Elevated Serum Titanium Level as a Marker for Failure in a Titanium Modular Fluted Tapered Stem

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Abstract

Serum ion concentrations of cobalt and chromium are commonly used to monitor for the development of local metal reactions in metal-on-metal total hip arthroplasties, as well as dual-modular constructs. Although rarely used in clinical practice, elevated serum titanium levels have the ability to indicate a failure with contemporary revision constructs, such as with titanium modular fluted tapered (TMFT) stems. The authors report the case of a 64-year-old man with a TMFT stem after revision total hip arthroplasty for a dual-modular neck construct who had set screw disengagement with subsequent proximal body loosening. The patient’s serum cobalt and chromium levels were normal, but he had a markedly elevated serum titanium level, indicating failure of the titanium modular junction. Implant failures at modular junctions in femoral components are well described. Although several different failure mechanisms have been defined, to the authors’ knowledge this is the first reported failure of this particular TMFT stem. In addition, this is the first report describing the use of serum titanium levels in identifying a novel failure mechanism. With the popularity of this stem, surgeons should be aware that an elevated serum titanium level may aid in the diagnosis of this unique complication. [Orthopedics. 2016; 39(4):e768-e770.]

As the frequency of revision total hip arthroplasties (THAs) increases,1 failure mechanisms have become better described. Several studies have shown instability, aseptic loosening, osteolysis and/or wear, and infection to be the most common modes of failure in revision surgery.2 However, as new implants are used in the revision setting, unique mechanisms of failure are being appreciated. Titanium modular fluted tapered (TMFT) stems are commonly used for femoral revisions. Although these devices have a longer history in Europe, their popularity is increasing in North America. Several clinical studies have shown excellent outcomes at midterm follow-up.3,4 The tapered geometry provides axial stability, while the fluted design controls torsional stability. In addition, the modularity of these implants allows for intraoperative adjustments of limb length, offset, and neck version. Moreover, the titanium composition in TMFT stems has a modulus of elasticity closer to bone, with a theoretical reduction in the incidence of thigh pain and stress shielding.5

On the other hand, mechanical failures still occur, including novel failure mechanisms. One concern is stem fracture at the modular junction. Although a rare complication, it has been previously reported, especially with older designs.3 Set screw disengagement with subsequent loosening of the proximal body in a TMFT stem has also been reported as a rare failure mechanism6 with the Link MP Reconstruction stem (Waldemar Link, Hamburg, Germany). In this article, the authors report a case of elevated serum titanium levels associated with a unique mode of mechanical failure in a Restoration Modular stem.
(Stryker, Mahwah, New Jersey), a TMFT construct.

**Case Report**

A 64-year-old man was referred for evaluation of left thigh pain after undergoing a revision left THA 11 months earlier at an outside institution. The patient initially underwent a primary THA at an outside hospital with a Rejuvenate stem (Stryker) and Trident acetabular component (Stryker) in 2011. He developed lateral hip discomfort, with elevated serum cobalt (4.8 ng/mL) and chromium (3.0 ng/mL) levels, and a pseudotumor was identified on magnetic resonance imaging. Given the concern for a local metal reaction with a dual-modular construct, the patient underwent revision surgery. He was revised to a Restoration Modular stem (a 15 × 155-mm distal conical stem with a 25 × 10-mm proximal body), and the acetabular component was maintained. The femoral head was made of Biolox delta ceramic (CeramTec, Plochingen, Germany) and was 36 mm with a -5-mm neck length.

On presentation to the authors’ clinic, the patient endorsed intermittent, positional, left proximal thigh pain that had been present since his revision hip surgery. It was worse with golfing. Examination showed a 10° external rotation contracture. Inflammatory markers were within normal limits. Serum cobalt and chromium levels were 0.2 ng/mL (reference range, 0-0.9 ng/mL) and 0.3 ng/mL (normal, ≤0.3 ng/mL), respectively. Serum titanium level, however, was markedly elevated at 15 ng/mL (reference range, 0-1 ng/mL), concerning for motion at the modular junction of the TMFT stem. A hip aspiration revealed 3952 cells with 52% neutrophils, with negative cultures at 30 days. Serial radiographs of the patient’s left hip revealed that the set screw had progressively loosened (Figure 1), with retroversion of the femoral component on the lateral radiograph. As such, the patient was suspected to have failure of the modular junction with motion at the proximal body-distal stem junction and titanium debris.

The patient subsequently underwent a revision left THA. Intraoperatively, the local tissue was discolored and had debris consistent with metallosis (Figure 2). The proximal body of the femoral component was rotating freely and independent of the distal conical stem. As anticipated, the set screw had disengaged and was easily removed. The proximal body was removed without complication. Multiple excoriations were noted on both the anterior and the posterior surfaces of the neck, indicative of cup-neck impingement. The inserter handle was then placed on the conical stem and the threads were noted to be appropriate and maintained. The distal component was well fixed and stable on intraoperative analysis. A new proximal body component was then inserted with approximately 20° of anteversion. The body was completely seated, and the set screw was placed and tightened to 180 N with an anti-torque handle in place on the trunnion. The patient had good restoration of leg length, as well as good stability with range of motion. Postoperative radiographs revealed a well-seated implant with no evidence of proximal body disengagement (Figure 3).

**Discussion**

Femoral stem modularity in revision hip arthroplasty has become increasingly popular during the past 15 years. Intraoperative adjustments in leg length, offset, and neck version are easily made, allowing the surgeon to optimize stability. Several modes of failure unique to modular stems have been described. Prevalently described by Martin and Trousdale, set screw loosening with disengagement of the proximal body from the distal stem is an extremely rare mechanism of failure in TMFT stems. However, such a failure...
mechanism has not been described with the Restoration Modular stem.

Although several studies are useful in arriving at this diagnosis, serum titanium levels have not traditionally been used. Serial radiographs can show if the set screw has become more prominent over time. In addition, progressive femoral retroversion may be noted on the cross-table lateral radiograph. Normal inflammatory markers and a negative hip aspiration can help rule out infection. Finally, an elevated serum titanium level, which is the result of motion at the proximal body-distal stem junction in this titanium construct, is also an important clue to reaching this diagnosis.

Surgical management of set screw disengagement with proximal body loosening depends on the stability of the distal fluted tapered segment. If the distal component of the TMFT stem is well fixed, then an isolated revision of the proximal body is indicated. However, if the distal fluted tapered segment is loose, then revision of the entire femoral component should be undertaken.

This rare mechanism of failure could theoretically have several different etiologies. One hypothesis is that the proximal body segment was not fully seated on the distal component at the time of set screw tightening. If the proximal body is not completely engaged on the stem when the set screw is tightened, subsequent motion at the modular junction could lead to set screw disengagement and ultimate stem failure. Another reason this can occur is if under-reaming of the proximal segment occurs. Reaming must be at the appropriate depth and diameter to ensure that the proximal body can completely engage the distal stem. As such, to avoid this complication, surgeons must fully ream to the size of the proximal body. In addition, they must ensure that the set screw is fully tightened and seated.

**CONCLUSION**

As TMFT stems become more popular in revision THAs, novel failure mechanisms may occur. In this case report, the authors described a novel failure mechanism with this particular stem in which the set screw became disengaged. In addition, although most have focused on serum cobalt and chromium levels to identify failures, serum titanium levels are also essential, as noted in this case.

**REFERENCES**


