Spontaneous Modular Femoral Head Dissociation Complicating Total Hip Arthroplasty

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abstract

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Modular femoral heads have been used successfully for many years in total hip arthroplasty. Few complications have been reported for the modular Morse taper connection between the femoral head and trunnion of the stem in metal-on-polyethylene bearings. Although there has always been some concern over the potential for fretting, corrosion, and generation of particulate debris at the modular junction, this was not considered a significant clinical problem. More recently, concern has increased because fretting and corrosive debris have resulted in rare cases of pain, adverse local tissue reaction, pseudotumor, and osteolysis. Larger femoral heads, which have gained popularity in total hip arthroplasty, are suspected to increase the potential for local and systemic complications of fretting, corrosion, and generation of metal ions because of greater torque at the modular junction. A less common complication is dissociation of the modular femoral heads. Morse taper dissociation has been reported in the literature, mainly in association with a traumatic event, such as closed reduction of a dislocation or fatigue fracture of the femoral neck of a prosthesis. This report describes 3 cases of spontaneous dissociation of the modular prosthetic femoral head from the trunnion of the same tapered titanium stem because of fretting and wear of the Morse taper in a metal-on-polyethylene bearing. Continued clinical and scientific research on Morse taper junctions is warranted to identify and prioritize implant and surgical factors that lead to this and other types of trunnion failure to minimize complications associated with Morse taper junctions as hip implants and surgical techniques continue to evolve.
Modular Morse taper constructs have been widely used in total hip arthroplasty (THA) for many years, with few reported complications.\(^1\)\(^-\)\(^5\) Modular heads have many advantages over monolithic components. They allow more flexibility in the recreation of limb length, offset, and soft tissue tension, with potential benefits for hip stability, patient satisfaction, functional outcome, and ease of revision surgery. Since the early introduction of these devices, there has been some concern about the potential for fretting, corrosion, and generation of particulate debris at the modular junction.\(^3\)\(^-\)\(^5\) More recently, this concern has intensified because of reports of adverse local tissue reaction as a result of corrosive debris and metal ions from taper junctions.\(^3\)\(^-\)\(^6\)\(^-\)\(^8\) Larger femoral heads, which have gained popularity in THA, are suspected to potentiate this process because of greater torque at the modular junction that results in increased fretting, crevice corrosion, and generation of metal ions, with a higher potential for local and systemic effects.\(^8\)\(^,\)\(^9\)

Dissociation of modular femoral heads is an even more unusual occurrence. In the past, Morse taper dissociations have been reported mainly in the context of a traumatic event, such as closed reduction of dislocation or fatigue fracture of the femoral neck or trunnion of a prosthesis.\(^10\)\(^-\)\(^12\)

This report describes 3 cases of spontaneous dissociation of a modular femoral head from the trunnion of the same tapered stem in association with severe trunnion fretting, wear, and corrosion.

**CASE REPORTS**

**Patient 1**

In March 2004, a 78-year-old man underwent primary right THA for the treatment of osteoarthritis using a cementless tapered size 4 Accolade TMZF 127° stem (Stryker, Mahwah, New Jersey) with a 36-mm +5 offset chrome-cobalt head. The acetabular component was a 64-mm cementless hemispheric titanium shell (Trident, Stryker) with 2 screws and a cross-linked polyethylene liner (Crossfire, Stryker) with a 10° elevated rim liner. The patient’s height was 185 cm and weight was 87 kg (body mass index, 25). Postero-lateral exposure was used with a limited incision that was approximately 4 inches long. The patient was discharged from the hospital 4 days after surgery and had an uncomplicated early recovery.

The patient was seen regularly at follow-up visits for 5 years with no symptoms. Radiographic findings consistently showed well-fixed components, with no evidence of osteolysis, loosening, or subsidence. The only radiographic finding on routine follow-up was mild asymptomatic heterotopic ossification that did not progress.

Seven years postoperatively, the patient presented to the emergency department with a 2- to 3-week history of increasing discomfort in the groin while ambulating associated with a grinding sensation in the hip. The patient had no history of trauma. Radiographs (Figure 1) showed dissociation of the modular femoral head from the trunnion of the stem. Intra-articular hip aspiration showed dark fluid, consistent with metal debris, and no evidence of infection.

At revision surgery, the incision was extended for increased exposure. Intra-operatively, significant metal debris was found within the hip joint and extending posteriorly and laterally into the trochanteric bursa. There was extensive synovitis involving the joint and trochanteric bursa, with metallic staining of the tissues. Severe corrosion was noted at the trunnion and bore of the femoral head. The taper of the trunnion showed significant wear, fretting damage, deformation, and burningish at the apex (Figure 2). Although the stem was well fixed, the trunnion was considered too damaged for reuse. The well-fixed stem was removed and revised to a modular titanium stem with a 40-mm chrome-cobalt head for enhanced stability because of soft tissue laxity. The liner was significantly scratched and deformed from articulating with the trunnion, but the locking mechanism of the acetabular component appeared pristine. Therefore, the liner was exchanged with a cross-linked polyethylene liner with an inner diameter of 40 mm.
The patient had an uneventful postoperative course, with no complications. He was pain-free, with no evidence of limp or weakness at the 20-month follow-up visit. Laboratory evaluation of the femoral component was performed subsequently and indicated severe corrosion of the trunnion taper.

**Patient 2**

On January 23, 2006, a 74-year-old man underwent uncomplicated primary left THA through a minimal incision posterolateral approach for osteoarthritis. Implants included a 58-mm titanium hemispherical acetabular shell (Trident, Stryker) and a neutral 36-mm cross-linked polyethylene liner (Crossfire, Stryker). The femoral component was a size 3.5 Accolade TMZF 127° stem with a 36-mm +5 chrome-cobalt head (Stryker). The patient's height was 165 cm and weight was 81 kg. Three months postoperatively, the patient underwent uncomplicated right THA with similar components. The patient was followed up at regular intervals postoperatively and remained pain-free with no symptoms. He was able to walk unlimited distances without a limp.

Six and a half years postoperatively, the patient presented to the surgeon's office urgently, reporting 1 to 2 weeks of increasing pain in the left groin, mainly with weight bearing and ambulation. He reported no changes in activities, no trauma, and no specific event that initiated his symptoms. Radiographs (Figure 3) showed dissociation of the femoral head from the trunnion, similar to that seen in Patient 1.

On admission, the patient underwent intra-articular hip aspiration that showed metallic-stained fluid. The erythrocyte sedimentation rate was 55 mm/h and the C-reactive protein level was 18.7 mg/L. However, findings on cultures from aspiration were negative and the cell count showed only white blood cells. Blood metal ion levels showed a cobalt level of 26.6 μg/L and a serum chromium level of 3.7 ng/mL. Although the track record of modular connections may contribute to a higher than anticipated rate of complications after THA, this report describes 3 cases of spontaneous dissociation of a modular femoral head from the trunnion of a femoral component. All cases involved the same tapered femoral component composed of a beta-titanium alloy with a 36-mm extended offset chrome-cobalt head. In both cases, the stems shared a high-offset, low-angle-geometry (127°) neck. Although many of these factors may play a causative role in the development of these complications, their exact contributions remain speculative. Langton et al8 showed an increased rate of fretting and volumetric taper wear associated with extended offset chrome-cobalt head. In a series of metal-on-metal retrievals, these factors increase the horizontal lever arm of the prosthesis and contribute to forces on the head-neck junction and taper coupling. Neck geometry and flexural rigidity are also known to influence the cumulative amount of corrosion seen at the trunnion over time. Mixed-metal couples, as seen here, show greater corrosion than couples of like alloys.1,2,4,5 More recent studies have suggested that larger

![Image](image_url)

**Figure 3:** Preoperative anteroposterior radiograph showing dissociation of the prosthetic left femoral head.

**Figure 4:** Postoperative photograph of the retrieved stem obtained from Patient 2, showing similar trunnion wear and deformation as seen in Patient 1, with deep grooves in the inferior femoral neck.

Significant metal debris was found within the hip joint and surrounding tissues, including the trochanteric bursa. The trunnion of the prosthesis showed corrosion, severe wear, and deformation, with deep grooves at the inferior aspect of the neck (Figure 4). The surgical procedure included revision of the acetabular liner, with retention of the shell, synovectomy, and debridement of the metal-stained inflammatory tissue and revision of the femoral component to a modular titanium stem with a 36-mm delta ceramic head. The postoperative course was uncomplicated, and the patient was pain-free with a normal gait at the 16-month follow-up.

**Patient 3**

Just recently, a third patient presented with the identical complication described in the first 2 cases. This patient was a 68-year-old man who presented with spontaneous dissociation of a modular 36-mm +10 chrome-cobalt head from a size 3 Accolade TMZF 127° stem (Stryker). This occurred 7 years following uncomplicated THA, and the patient was completely pain-free and asymptomatic up until the time of dissociation. Intraoperative findings were similar to those of the first 2 patients.

**DISCUSSION**

Although the track record of modular tapers has been well established in THA, there is also increasing concern that modular connections may contribute to a higher than anticipated rate of complications after THA.1,3,7,9

This report describes 3 cases of spontaneous dissociation of a modular femoral head from the trunnion of a femoral component. These factors increase the horizontal lever arm of the prosthesis and contribute to forces on the head-neck junction and taper coupling. Neck geometry and flexural rigidity are also known to influence the cumulative amount of corrosion seen at the trunnion over time. Mixed-metal couples, as seen here, show greater corrosion than couples of like alloys.1,2,4,5 More recent studies have suggested that larger
femoral heads, 36 mm and larger, show greater fretting and corrosion because of a higher degree of torque at the modular connection of the head and trunnion.8,9,13

Because of the significant degree of corrosive debris and trunnion damage seen intraoperatively in these cases, the authors suspect that micromotion and fretting damage from the large 36-mm heads lead to corrosion and further cumulative wear and damage to the trunnion, ultimately leading to gross motion, accelerated taper wear, and femoral head dissociation. Meyer et al13 noted that most femoral heads in their series of retrievals showed instability and loosening of the cone-taper construct in large-diameter heads in association with metal-on-metal THA. Significant corrosion and frequent adverse local tissue reactions occurred in association with these tapers. The process seen in the current cases is most likely cumulative, taking 6 to 7 years to develop, during which time the patients have remained asymptomatic.

In addition to head size, stem composition, and neck and taper geometry, other surgical factors may contribute to the development of the type of severe fretting, corrosion, and trunnion wear seen in these cases. These factors include the force of impaction used to seat the initial femoral head and the presence of fluid and tissue debris at the time of implant assembly.2,3,14

Although it is difficult to evaluate in these cases, the force of impaction appears to contribute considerably to head-neck association strength, potentially increasing the mechanical strength of the taper construct and the potential for fretting and corrosion. The number and force of blows applied to the femoral head during impaction of the taper has a direct correlation with stability and distraction force.14 A single strong blow from the femoral ball to the femoral neck accounts for 90% of the association strength at the head-neck junction.14 It has been reported that the relationship of implanted femoral stem-and-ball components performs unpredictably when the interface between the 2 is wet during implantation.14 Drying the neck of the femoral stem component before placement and impaction of the ball yields a more predictable outcome and greater stability.14 Ensuring a clean and dry trunnion may be more difficult in minimally invasive exposures, as was performed in these cases, potentially compromising the strength of the mechanical interlock at the taper junction.14,15

CONCLUSION

This article describes the first reported cases of spontaneous dissociation of a modular head in THA not associated with trauma or component fracture. In these cases, the most likely cause of dissociation is fretting, corrosion, and catastrophic wear of the Morse taper junction. Factors that may contribute to the development of this phenomenon include the metal composition of the stem (beta-titanium alloy) and its couple with a head of dissimilar (chrome-cobalt) metal, a larger femoral head (36 mm), a low neck shaft angle and extended offset configuration, the geometry and flexural rigidity of the neck, and surgical factors related to the impaction and assembly of the Morse taper. Continued clinical and scientific research on Morse taper junctions is warranted to identify and prioritize implant and surgical factors that lead to this and other types of trunnion failure to minimize complications associated with Morse taper junctions as hip implants and surgical techniques continue to evolve.

REFERENCES