.

ETO is an important tool in the armamentarium of the arthroplasty surgeon who performs revision hip surgery. Although widely recognized as the workhorse procedure for revision hip surgery, ETO requires extended incisions, risk of osteotomy nonunion, and protected postoperative weight bearing. In a series by Miner et al [19], the reoperation rate of ETO was 10.2%, with an average time to union of 12.8 weeks, 1.2% nonunion rate, and 10.8% nondisplaced fractures extending distally. More recent studies have also described 8.3%-23% intraoperative fracture rate when using ETO for revision THA [21].

In the case of well-fixed modular neck femoral stem revision for taper corrosion–associated ALTR, removal of well-fixed femoral stems without an ETO provides the potential advantages, eliminating risks of delayed bony union and potentially reducing time to ambulatory rehabilitation. However, there is a paucity of literature on alternative revision THA techniques for modular neck-stem taper corrosion. The aim of our study is to (1) describe our top-out stem removal surgical technique without the need for an ETO; (2) report complication rates; and (3) identify preoperative radiographic risk factors associated with periprosthetic fractures when using the top-out technique in patients with well-fixed dual-taper femoral stem THA.

Materials and Methods

Patients

This is a retrospective, single-surgeon case series reporting on patients requiring revision surgery for modular femoral neck-stem corrosion secondary to ALTR at a tertiary referral center. Institutional review board approval was obtained. A total of 83 consecutive patients with modular neck-stem THA taper corrosion associated with ALTR underwent revision surgery from April 2013 to February 2014. Indications for revision THA included elevated cobalt and chromium serum metal ion levels in symptomatic patients with dual-taper modular neck stems with the presence of adverse tissue reaction on cross-sectional imaging. Mean time from index surgery to revision surgery was 31.3 ± 12.8 months. In 25 cases, the acetabular components were assessed to be loose intraoperatively and were revised with a highly porous tantalum acetabular cup (Trabecular Metal Modular Acetabular cup; Zimmer Inc, Warsaw, IN). In the presence of reactive tissue necrosis, the area of necrosis was extensively debrided except in the close proximity of neurovascular structures. Patients received revision titanium modular tapered femoral stems (Stryker, Mahwah, NJ) to optimize intraoperative stability in the setting of taper corrosion–related periprosthetic tissue necrosis. All patients received ceramic on highly crosslinked polyethylene articulations. Our mean patient follow-up time was 19.3 ± 7.7 months after the revision surgery (Table 1). Preoperative and postoperative Harris hip score (HHS), EuroQol 5-dimension questionnaire (EQ-5D), and University of California, Los Angeles (UCLA) activity scores were recorded (Table 2).

Top-Out Femoral Stem Removal Technique

Lateral decubitus patient positioning was used for all revision surgery. To allow for maximum femoral exposure, the patient is positioned toward the anterior edge of the operating table, which allows the operative leg to be fully flexed and adducted beyond the edge of the operating table. A standard posterolateral approach is preferred due to its extensile nature. The extent of ALTR is determined, and any necrotic tissue is removed to the extent of the safe anatomic margins, without compromising juxtaposed neurovascular structures. Four working quadrants are delineated, including the anterior and posterior flat margins around the stem, as well as the lateral along the greater trochanter and medial under the calcar (Fig. 1).

The degree of trochanteric overhang is determined and any extra bone removed. A pineapple-shaped burr (Medtronic, Las Vegas, NV) is helpful by providing stepwise controlled access without splintering or torqueing the bone fragments. Any bony overgrowth or osteophytes around all 4 quadrants should be removed and cleared. Once all quadrants have been visualized and the implant-bone interface is cleared of any soft tissue, the junction is clearly visualized for removal of the modular neck and subsequent removal of the stem can be attempted. Most systems have a implant-specific removal device that slides around the modular neck and allows for disengagement of the modular neck component from stem. In the absence of such device, a pair of pliers or vice grips can be used to grab onto the neck and tamp it out with a mallet. Once removed, the extent of visible corrosion should be carefully documented.

A top-out technique involves using a pencil-tipped burr (Medtronic, Las Vegas, NV) to disrupt the bone and implant interface. Cortical thickness and the proximal geometry of the implant are critical as it directs the orientation of the burr. The pencil-tipped burr is carefully introduced into the bone-implant interface paralleling the implant. To preserve maximum amount of bone in cases of eccentrically positioned implants with minimum space between

Table 1
Patient Demographics.

Variable	
Gender	
Male	36 (43%)
Female	47 (57%)
Age (y; mean ± SD)	61.8 ± 10.3
BMI (kg/m^2; mean ± SD)	30.2 ± 8.6
Revision surgery operative duration (mo; mean ± SD)	31.3 ± 12.8
Operative duration (min; mean ± SD)	135 ± 22
Mean preoperative metal ion levels	
Cobalt (ug/L)	4.5 ± 3.4
Chromium (ug/L)	1.8 ± 7.6
Type of modular femoral stem implant	
ABG/ABGII modular anatomic reconstruction	46 (56%)
Rejuvenate total hip system	35 (42%)
Profemur Plasma Z	1 (1%)
Profemur Renaissance	1 (1%)
Type of revision implant	
Restoration modular system	80 (96%)
Wagner cone prosthesis	3 (4%)
Mean stem diameter (mm)	16.0 ± 1.8
Mean head size (mm)	33 ± 5.0

SD, standard deviation; BMI, body mass index.

Table 2
Preoperative and Postoperative Functional Outcome Scores.

Functional Score	Preoperative	Postoperative	*P* Value
HHS (mean ± SD)	69.1 ± 19.4	76.9 ± 19.3	**.004**
EQ-5D (mean ± SD)	53.7 ± 29.4	69.8 ± 26.3	**<.001**
EQ-5D US adjusted (mean ± SD)	66.8 ± 19.0	77.6 ± 17.8	**<.001**
UCLA (mean ± SD)	5.1 ± 2.1	5.4 ± 1.9	.28 (n.s.)

HHS, Harris hip score; EQ-5D, EuroQol 5-dimension questionnaire; UCLA, University of California, Los Angeles; SD, standard deviation; n.s., not significant.