Metal-on-metal bearings for total hip arthroplasty (THA) became popular in the early 2000s. However, because of recent reports of increased negative outcomes and failure rates for these bearing surfaces, their use has decreased.\(^1\)\(^-\)\(^3\)

There have been multiple reported causes for the failure of metal-on-metal hips,\(^2\)\(^-\)\(^4\) and large-diameter femoral heads have been particularly noteworthy for their high rates of failure.\(^5\) With the multiple modes of failure that have been described for metal-on-metal hips, there is a need to establish commonality and possible root causes of these failures.

This report describes a patient with a history of bilateral large-diameter metal-on-metal THA complicated by failure of the right hip as a result of fretting and mechanically assisted crevice corrosion, with subsequent notching of the femoral neck and head dissociation 10 years after the primary procedure. This report describes the history of metal-on-metal THA, the current patient’s presenting symptoms, and the mode of treatment, including component removal, revision techniques, and implantation of ceramic-on-polyethylene components.
had undergone staged bilateral metal-on-metal THA 10 years earlier. He had recent onset of squeaking in the right hip and a 3-day history of severe pain, with shortening of the right lower extremity. Review of systems showed no significant findings. The pain was completely disabling. The patient was unable to walk upstairs or perform most of his daily activities. The left THA was well functioning.

Outside medical records showed that identical metal-on-metal components (Biomet, Warsaw, Indiana) had been used on both sides, with some subtle but important differences. The implant on the right side included a size 14 Balance primary femoral component with a 38+9-mm femoral head and a 58-mm M2A-38 metal-on-metal acetabular shell (Biomet). The implant on the left side, which was 1 year older, included a size 15 Balance primary femoral component with a 38+0-mm femoral head and a 60-mm M2A-38 metal-on-metal acetabular shell (Biomet).

On physical examination, body mass index was 40.6 kg/m². The patient had significant pain on passive motion of the right leg, with a catching sensation as well as an audible clicking noise. The right lower extremity was 1.5 cm shorter than the left side. Anteroposterior right hip and anteroposterior pelvis radiographs showed dissociation of the femoral head from the femoral neck (Figure 1). The right-sided size 14 femoral stem was sitting lower in the proximal femoral metaphysis than the left-sided size 15 stem.

Urgent revision THA was performed with an extended trochanteric osteotomy to remove the well-fixed femoral stem. Intraoperative attempts to aspirate yielded no appreciable synovial fluid, but the tissue frozen section was negative for acute inflammation, and final cultures ultimately showed no growth. Findings included notching of the femoral neck with impending fracture of the head-neck junction (consistent with fatigue injury; Figure 2), with dissociation of the femoral head, which remained reduced in the acetabular cup. Also noted were significant metal debris, retroacetabular osteolysis, a large area of necrotic tissue indicative of an adverse local tissue reaction, and otherwise well-fixed components.

Revision implants used included a size 70 Trabecular Metal acetabular component (Zimmer, Warsaw, Indiana), a Zimmer Wagner SL Revision Stem (15 × 265 mm with 3 Biomet cables), a 36+0-mm Biolox ceramic head (Zimmer), and a Longevity highly cross-linked polyethylene liner (Zimmer). Standard postoperative revision THA protocols for extended trochanteric osteotomy were followed. At 3-month follow-up, the patient had limited pain with hip flexion past 90° and 30° abduction. Anteroposterior pelvis and anteroposterior right hip radiographs showed good component alignment, osteotomy union, and good joint stability (Figure 3).

At 4 months, the patient fell at home and dislocated the revised right hip. Closed reduction was performed in the operating room with no complications. At the most recent follow-up, 5 months after revision surgery and 1 month after reduction, the patient reported minimal pain in the right hip and showed full passive range of motion without pain. He was still using a cane when walking long distances and reported occasional stiffness in the hip after physical exertion. Abductor strengthening was suggested to help alleviate the symptoms.

**Discussion**

This patient experienced THA component failure 10 years after the primary procedure as a result of fretting and mechanically assisted crevice corrosion, with subsequent notching of the femoral neck and head dissociation. The patient under-

**Figure 1:** Anteroposterior radiographs of the right hip (A) and pelvis (B) showing dissociation of the femoral head from the femoral neck. The right-sided size 14 femoral stem sits lower in the proximal femoral metaphysis than the left-sided size 15 stem.

**Figure 2:** Intraoperative findings showing notching of the femoral neck, with impending fracture of the head-neck junction, a pattern consistent with fatigue injury, and dissociation of the femoral head.

**Figure 3:** Anteroposterior radiographs of the right hip (A) and pelvis (B) at 3-month follow-up showing good component alignment, osteotomy union, and joint stability.
went THA in 2005, when metal-on-metal implants were popular, primarily because of the belief that these implants reduced chronic wear-induced osteolysis (especially in younger patients) and because their larger femoral head sizes increased stability and longevity while decreasing rates of dislocation compared with traditional designs. Several large prospective studies at the time showed excellent outcomes for metal-on-metal THA procedures with small-diameter femoral heads (28 mm) and modular stems (mean follow-up, 3-5 years). A more recent 2010 study that reported excellent outcomes for metal-on-metal hips had a mean follow-up of 12 years, and this study included only 28-mm femoral heads.

Despite the original perceived advantages of metal-on-metal implants, recent literature has raised concerns about them. Although most notable is the attention paid to physiologic responses to metal particle fragments, studies have shown increased negative outcomes and failure rates for metal-on-metal implants, and these findings have led to a decrease in their use. The cause of these failures must be evaluated because aseptic revisions of failed metal-on-metal THA components have been associated with high rates of negative outcomes, including infection.

Large-diameter metal-on-metal femoral heads have had particularly high rates of failure. When these larger femoral heads are paired with relatively small femoral neck tapers and long-neck offsets, there is concern about localized corrosion at this junction, particularly with varus and longer femoral head-neck lengths. However, few studies have reported such cases that have failed as a result of notching or dissociation of the components.

In the current patient, the 38-mm femoral head, coupled with the smaller neck taper and longer neck offset (+9 opposed to +0 on the well-functioning side), was the most likely reason why corrosion and notching of the neck occurred on the right side and the left-sided components remained intact. Treatment included acetalubar component revision to change the bearing surface, a ceramic head with a +0 mm neck, and a highly cross-linked polyethylene liner. On the femoral side, a long-splined, tapered titanium alloy stem was used and placed at a level to minimize the necessary length of the femoral head and ensure a lower risk of corrosion and future dissociation.

The authors used a ceramic-on-polyethylene bearing for this patient. Although femoral head size has been associated with increased fretting and corrosion in metal-on-metal hips, recent studies of metal-on-polyethylene hips have not shown the same association. In fact, these studies showed that modularity, length of implantation, and the nature of the metals used were more closely associated with corrosion of the implant.

A ceramic head was used to further minimize the potential for junctional corrosion and failure in this patient. This decision was guided in part by literature showing that metal-on-polyethylene hips also undergo corrosion and trunnionosis occurs more commonly than was thought in the modern era of cobalt-chromium femoral heads. Ceramic-on-polyethylene hips have effectively reduced the risk of corrosion in these constructs. Trusting these basic tribologic principles, the authors selected the final implants with the goal of reducing the risk of repeat failure.

**Conclusion**

The ideal THA articulation is a topic of debate and ongoing research. The current patient experienced corrosion at the modular head-neck junction, and there has been emerging evidence that modular components are associated with high rates of “trunnionosis,” especially at metal-on-metal articulations. Despite the high incidence of metal-on-metal corrosion and emerging evidence of metal-on-polyethylene corrosion, modular implants afford other advantages that monoblock systems do not. Modular implants allow for a tremendous reduction in THA inventory while still allowing the surgeon ample intraoperative flexibility to fine-tune leg length, offset, and hip stability. Although this may not be feasible or realistic, a return to monoblock femoral components could solve the current trunnion issues. However, the most probable scenario is an improvement in trunnion design, taper technology, and material fabrication. This case highlights a weak link in THA. There is much to learn about biomaterials and taper topography, and further research may resolve the recent concerns about modularity.

**References**


