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Case report

Gross trunnion failure after a metal-on-polyethylene total hip arthroplasty leading to dissociation at the femoral head-trunnion interface

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ABSTRACT

Gross trunnion failure (GTF) leading to dissociation at the femoral head-trunnion interface is an uncommon complication after total hip arthroplasty (THA). The incidence of this complication is currently unknown due to the limited number of reported cases but it is significantly more common in the context of a recalled femoral head. This report details the case of a gross trunnion failure and secondary polyethylene failure of a non-recalled metal-on-polyethylene primary THA from a taper type previously reported to be associated with an increased prevalence of mechanically assisted crevice corrosion (MACC). This case describes a 77-year-old man who was 10 years status post right THA presenting with acute-onset right hip pain after trying to rise from a seated position. Radiographs showed that the right femoral head was dissociated from the femoral component. At the time of surgical revision, there was extensive dark metallic debris in the hip joint. A revision THA was performed using a modular revision system. Clinicians must be aware that MACC can eventually lead to GTF, which can result in dissociation at the femoral head-trunnion interface in metal-on-polyethylene primary THA. Further research is needed to determine patient and implant factors that make patients susceptible to MACC/GTF so that adequate screening and patient counseling can be performed.

Introduction

Total hip arthroplasty (THA) is one of the most successful and replicable procedures in orthopedic surgery. One challenge during THA is to recreate the patient's normal biomechanics. This was particularly challenging with the first generation of implants due to a lack of modularity. Modularity in THA was introduced in the 1980s. It has led to a decrease in hospital inventory and has allowed for better restoration of the native hip mechanics by giving surgeons more flexibility when adjusting leg length and offset and facilitates revision exposures [1-3]. The disadvantage to modularity is that the head-neck junction and the femoral head are often made of different metals: titanium alloy (Ti-6Al-4V) or cobalt-chromium (CoCr) both of which have protective oxide surfaces. The head-neck junction is susceptible to potential micromotion. This, in turn, may lead to disruption of the protective oxide surfaces of the implants, and with repetitive loading a series of complex reactions which includes disruption of the protective oxide layers, production of metal ions and acid which further potentiates corrosion at the taper junction [4]. This process is called mechanically assisted crevice corrosion (MACC). MACC at the femoral head-trunnion interface eventually increases susceptibility to adverse local tissue reaction which is a local hypersensitivity response to Co fretting and corrosion products from MACC [5]. Long-standing MACC causes material loss at the taper junction which in rare cases may lead to gross trunnion failure (GTF) with frank taper disassociation and issues such as marked trunnion deformity, fracture, with or without dislocation at the femoral head-trunnion interface [3,5-7].

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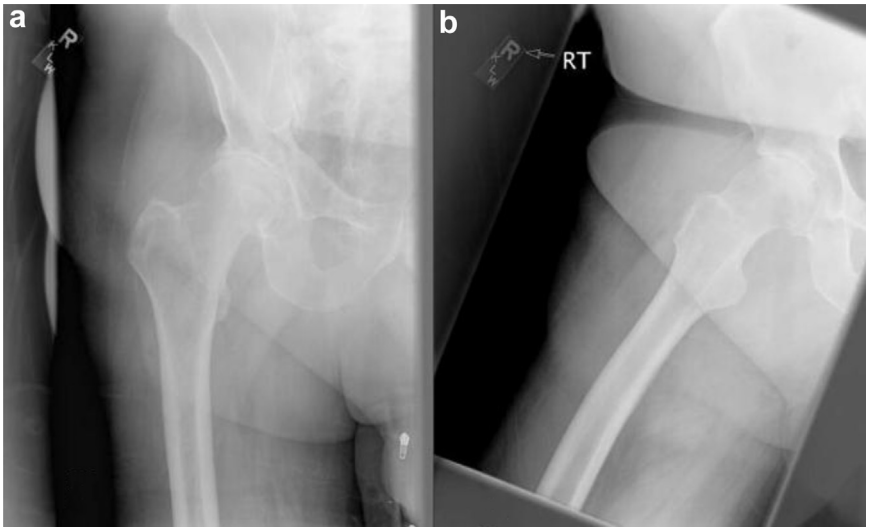

Figure 1. Preoperative anteroposterior (a) and frog leg lateral (b) radiographs of the right hip from September 2008 demonstrating severe osteoarthritis of the right hip.

Case history

Our patient is a 77-year-old man who was 10 years status post right THA. His index procedure was performed with a Zimmer Trabecular porous proximally coated double-taper titanium primary femoral stem (Zimmer Orthopedics, Warsaw, IN), while the acetabular component used was a Zimmer Trabecular metal cup (Zimmer Orthopedics, Warsaw, IN). The base of both components was composed of Tivanium, a proprietary Ti-6Al-4V titanium alloy. The femoral head component was a 36-mm CoCr alloy head. Femoral length and offset information could not be obtained. Figures 1 and 2 are his preoperative and postoperative radiographs from 10 years before presentation. The patient was doing well without any prodromal symptoms for 10 years until he had an acute onset of right groin pain upon trying to rise from a seated position. He noted a "loud pop" with associated sharp groin pain during the incident. Immediately after the incident, he was only able to bear partial weight on his right lower extremity secondary to pain and weakness. He started using a walker to assist with ambulation. Clinically, the patient had a leg length discrepancy. His right lower extremity was 3.5 cm shorter than his left. The anteroposterior and lateral radiographs of the affected hip demonstrated what appears to be a GTF [3,6,7] (Fig. 3).

Informed consent for revision surgery and case report was obtained from the patient. At the time of revision surgery, a posterolateral approach to the hip was used using the prior incision from his initial THA procedure. After performing a capsulotomy, there was gross evidence of dark metal debris and possibly corrosion products within the hip joint (Fig. 4a and b). Multiple tissue cultures were negative. The femoral head was noted to have completely dissociated from the femoral stem trunnion. The polyethylene liner was fractured at the anterior superior edge (Fig. 4c and d), and the trunnion was severely worn to the point of being elliptical as opposed to cylindrical (Fig. 4d and e). Both the femoral stem and the acetabular component were well fixed without evidence of osteolysis. Excisional debridement of the dark-stained and necrotic soft tissue was performed, followed by irrigation and liner exchange with placement of a new highly cross-linked polyethylene liner in the original acetabular component because there was no damage to the locking mechanism. With regard to the femoral stem, the trunnion wear was so severe that the trial head would not stay in place on the femoral trunnion, so femoral revision was performed. We used an extended trochanteric osteotomy for removal of the femoral stem. A Zimmer Biomet tapered modular cementless revision stem (Zimmer Orthopedics, Warsaw, IN) with a 36-mm ceramic head was placed (Fig. 5).

The patient's postoperative course was uneventful and at the patient's latest follow-up (8 months postoperatively), the osteotomy site had completely healed (Fig. 6). The patient was mobilizing pain free, without functional limitation, and had returned to his usual activities.

Discussion

It is estimated that symptomatic MACC affects up to 4% of all THAs [2,3]. The true cause of symptomatic MACC is currently unknown but several factors have been implicated, including both implant- and patient-related factors. The factors associated with a higher prevalence include body mass index (BMI), patient gender, activity level, failure to achieve initial engagement of the femoral head on the trunnion, mechanical stress, implant design, components with different composition, suboptimal implant position, recalled femoral heads, and, in one study, a single design 12/14 taper style implanted with Co alloy heads between 2009 and 2012 [1,3,5,8,9].

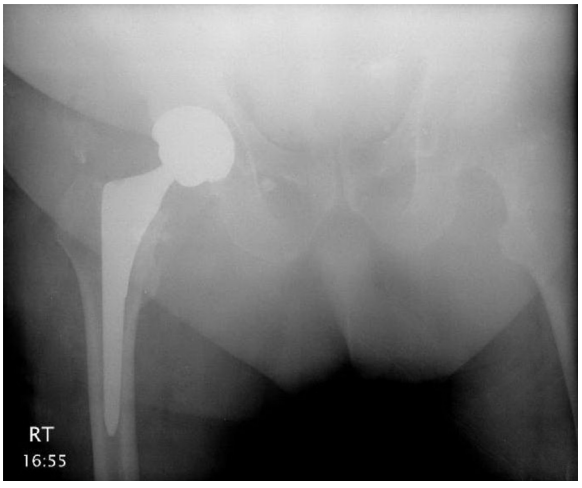

Figure 2. Postoperative anteroposterior pelvis radiograph from September 2008 after right total hip arthroplasty.

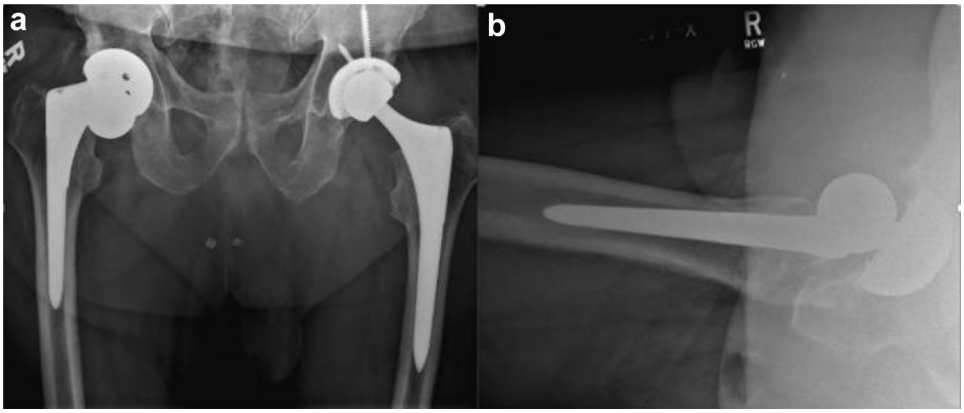

Figure 3. Anteroposterior pelvis (a) and lateral hip radiographs (b) from January 2018 demonstrating hardware failure consistent with dissociation at the right femoral head-stem interface. Left total hip arthroplasty was performed on 03/2017 by a different surgeon.

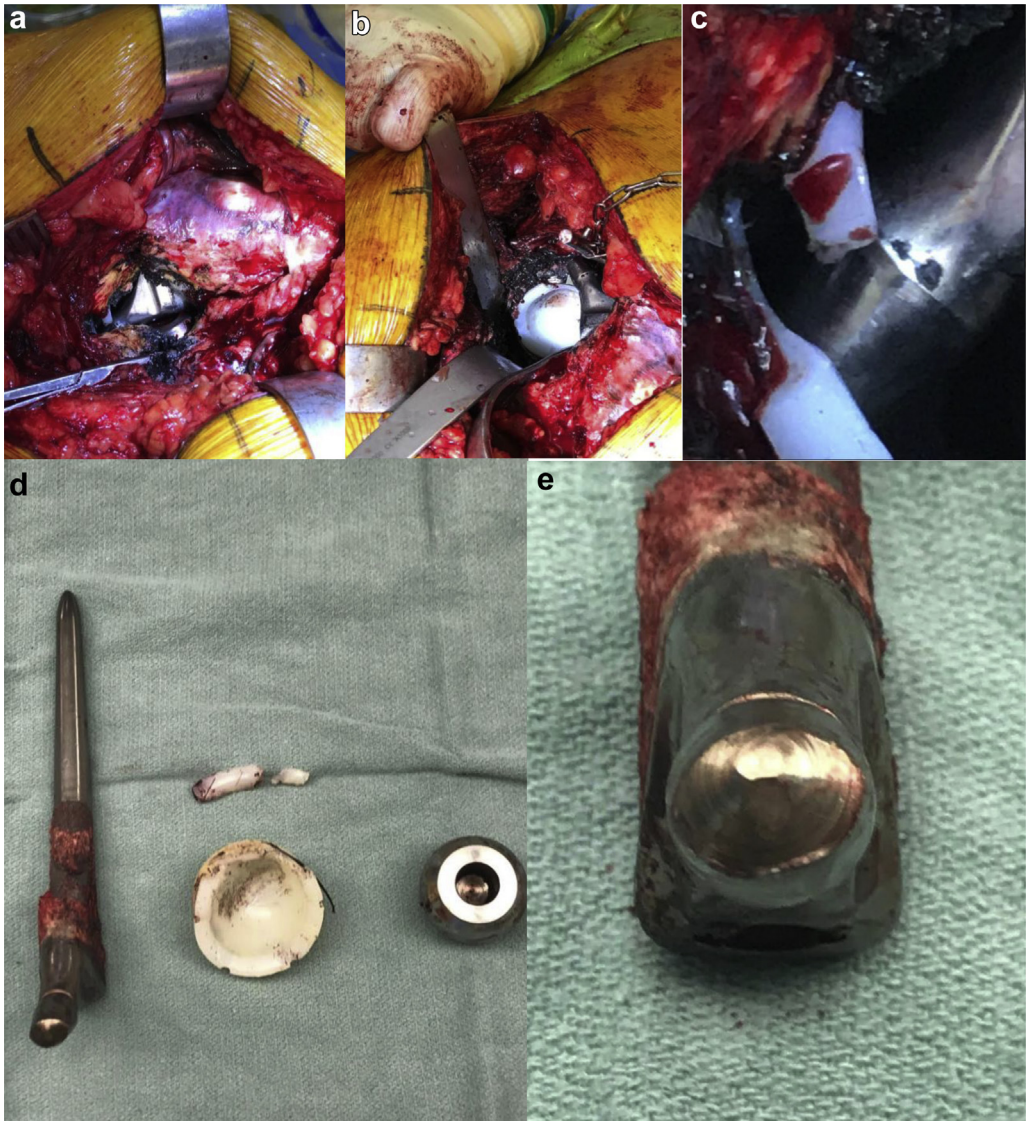

Figure 4. Intraoperative images from the revision right total hip arthroplasty in February 2018. (a) Posterolateral surgical approach to the right hip with obvious metallosis in the hip joint and the soft tissues surrounding the implants. Notable is the dislocated CoCr femoral head that the instrument is pointing to. (b) Evidence of wear on the polyethylene liner from the femoral stem after dissociation of the head. (c) Fractured polyethylene liner. (d) Explanted components with significant wear noted about the trunnion to the point that the trunnion was elliptical instead of cylindrical, and on the polyethylene with notable fracture of the liner. (e) End-on view of the worn trunnion.

Figure 5. (a) Postoperative anteroposterior pelvis radiograph showing the reconstruction with a modular femoral stem, cables, and greater trochanteric hook plate. (b) Postoperative anteroposterior and lateral radiographs of the right hip from February 2018 after revision right total hip arthroplasty.

GTF as defined by Banerjee et al. [3]is a trunnion that exhibits gross loss of volume and/or material or a fracture leading to failure at the femoral head-trunnion interface. GTF as a cause of dissociation at the femoral head-trunnion interface has just recently been studied, and over the past decade, there appears to be an increase in reported cases [3]. Dissociation at the femoral head-trunnion interface is more commonly seen following a traumatic event, such as reduction of a hip dislocation in which the inferior edge of the head is distracted against the acetabular component causing dissociation of the 2 components, or after direct trauma to the hip [10]. This case report demonstrates GTF with malformation of the trunnion leading to dissociation at the head-trunnion interface. We

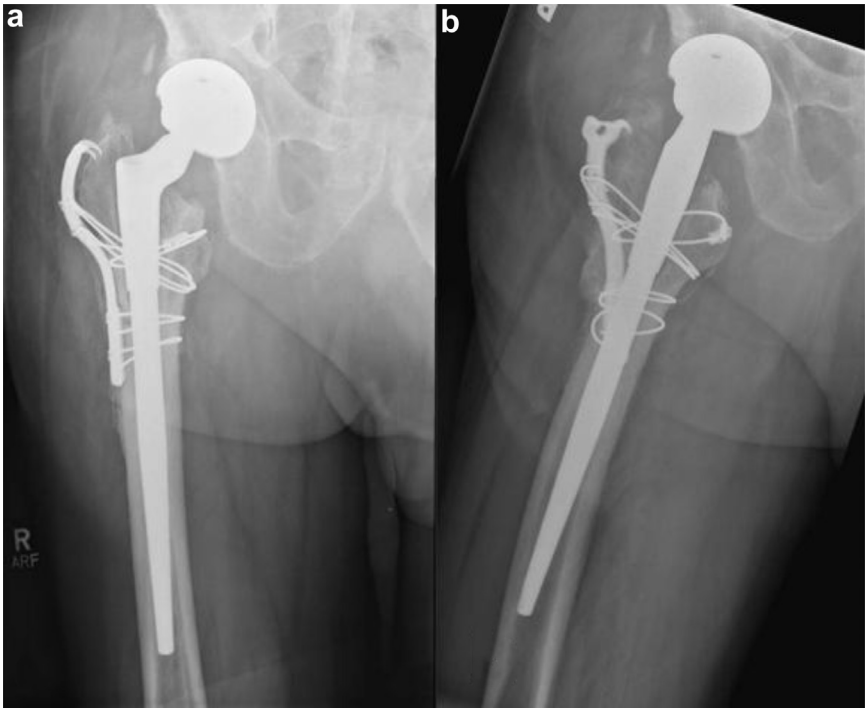

Figure 6. Anteroposterior (a) and lateral (b) radiograph of the right hip from August 31, 2018, showing maintenance of good alignment of all the hardware, good interval healing, and no complicating features.

hypothesize that this was secondary to MACC based on the time to failure, prior proposals of the mechanism of GTF [6,7] and the fact that this type of implant (a titanium alloy trabecular metal stem with 12/14 trunnion) has previously been described to have MACC in the time frame implanted [9]. In a case series of 5 patients who presented with GTF after non–metal-on-metal THA bearings, Banerjee et al. [3] noted similarities/commonalities in patient and implant factors that may be predictive of these type of failures. These similarities/commonalities were similar to the factors described by Matsen et al. [8]. In their case series of 5 patients with GTF, Matsen et al. reported demographic similarities and other common patient factors present in all of the patients in their series. They believed that these commonalities were actually risk factors that might have increased these patients' risk of GTF, and they include male sex, BMI > 30, implant time older than 6 years, high activity level, high offset, CoCr femoral head with larger femoral head size (>36 mm), and longer neck length. They believe that these factors create a greater force at the femoral head-trunnion interface leading to increased wear and subsequently MACC [8]. Evidence to support their assertion was found in a review article by Weiser et al. [2], where the authors concluded that MACC is complex and multifactorial in nature and can be minimized if surgeons can avoid or limit their use of increased femoral head size (femoral head > 32 mm) and increased offset.

Our case supports previously published literature as our patient had several identified risk factors listed above. Our patient is male, with a BMI of 33.8, and had an implantation time of 10 years. Our patient also had a 36-mm CoCr femoral head. We believe the cause of failure to be several years of MACC, leading to GTF and subsequent polyethylene damage related to the trunnion articulating with the polyethylene liner after the dissociation. It is important to note that we cannot definitively confirm MACC as the cause of failure because we did not obtain serum metal levels preoperatively, but given the similarities shared between our patient and previously published risk factors, MACC is likely cause of failure. MACC leading to GTF continues to gain awareness as a rare but significant complication of THA, as the number of reported cases increases. Recent evidence shows that certain implants and patients with certain demographics are at greater risk of developing MACC [1,11]. At-risk patients should be identified based on the factors listed above. Some surgeons believe that patients with risk factors for MACC should have scheduled follow-up every 3 years with radiographs to evaluate for early signs of implant failure and screening for serum Co and Cr levels [8]. Some surgeons even advocate that symptomatic patients with positive screening studies should be further evaluated for pseudotumor with metal artifact reduction sequence magnetic resonance imaging and be considered for early revision surgery with femoral head exchange to a ceramic head with titanium sleeve or to a smaller head size while the trunnion is still salvageable [8,9,12]. More importantly, we suggest being thoughtful about minimizing the risk factors listed above when able in high-risk patient populations to reduce the incidence of MACC. Further research is needed to determine patient and implant factors that make patients susceptible to MACC so adequate screening and patient counseling can be performed. Our case report is limited by the fact that we did not obtain cross-sectional imaging before revision to look for any fluid collection around the hip. We also did not obtain serum Co and Cr levels preoperatively. We do believe that our case report is helpful and unique because it is in a femoral head and stem that is not part of a recall for manufacturing defect. This is the first case of a Zimmer 12/14 taper trabecular metal stem demonstrating GTF type 1 failure. This implant failure has been reported to the manufacturer.

Summary

We present a unique case of a 77-year-old man, 10 years status post right THA that was complicated by GTF. At revision surgery, there was gross evidence of metallosis within the hip joint and dissociation of the femoral head from the trunnion. A tapered modular cementless revision was placed. All components were successfully fixed. Based on retrieval evaluation of similar failures [6,7] we believe this failure

occurred as a result of unrecognized MACC leading to subsequent GTF, and polyethylene liner failure. With the support of current literature, we hypothesize that this patient's THA failed because he has several risk factors that have been associated with MACC and GTF. These factors include male gender, BMI > 30, implant time > 10 years, a large CoCr femoral head, and mixed metal bearings. This case demonstrates the need for further research to determine factors that put patients at risk of MACC so adequate screening and patient counseling can be performed.

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