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Methods Article

Removal of Well Fixed, Fluted Cementless Femoral Stem. Revisiting The Antegrade Drilling Technique for Easier Stem Extraction.

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In this study, we aimed to revisit and highlight the technique of antegrade drilling of the femur-stem interface during revision hip arthroplasty for extraction of the fluted cementless tapered stems, and to highlight the risk for femoral comminution with unplanned stem extraction. The unique design of fluted stems creates several stress risers in the femoral cortex, and care should be taken while performing a trochanteric osteotomy for stem extraction in such cases in order to avoid unplanned bone fracture, which could compromise the stability of the new implant.

INTRODUCTION

Whenever indicated, extraction of a well-fixed femoral stem is a challenging procedure that may lead to iatrogenic femoral cortical fractures with an incidence ranging from 12-82.8%. (Masri, Mitchell, and Duncan 2005; Matthys, Van Meirhaeghe, and Pattyn 2021). To reduce the risk of iatrogenic fracture, it is essential to carefully identify the reason behind the revision and plan for the utilized surgical technique. Accordingly, the particular stem type selected as well as the tools and implants used will be taken into account. (Barrack and Burnett 2005; Haynes et al. 2016).

Cementless fluted, tapered femoral stems were introduced to allow for rigid primary stability, provided by the

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Conflicts of Interest Statement for Dr. El-Husseini

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Conflicts of Interest Statement for Dr. Horwitz

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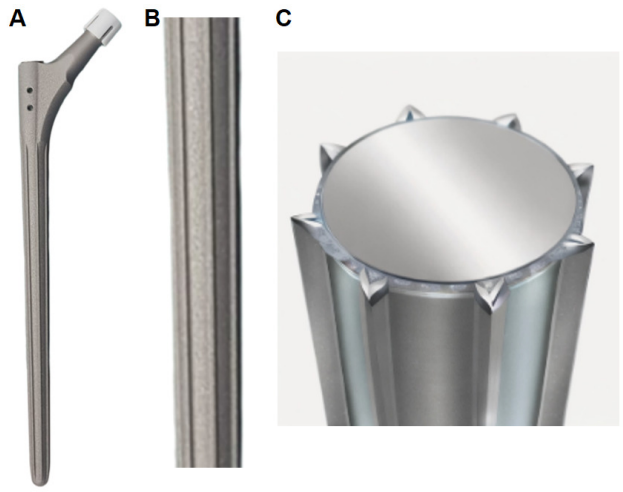

Figure 1. A) A cementless, tapered fluted femoral stem. B) Note the longitudinal splines along the stem. C) Formulated cross-section of a conical, fluted stem showing the stem splines.

roughened surface and the longitudinal splines along the stem **(Figure 1)** and secondary stability through osseointegration (bone ongrowth) along the stem, in revision hip arthroplasty (Abdel et al. 2017). Since its introduction, several studies reported excellent survival results (Masri, Mitchell, and Duncan 2005; Zang et al. 2019; Otero et al. 2020; Park et al. 2021) despite their various designs. The reported adequate osseointegration with these stems **(Figure 2)**, providing long-term implant stability (Park et al. 2021), has rendered them the implants of choice in revision hip arthroplasty among many surgeons (Wagner and Wagner 2000; Otero et al. 2020; Park et al. 2021).

Given these stem characteristics and the remarkable osseointegration, extraction of fluted, tapered cementless stems during revision surgery can be technically demanding. The stem splines may have already created several stress risers at their contact with the femoral cortex. Unplanned insertion of osteotomes/ chisels in the stem-bone interface, and unplanned extended femoral osteotomy (King et al. 2008) in these settings may lead to iatrogenic perforations and fractures of the femoral cortex **(Figure 3, 4A-G)**, which can compromise the stability of the new revision femoral stem.

Despite the presence of several reports that discuss how to revise femoral stems (Burstein et al. 2004; Masri, Mitchell, and Duncan 2005; Laffosse 2016; Khan et al. 2015), there is only one study that discussed in detail the K-wire drilling technique for extraction of cementless femoral stems in general (Hafez 2017). The purpose of this study is to revisit the K wire extraction technique, particularly for the tapered fluted cementless stems, giving their unique design. We believe this technique is simple and reproducible and does not require specific advanced surgical instruments.

TECHNIQUE

The patient is positioned, and surgical exposure is performed through the approach of the surgeon's discretion. After exposure of the proximal portion of the stem, a trial of stem extraction using the stem applicator and back hammering may be attempted if the stem is felt to be loose. In cases where it is well fixed, further exposure of the proximal portion of the stem is performed using burrs, fine bone rongeurs and/or chisels until clearly viewing the proximal portion of the flutes or splines of the stem. This may necessitate performing bone trimming around the proximal, non-ridged portion of the stem in order to visualize the splines (ridges) and flutes.

At this stage, after proper exposure of the proximal portion of the stem, until viewing the proximal end of the splines, multiple forward and backward longitudinal drills were passed through the flutes between the splines downwards, guided by the C arm. Repeated drill passages are performed from proximal to distal until completing all the holes between splines (see Video 1 in the Supplementary Materials). Either a 1.8-2.2mm K-wire or 2-2.5mm drill bit is used and longitudinal drilling is performed along the 8 holes (Figure 4 I,J). The drill bit or K wire may be tilted between the splines during drilling. Additionally, a fine chisel may be then used in the same manner between the splines from proximal to distal to further free the stem. At this stage, the stem is almost loose and can usually be extracted utilizing the applicator and back hammering, or through an extended trochanteric osteotomy that should leave a single, intact femoral cortex (Figure 4 K). This is followed by fixation of the osteotomy with cerclage wire (Figure 4 L) and insertion of a spacer or revision THA stem as planned. A longer and larger, diaphyseal fitting stem is usually utilized when revising a fluted stem, and utilization of a stem with distal transfixing screws is a viable option.

EXPECTED OUTCOMES

The longitudinal drilling technique can assist the surgeon in extracting a well-fixed, fluted cementless femoral stem while decreasing the risk for iatrogenic femoral fracture.

COMPLICATIONS

Potential complications include iatrogenic femoral metaphyseal and femoral shaft perforation with the wire, drill bit or wire breakage inside the femoral canal. Careful placement of the wires or drill bits inside the flutes through proper proximal exposure may decrease the chance of iatrogenic perforation or hardware breakage.

DISCUSSION

This study describes a reproducible method for extraction of well fixed, uncemented, fluted conical stems. Although this technique is utilized by many surgeons it has only been described once in detail for uncemented femoral stems in

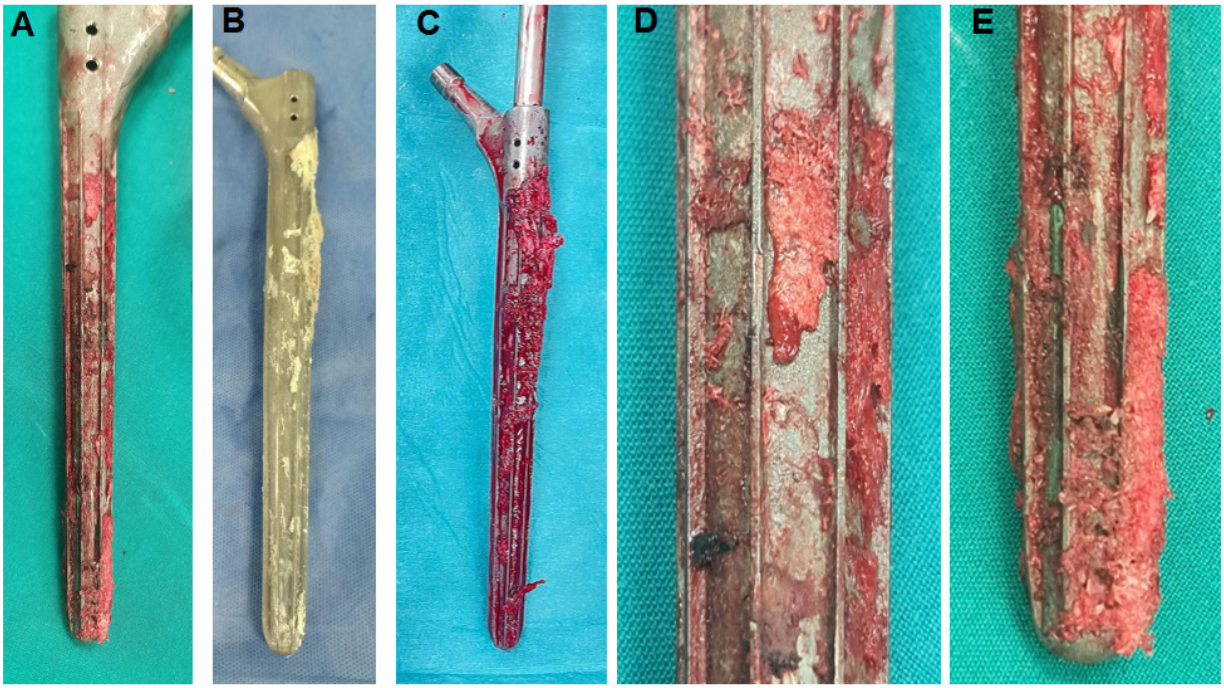

Figure 2. A-C) Explanted fluted stem. Note the bone ongrowth throughout the stem length. D, E) Bony ongrowth is more noticed on the distal portion of the stem.

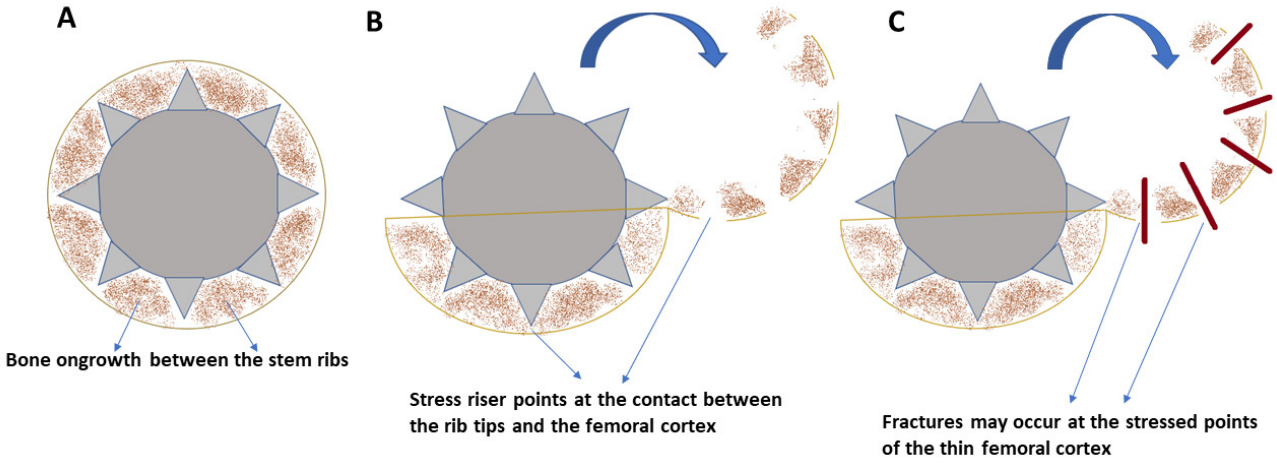

Figure 3. A) Conceptualized cross-section of a tapered, fluted stem with bony integration between the 8 stem splines ribs. At the points of contact between the rib tip and the femoral cortex, the bone may be very thin. B) When the femoral cortex is directly osteotomized without preparation, the created stress risers may lead to potential comminution (C) in the femoral cortex.

general (Hafez 2017). Given the unique design of fluted stems, we believe this technique is particularly useful in such stems and we aimed to add to the existing literature for more popularization of the technique. The presence of flutes and splines in such stems can guide the drilling technique while decreasing the chance of femoral cortical perforation and K wire bending or breakage.

Extraction of well-fixed cementless stems in revision THA is a technically challenging procedure. Preserving a well-fixed original stem during revision surgery, when acetabular-side revision alone is adequate, has the potential to reduce time, blood loss, and minimize the risk of additional tissue injury and bone damage (Hafez 2017). However, stem removal is performed for multiple indications during the revision surgery, including infection, recurrent instability due to stem version and offset defects, stem breakage, taper damage, limb length discrepancy due to stem subsidence or mal insertion causing lengthening, femoral osteolysis, taper mismatch with the revision system, bony ankylosis, or during the revision of excessively medialized or mispositioned cup (Laffosse 2016; Randhawa

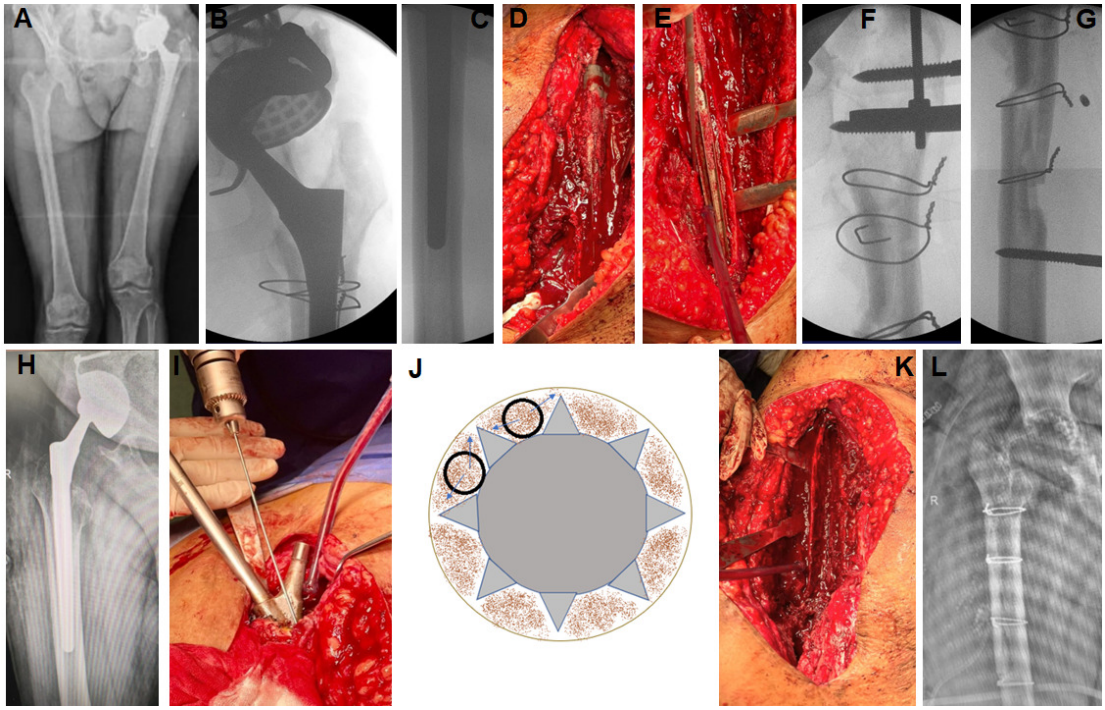

Figure 4. A-G) Case 1: A) Plain pelvic radiographs of a 42-year-old female who presented with recurrent left prosthetic hip dislocation and left lower limb shortening. Upon revision, the stem was found to be markedly anteverted. B, C) Intraoperative C-arm radiographs showing well fixed fluted stem. D, E) In this case, Wagner Osteotomy was performed without adequate femoral preparation to dis-engage the well-fixed stem, leading to femoral cortical comminution. Note the bone ongrowth over the stem and between the stem splines. F, G) Intraoperative C-arm radiograph showing femoral cortical comminution after removal of the femoral stem. The iatrogenic fractures were fixed with cerclage wires and an external fixator. H-L) Case 2: H) Plain radiograph of a case of a 48-year-old male who presented with infected THA. I) After exposure of the proximal portion of the stem, multiple longitudinal drills were performed through flutes, guided by the C arm, to complete the holes between splines. J) Conceptualized cross-section of the proximal end of the stem as viewed from upwards, illustrates the placement of a drill bit or K-wire between splines before longitudinal drilling, with the possibility of tilting the drill bit during the process (blue arrows). K) Trochanteric osteotomy with intact bone after extraction of the stem. L) Plain radiograph after removal of implants and insertion of antibiotic beads. Note the integrity of trochanteric osteotomy, compared to the previous case.

et al. 2009; De Thomasson et al. 2001; Wahl et al. 2021; Reina et al. 2013).

Given the unique stem design and bone ongrowth, unplanned stem removal may result in unexpected bony damage. The proposed technique of axial drilling allows for a more predictable stem extraction, minimizing bone damage. Since it does not require specific instruments and could be tried in a timely fashion, we believe this technique is reproducible and helpful to be performed whenever extraction of a fluted, tapered stem is required.

CONCLUSION

The longitudinal drilling technique along the stem flutes is a reproducible technique that allows for partial loosening of well-integrated, fluted cementless tapered stems. This technique allows for easier stem extraction minimizing the risk of significant bony comminution or damage.

CONFLICTS OF INTEREST

None to declare.

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SUPPLEMENTARY MATERIALS

Video 1. Antegrade Drilling

Download: https://journaloei.scholasticahq.com/article/121293-removal-of-well-fixed-fluted-cementless-femoral-stem-revisiting-the-antegrade-drilling-technique-for-easier-stem-extraction/attachment/242993.mp4