



## Case report

## A case of bilateral hip mechanically assisted crevice corrosion after staged total hip arthroplasty

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## ABSTRACT

Mechanically assisted crevice corrosion (MACC), also known as trunnionosis, and adverse local tissue reaction (ALTR) are entities that can lead to pain and necessitate revision in total hip arthroplasty (THA). We present a case of a 75-year-old female who received a bilateral staged primary THA with metal on cross-linked polyethylene implants and had subsequent bilateral revisions for MACC and ALTR. In both instances, she presented with anterior thigh pain, weakness, and difficulty ambulating, and she was revised to ceramic on cross-linked polyethylene implants. This case may suggest a biologic predisposition or systemic immunogenic reaction to metal debris in some patients with ALTR or represent an implant-specific complication. To our knowledge, this is the first case reported of a patient having bilateral MACC from staged THA performed by 2 different surgeons using the same brand implant.

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## Introduction

Large head metal-on-metal (MoM) total hip arthroplasties (THAs) are regarded as a failure of modern orthopedics [1,2]. The increased wear, release of metal ions into the synovium and blood stream, formation of pseudotumors, and other soft tissue complications led to a great number of revisions, industry recalls, and implant extractions. These failures contributed to research into adverse local tissue reaction (ALTR), its causes, and its biology [3,4]. These complications were initially thought to only arise from the MoM-bearing surface articulation of the implant. However, as similar findings were observed in patients with metal-on-polyethylene (MoP) implants, it became clear that release of metal ions and debris can also occur from nonarticulating junctions, including the modular femoral head-neck taper junction [1,5].

Patients with modular taper corrosion, also known as mechanically assisted crevice corrosion (MACC) or commonly

known as trunnionosis, can present with hip, thigh, groin, or buttock pain, swelling, weakness, gross instability, or other vague lower extremity complaints [5–9]. Typically, plain radiographs may appear normal, but on advanced imaging, there may be soft tissue destruction and pseudotumor formation [5–8,10,11]. In the later stages of the process, there may be some subtle osteolysis by the calcar or the superolateral rim of the acetabulum. If left untreated, more obvious osteolysis may occur. The prevalence of this condition, according to one recent study, is 3.2% but varies by implant and date of surgery [12]. Patients may present as early as a few months from their index procedure and as late as 10 years, but they typically present between 1 and 3 years [4]. Symptomatic MACC at the head-neck junction in MoP THA appears to be reported in the literature more commonly with certain implants as well [12–14].

In this article, we describe such a case occurring in the same patient with 2 different surgeries, which to our knowledge is the first such report in the literature.

## Case history

The patient was informed that data from her case would be submitted for publication, and she agreed.

The patient is a 75-year-old Caucasian female with a history of hypothyroidism and body mass index of 23.2 with bilateral hip osteoarthritis (Fig. 1) who underwent staged bilateral THA via posterolateral approach with 2 different surgeons, with the procedure

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**Figure 1.** Anterior-posterior (AP) pelvis radiograph upon initial presentation showing bilateral hip osteoarthritis.

performed in right side in June 2009. She recovered well and was asymptomatic at the time of the left-sided surgery, 3 years later, performed in December 2012 by a second surgeon, which was similarly uncomplicated. She had 32-mm CrCo femoral heads on a titanium stem with a 12/14 taper on bilateral hips, both with Trilogy acetabular components and an M/L taper standard stem (right) and extended offset (left) (Zimmer Biomet, Warsaw IN). Neck lengths were +3.5 mm in the right hip and –3.5 mm in the left hip. Each femoral head was affixed with 3 mallet blows onto a straight head impactor, consistent with the surgeons' standard technique and force.

Approximately 5 years after her right THA, she presented with unilateral, worsening right hip pain, without pain on the left. She had no pain with walking but had pain in the groin area that radiated down her leg into the anterior thigh, which was exacerbated by coughing or straining. Plain radiographs of the affected hip showed no sign of hardware malposition, loosening, osteolysis, or other signs of failure (Fig. 2a and b). Owing to this presentation, she was referred to a general surgeon, who, with ultrasound, ruled out an occult inguinal hernia.

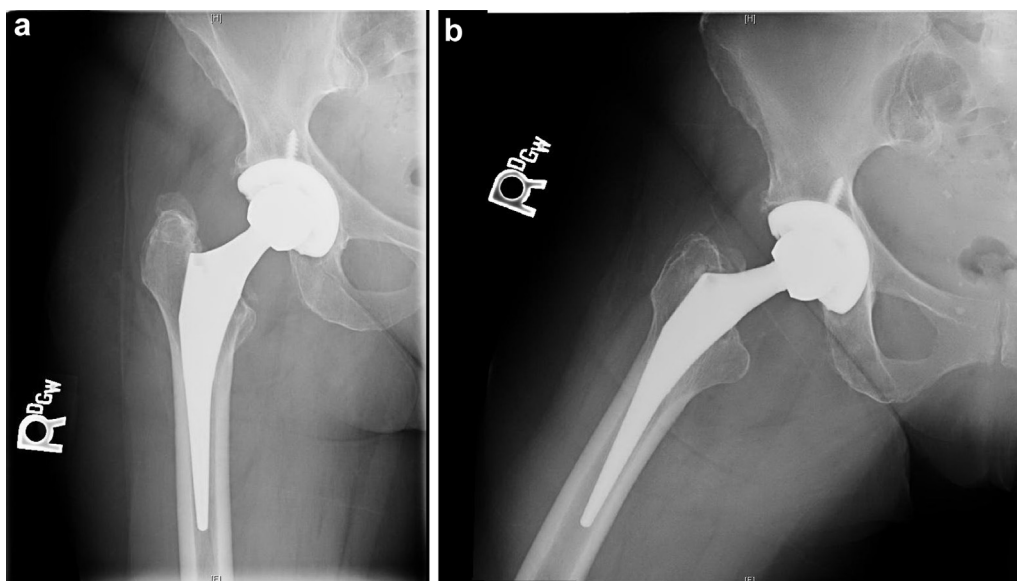
Five months later, she returned after a trial of physical therapy but was complaining of worsening pain and difficulty ambulating.

Her left side remained asymptomatic. Laboratory tests were drawn, which revealed an erythrocyte sedimentation rate (ESR) of 51 mm/h (normal, <20 mm/h), C-reactive protein (CRP) of 27 mg/L (normal, <10 mg/L), serum cobalt (Co) level of 11.4 ppb (normal, <1 ppb), serum chromium (Cr) level of 1.5 ppb (normal, <1 ppb), and white blood cell count (WBC) of  $5.7 \times 10^3/\mu\text{L}$  (normal,  $3.48\text{--}9.42 \times 10^3/\mu\text{L}$ ) with 21% lymphocytes and 70% neutrophils. Magnetic resonance imaging showed soft tissue swelling and a fluid collection near the femoral head of the right hip, in addition to joint space distention on proton density sequences, with no abnormal findings on the contralateral side (Fig. 3).

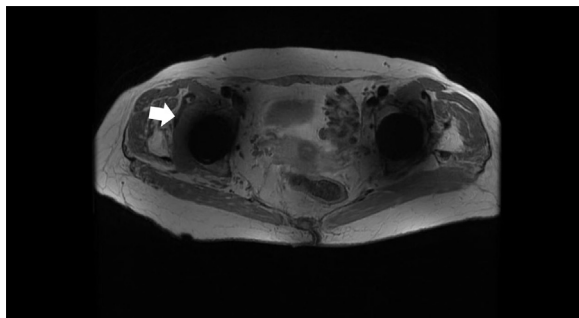
At this point, a diagnosis of MACC and ALTR was made, and she underwent revision THA. Intraoperatively, an extensive amount of necrotic-looking fibrous tissue was noted throughout the hip joint, and upon performing the capsulotomy, a thick, greenish, gelatinous material was encountered. Tissue was sent for frozen section, which demonstrated necrosis but no acute inflammation. There was also a moderate amount of typical black fretting/corrosion debris at the femoral head/neck taper junction and on the trunnion itself (Fig. 4a and b). The joint was thoroughly irrigated, the necrotic tissue was excised, the trunnion was thoroughly cleaned of corrosion debris, a modular titanium taper sleeve was placed, and her bearing surface was converted to ceramic-on-polyethylene material. Final pathology revealed acellular fibrinoid material, chronic inflammation, and necrosis. She rehabilitated from her revision well and had no postoperative complications.

Twenty-one months later, approximately 2 years after her left THA, she represented with similar symptoms in her left hip; the right hip was now asymptomatic. She reported increasing need for pain medication, difficulty ambulating, and the same anterior groin pain as she had on the right side before revision. Radiographs again showed no evidence of hardware failure and no evidence of calcar lysis (Fig. 5a-c). Laboratory results showed an ESR of 83 mm/h, CRP of 66.2 mg/L, serum Co level of 9.8 ppb, serum Cr level <1.0 ppb, and WBC of  $8.2 \times 10^3/\mu\text{L}$  with 15% lymphocytes and 76% neutrophils.

Owing to the nature of her symptoms and her laboratory results, a diagnosis of MACC was again made. A second magnetic resonance imaging was deemed unnecessary, and she again underwent a revision. Intraoperatively, we were prepared for abductor insufficiency, but none was noted. There was capsular swelling and a white creamy exudate within the joint capsule. There was also a



**Figure 2.** AP (a) and lateral (b) radiographs of the right hip upon presentation approximately 5 years after the initial right THA show no sign of complication.



**Figure 3.** Axial proton density sequence magnetic resonance imaging (MRI) demonstrates soft tissue swelling and a fluid collection near the femoral head of the right hip, in addition to joint space distention approximately 5 years after the initial right THA (arrow). Note that the left hip appears normal approximately 18 months after primary THA.

pseudotumor surrounding the posterior joint capsule. Again, there was a moderate amount of black fretting/corrosive debris at the base of the trunnion. The left hip was treated similarly with synovectomy, pseudotumor excision, cleaning of the trunnion, and placement of a titanium taper sleeve, and she was again converted to a ceramic-on-polyethylene arthroplasty. Final pathology of this specimen confirmed the presence of acellular, fibrinoid material with evidence of chronic inflammation and necrosis, similar to the contralateral hip.

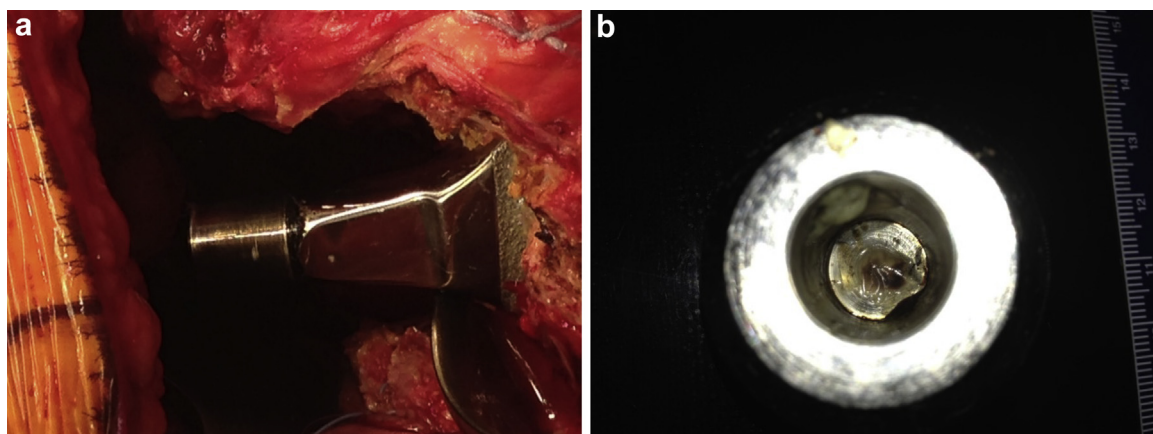
She recovered from both the surgeries. She unfortunately had a dislocation of her right hip about 5 months after the revision on the left side, which was closed reduced, and she has continued to recover well without any further instability. Laboratory results obtained 5 months after her second revision were all within normal limits, with the exception of Co, which was mildly elevated but was significantly decreased compared with prior testing (ESR, 4 mm/h; CRP, 1.2 mg/L; Co, 1.7 ppb; Cr < 1.0 ppb, WBC, 6.55 with 14.5% lymphocytes and 77% neutrophils). At the latest follow-up, 16 months after her second revision, she is pain free and walking well without any assistive devices ([Timeline](#)).

## Discussion

To our knowledge, this is the first case reported in the literature of bilateral ALTR and MACC in the same patient with MoP implants and 2 different surgeons. This case raises several questions: what is the cause? what contributes to the formation of MACC and ALTR? and as this case possibly points out, is there a genetic, biologic, or immunologic predisposition that some patients may have this complication or is there an inherent issue with the implant itself?

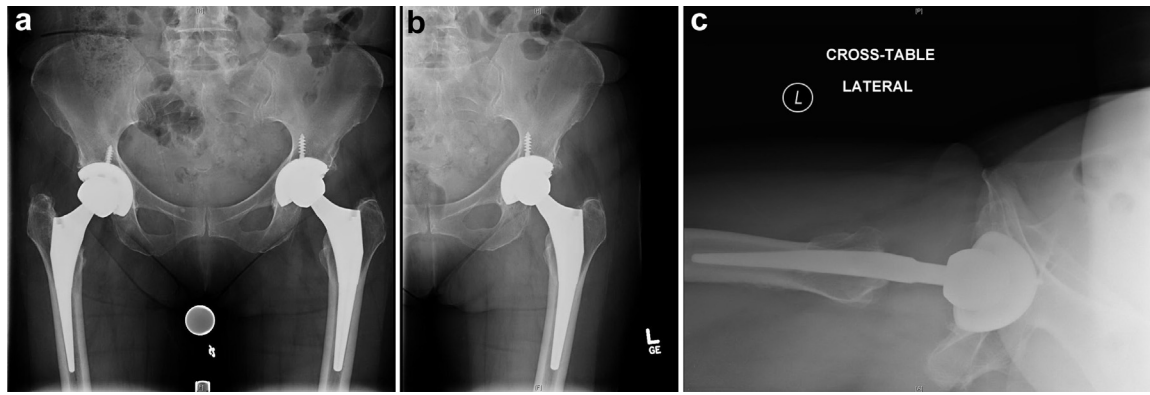
The causes of femoral head-neck corrosion and surrounding soft tissue response, although not fully understood, appear to be multifactorial. In a recent review by Mistry et al. [15], several factors are discussed. It has been postulated that larger femoral heads contribute more to trunnion stress and wear by exerting a larger frictional torque and therefore increasing the risk for the development of MACC [16]. However, the results regarding femoral head size and development of MACC are inconclusive [17–21], with some studies finding that larger femoral heads are directly correlated to increased wear [17] and others finding no difference [21]. Our patient had 32-mm CrCo femoral heads on a titanium stem with a 12/14 taper on bilateral hips, both with Trilogy acetabular components and an M/L taper standard stem (right) and extended offset (left) (Zimmer Biomet, Warsaw, IN). The design of the trunnion itself may contribute to the development of MACC [22,23]. The base of shorter trunnions lies within the taper of the femoral head, which may increase edge loading and base corrosion [24] and may increase material wear [25]. The evidence is conflicting regarding taper angle, with one study showing significantly higher fretting scores in 11/13 tapers than those in more narrow type 1 tapers [26], but others show more wear with wider 12/14 tapers than with 11/13 [25]. Assembly conditions may also predispose toward corrosion [27,28]; however, given that these THA constructs were assembled in 2 different operative settings with 2 different primary surgeons, it is unlikely she was subjected to the same factors during each procedure, which suggests against this as a cause of MACC. In short, the exact cause of MACC, in terms of implant design, has not been fully elucidated, although certain implant types have been noted to have a higher prevalence of MACC [12].

In a recent cross-sectional study by Hussey and McGrory, 10 years of consecutive MoP THAs performed by a single surgeon were reviewed and analyzed for prevalence of MACC with various factors, including implant type [12]. In it, the authors note that the overall prevalence of MACC in this cohort was 3.2%, but in certain years, specifically 2009–2012, the M/L Taper stem had greater prevalence. This raises the possibility that implant type/manufacturing may also play a role in the development of MACC and, in turn, ALTR. In our case, the primary THAs were performed in 2009 and 2012 and used the M/L Taper. The implants from this case were not sent to the manufacturer (Zimmer) for evaluation. In addition, recent literature also shows a high complication rate after revision for MACC/ALTR. One recent report has a total complication rate of 25%, with a 22% dislocation rate [14], with other studies noting dislocation rates between 7% and 20% [5,29–32]. So the fact that she had a dislocation after her second revision is not unexpected, though the specific cause of this instability is unknown [9].



**Figure 4.** Clinical photographs of the femoral neck trunnion (a) and the inside of the femoral head implant (removed) (b) during revision surgery on the right hip.





**Figure 5.** AP pelvis (a) and AP (b) and lateral (c) radiographs of the left hip upon presentation approximately 2 years from the initial left THA and 21 months after the revision surgery on the right side. No calcar lysis is noted.

Besides the design of the implant itself, the fact that this happened bilaterally in our case could intimate a biological predisposition. ALTR has been well described as tissue necrosis, lymphocytosis, and chronic inflammation due to an immune reaction to metal debris from corrosion at any MoM modular junction in THA [3,4]. In the reported cases in the literature, there is a clear preponderance of women vs men presenting with ALTR [4]. In light of the study by Hussey and McGrory, this case likely was due to implant-related factors. However, we hypothesize that it is also plausible that the patient was predisposed to ALTR or primed to react to metal debris after the first occurrence. The immune system often becomes sensitized to stimuli, and this patient may have been sensitized to metal debris and more vulnerable to ALTR. This is important for surgeons and scientists to consider, although at this time there is a paucity of evidence exploring this possibility and more study is required.

## Summary

In conclusion, ALTR due to MACC in contemporary implants should be considered in the differential diagnosis of every orthopedist when patients complain of pain, weakness, swelling, or other symptoms after THA, even after one side has been revised and after periprosthetic infection has been ruled out. Although there is much postulated regarding implant design as a potential cause of ALTR, current literature is inconclusive. In addition, device manufacturing and implant type may also play a role, with certain implants having a track record of MACC reported in the literature. Furthermore, there may be unrecognized biological factors at play that could predispose patients to this complication. Further research into both implant design and biological response to metal debris and ALTR is needed to understand this entity and provide the best possible counseling and care to patients.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.artd.2018.05.003>.

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