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Case report

Taper fretting corrosion with Stryker Anato stem after hip replacement

David M. Freccero, MD, Kenneth J. McAlpine, MD *, Eric L. Smith, MD

Department of Orthopaedics, Boston Medical Center, Boston, MA, USA

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ABSTRACT

We report a case of head-neck taper fretting corrosion in a patient who had a total hip replacement with a noncemented Stryker Anato femoral stem and a V40 metal head with a Stryker Tritanium hemispherical socket with a highly cross-linked polyethylene liner (metal on polyethylene) (Stryker, Mahwah, NJ, USA). A 57-year-old man presented with early-onset hip pain after right total hip arthroplasty. Workup was negative for infection. Metal artifact reduction sequence MRI revealed an encapsulated fluid mass. Metal ion cobalt level was elevated at 6 ppb. The patient underwent right revision total hip arthroplasty with excellent results at 1-year follow-up.

Introduction

Modularity used in total hip arthroplasty aids in the optimization of leg length, offset, and stability. Femoral head-neck modularity allows the surgeon intraoperative variability to restore the hip center of rotation, facilitates revision total hip replacement, and can help lessen inventory burden. However, it is known that mechanically-assisted crevice corrosion (MACC) may occur with cobalt chromium alloy femoral stems and cobalt chromium femoral heads or with titanium femoral stems and cobalt chromium femoral heads [1,2]. Taper corrosion in metal on polyethylene (MOP) total hip replacement can result in adverse local tissue reactions (ALTRs) and pain and disability for the patient [1-3]. Cooper [2] and Plummer [3] reported ALTR in MOP total hip replacements, and their reports include hip implants from 4 different orthopedic device manufacturers. More recently, Patel et al [4] reported ALTR developed from head-neck taper corrosion after total hip arthroplasty with a Stryker Meridian stem (Stryker, Mahwah, NJ, USA). They highlight that identification of stems at risk will aid in implant utilization, allow for close patient surveillance, and ultimately drive implant innovation [4].

We report a case of head-neck taper fretting corrosion resulting in ALTR in a patient who had a total hip replacement with a noncemented Stryker Anato (Stryker, Mahwah, NJ, USA) femoral stem and a metal head with a Stryker Tritanium (Stryker, Mahwah, NJ, USA) hemispherical socket with a highly cross-linked polyethylene liner (MOP). To our knowledge, this is the first reported case of head-neck taper corrosion involving the Stryker Anato (Stryker, Mahwah, NJ, USA) stem and 40 mm low-friction ion-treated (LFIT) cobalt-chromium femoral head with V40 bore.

Case history

The patient was a 57-year-old male who underwent index right total hip arthroplasty through a posterior approach in February 2016 at an outside hospital. He recovered well for approximately 6 months and then developed worsening right hip pain. He complained of groin pain in the right hip and was unable to use an exercise bicycle or walk for more than 5-10 minutes because of progressively worsening right hip pain. He was referred to our medical center for evaluation 1 year postoperatively, in February 2017. He did not experience any instability events and denied any traumatic events since his hip replacement surgery. He complained of worsening right hip pain despite conservative measures.

Physical examination demonstrated that he had tenderness to palpation over the anterior groin and posterior buttock area of the

* Corresponding author. Boston Medical Center, 850 Harrison Avenue, Boston, MA 02118, USA.
E-mail address: Dr.ken.mcalpine@gmail.com

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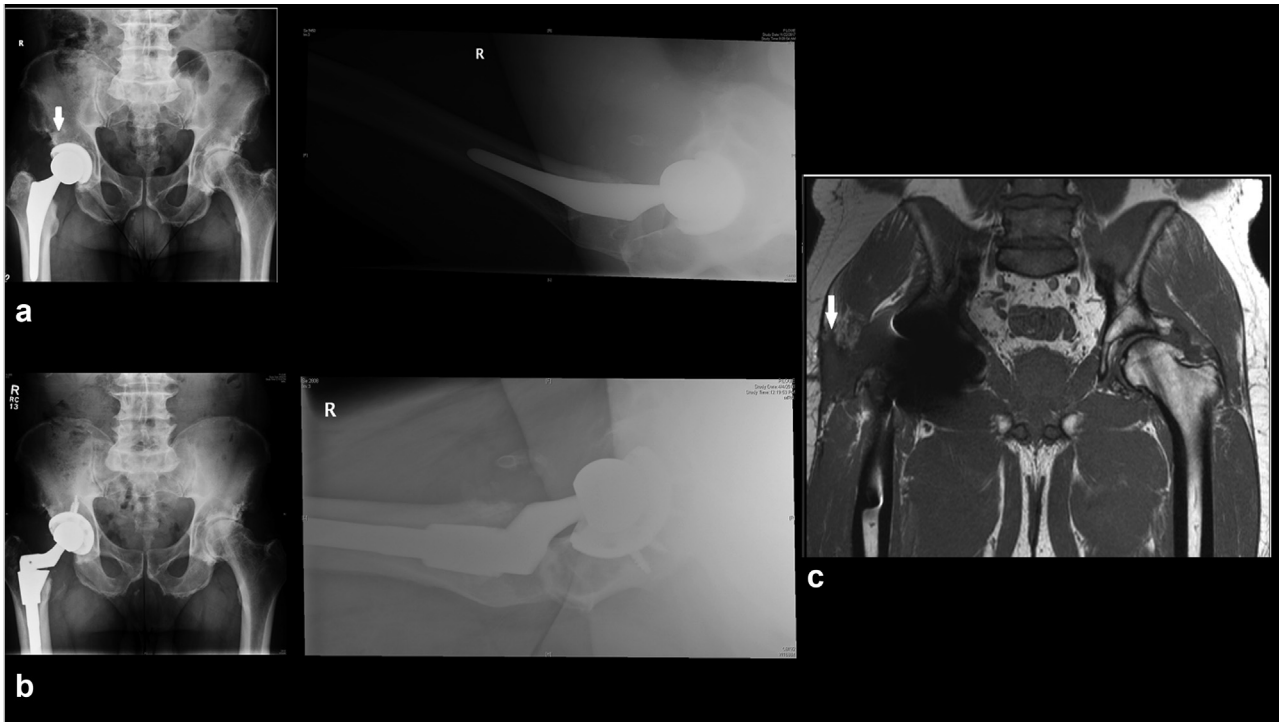

Figure 1. AP and lateral radiographs of the pelvis and right hip. The white arrow indicates an area of lucency (a). AP and lateral postoperative radiographs (b). MARS MRI with fluid collection indicated by a white arrow. MARS, Metal artifact reduction sequence (c).

right hip. Clinically, his leg lengths were equivalent. He ambulated with an antalgic gait. He had 5/5 abductor strength in his right hip. He had a negative Trendelenburg sign with single limb stance bilaterally. His right hip range of motion was 0-100 degrees of flexion with pain, external rotation was 0-20 degrees, and internal rotation was 0-10 degrees. He had no tenderness over his posterior lumbar and thoracic spine. Light touch sensation was intact to L2-S2 dermatomes of bilateral lower extremities.

Radiographs included an anteroposterior (AP) pelvis, a cross-table lateral of the right hip, and an AP view of the right hip (Fig. 1). Radiographs revealed a well-fixed femoral component in mild varus alignment. The acetabular component was in good alignment, but there was lucency noted in the superolateral aspect of the acetabular bone-implant interface in zone 1 [5], potentially concerning for loosening. There was no osteolysis of the femur or acetabulum noted. No periprosthetic fractures were noted, and there was no evidence of polyethylene wear. Workup included serology testing including sedimentation rate (ESR), C-reactive protein (CRP), and white blood cell (WBC) count. The ESR was 23 mm/hr (0-20 mm/hr), the CRP was 26 mg/L (normal < 5 mg/L), and the WBC count was 6000 cells/ml^3. Right hip arthrocentesis was performed. The synovial fluid WBC count was 700 total nucleated cells (automated count), with no differential completed, and the synovial fluid cultures were negative after 14 days. Cobalt ion levels were 6 ppb (normal <1.8 ppb), and chromium ion levels were 0.7 ppb (normal <3.6 ppb), fitting the pattern of cobalt greater than chromium elevation for trunnion-related failure [6]. Metal artifact reduction sequence MRI of the pelvis was ordered. It revealed an encapsulated fluid mass measuring 240 cm^3, extending from the greater trochanter to the hip joint. This fluid collection was consistent with an ALTR. The operative report documented use of a size 6 Stryker Anato femoral stem with a V-40 taper, a Stryker 40 mm + 0 mm cobalt-chromium metal femoral head, and Stryker Tritanium 58 mm hemispherical acetabular socket with an X3 highly cross-linked polyethylene liner (Stryker, Mahwah, NJ, USA).

Revision surgery was performed using a posterior approach. Intraoperatively, there was dark-pigmented staining of pericapsular tissue with whitish cottage cheese fibrinous material dispersed adjacent to the hip capsule as well. There was significant MACC visible on the femoral neck with notching and mechanical defects of both the femoral neck and inner taper of the prosthetic metal head (Goldberg classification and Goyal classification) [1,7]. The abductor musculature was viable, beefy red, contractile to electrocautery stimulation, and intact. The femoral stem was well-fixed and was removed using a combination of flexible osteotomes, Kirschner wires, and a looped femoral stem extractor. The acetabular component was loose and was removed uneventfully with the Zimmer Explant Acetabular Cup Removal System (Zimmer, Warsaw, Indiana, USA) (Fig. 2). Debridement of the pigmented and

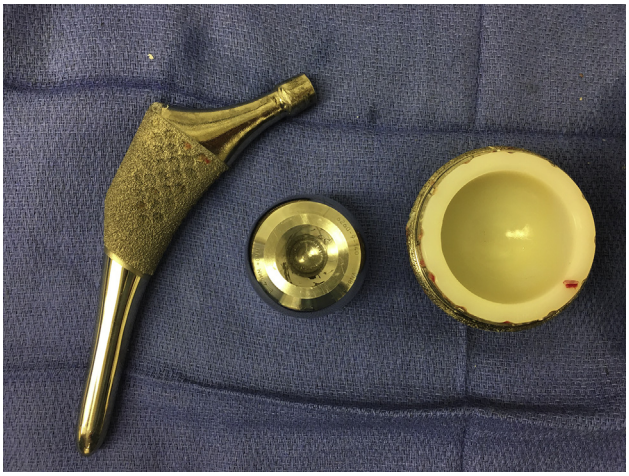

Figure 2. Explanted femoral stem, femoral head, and acetabular component. Damage to the trunnion is noted as well as metal residue.

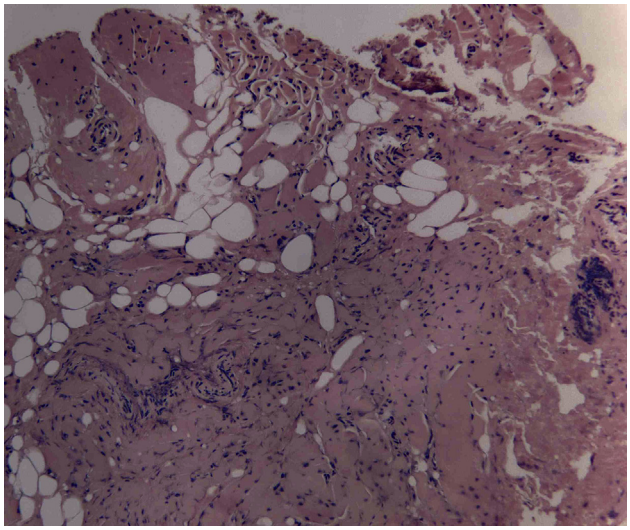

Figure 3. Representative pathologic specimen with hematoxylin and eosin staining. Multiple lymphocytes are seen representative of adverse local tissue reaction.

fibrinous ALTR tissue was performed. The wound was irrigated with copious irrigation, including use of dilute povidone solution. Frozen sections revealed no acute inflammation, but showed multiple lymphocytes characteristic of aseptic lymphocyte vasculitis-associated lesion (Fig. 3). Revision right total hip replacement was performed with DePuy/Johnson & Johnson Pinnacle Sector multihole acetabular component and a highly cross-linked polyethylene liner, and an S-ROM femoral stem with a Biolox Delta ceramic femoral head (DePuy, Warsaw, Indiana, USA). Postoperatively, the intraoperative cultures were positive for *Staphylococcus epidermidis* (1 specimen of 3 sent was broth-only positive). Infectious disease consultation was obtained and postoperative IV antibiotics were recommended for 6 weeks. A peripherally inserted central catheter (PICC) line was placed, and he received a 6-week course of IV Ancef (2 g every 8 hours), followed by 6 weeks of PO rifampin (300 mg daily). Postoperatively, he recovered uneventfully in the hospital and was discharged to home. At 1 year postoperatively, he had no right hip pain, and his ESR and CRP levels were normal. The cobalt level decreased to undetected levels, and the chromium level decreased to undetected levels (Table 1). He was able to use the exercise bicycle and ambulate without pain and resume physical fitness activities without pain.

The patient provided informed consent for this article.

Discussion

To our knowledge, this is the first report of MACC resulting in ALTR involving the Stryker Anato stem. There are reports of the Stryker Accolade stem and Stryker Meridien stem developing head-neck taper corrosion and ALTR [1-4,8]. These stems are Ti-12Mo-6Zr-2Fe (TMZF) alloy stems with a V-40 taper. The Stryker Anato stem is also a TMZF alloy stem with a V-40 taper. It is a double-wedge, metaphyseal-engaging stem. Based on the previous reports of MACC involving TMZF stems with a V-40 taper, [2-4,8,9] along with this report of the Stryker Anato stem MACC and ALTR, particular design features including TMZF alloy and small V-40 tapers may be contributing factors to head-neck taper corrosion.

Stryker LFIT cobalt-chromium femoral heads have also been implicated in MACC leading to gross trunnion failure [9]. In 2016, there was a limited recall of certain sized 36, 40, and 44 mm diameter femoral heads. The recall was expanded in May 2018 to include all V40 LFIT femoral heads manufactured between January 1, 2002 and March 4, 2011, to include all 36, 40, and 44 mm diameter heads [10]. Our patient's femoral head was manufactured outside of this time period, but it is important to note that the femoral head itself can be a cause for painful total hip leading to revision.

Table 1
ESR, CRP, cobalt, and chromium levels pre-op, 6 months post-op, and at 1 year post-op.

Lab test	Pre-op	2 Days post-op	6 Months post-op	1 Year post-op
ESR	23	57	21	13
CRP	26	44.3	4.5	2.7
Cobalt	6.0		<0.5	<0.5
Chromium	0.7		1.2	<0.2

ALTR after total hip arthroplasty is an increasingly prevalent complication [10]. Reports indicate that it may be present in up to 0.032%-2% of all total hip arthroplasties (THAs) [9,11-14]. ALTR may occur in MOP THA constructs and can present as acetabular component loosening and/or femoral component loosening. It can also manifest itself solely as pain, and diagnosis may require blood metal ion level assessment and three-dimensional imaging. It may also cause severe abductor deficiency and resultant hip instability or an abductor lurch gait with a positive Trendelenburg sign. ALTR can also manifest as gross femoral component failure with neck deformation and/or fracture [15,16].

Treatment for ALTR requires removal of the metal ion generator. Frequently, this involves retention of the femoral stem with femoral head exchange to a ceramic head with a titanium sleeve over the trunnion. There have been good results with this technique reported, with low rates of ALTR recurrence [2-4,7,11,17-19]. Alternatively, treatment may also require complete femoral stem revision and/or acetabular component revision if the components are loose. Complete femoral stem revision may also be required if there is gross trunnion failure or severe deformity or etching of the trunnion surface [1,16,19]. Complete femoral stem revision may also be indicated for malpositioned components or recalled implants. In certain clinical scenarios, the femoral head may be cold-welded to the trunnion, requiring complete femoral stem revision as well. In the case of complete femoral stem revision, advanced techniques may be required to remove a well-fixed femoral stem. These techniques may include use of Kirschner wires or Steinman pins or motorized burrs to disengage bone in-growth or ongrowth areas from the stem, as well as the use of special device extractor tools to forcefully extract a well-fixed stem from the femoral canal. The extended trochanteric osteotomy may be a useful technique to facilitate access to well-fixed noncemented diaphyseal-engaging stems [20,21].

It is always important to consider infection in the setting of revision total hip replacement. In the workup of this patient's painful total hip replacement, standard inflammatory markers were slightly elevated. This prompted an aspiration of the hip joint, which was negative for infection. During the surgery, there were no clinical signs of infection, but per our protocol, tissue samples were sent to the microbiology laboratory for analysis. One of the three samples sent resulted positive. According to the musculoskeletal infection society criteria for periprosthetic joint infection, the patient had no major criteria. The patient had a positive ESR and CRP, plus one positive intraoperative culture for minor criteria, giving an overall inconclusive score. After a discussion with the patient and the infectious disease team, a shared decision was made to treat the positive culture, as the risk of completing a course of antibiotics outweighed the risk of infection after revision hip replacement.

Summary

In conclusion, MACC is increasingly prevalent after THA. The use of ceramic heads may help reduce its incidence, but published data

to date are not definitive in this regard. Certain patient factors such as high activity level and high BMI may contribute to its development. [11] Large metal femoral heads (greater than 36 mm diameter) may be contributing factors to ALTR in MOP THAs. Certain surgeon factors such as appropriate preparation of the trunnion and adequate impaction force to engage the femoral head on the trunnion may reduce its incidence [22]. Certainly, continued surveillance of femoral stems and analysis of the metallurgy of femoral stems is important to better understand this phenomenon and ultimately to reduce its occurrence.

Conflict of interest

Eric L. Smith, MD, Speakers bureau/paid presentations and paid consultant for Depuy; Research support for Conformis.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2020.01.011

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