CASE REPORT

Trunnion Corrosion as a Cause of Recurrent Pseudotumor

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Introduction

With the introduction of second generation metal-on-metal (MM) hip implants in the mid-1990s, increased interest has arisen regarding the local biological effects of metal wear particles and ions on soft tissues, which have been grouped under the term

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adverse reactions to metal debris (ARMD). When these reactions constitute a soft tissue mass, they are usually referred to as a pseudotumor [15]. Histological studies of these masses have shown the presence of features characteristic of a non-specific inflammatory reaction (macrophages and wear particles) but also the presence of perivascular infiltrates of lymphocytes that are suggestive of a hypersensitivity reaction [3, 7, 13].

The first description of a hip implant-related pseudotumor was made in 1988 with a metal-on-polyethylene (MPE) bearing. The mass was attributed to a local response to metal ion release from corrosion at the Morse taper head-neck junction [16]. In 2008, a report of a multisurgeon experience with MM hip resurfacing arthroplasties (HRA) estimated that pseudotumors occurred in approximately 1% of patients within 5 years, but acknowledged that with time, the incidence of these pseudotumors may increase [15]. A year later, the same group reported on 16 cases of pseudotumors that went to revision surgery [6]. Five cases required re-revision for instability and loosening, and three of these cases had evidence of pseudotumor recurrence at the time of revision.

We report on a patient who, after a hip resurfacing, presented with a pseudotumor that recurred after conversion to a conventional MPE total hip replacement (THR). Our hypothesis is that the recurrence was caused by ongoing corrosion at the Morse taper junction between the titanium stem and the cobalt-chromium-molybdenum (CoCrMo) head. The patient consented for the publication of this case.

Case Report

A 43-year-old male patient underwent an uncomplicated right HRA in December 2004 at our institution for treatment of advanced femoral head avascular necrosis secondary to prednisone use for dermatomyositis. The patient was treated for his dermatomyositis with oral prednisone (up to 20 mg per day), but the condition went into remission in 2004 and he did not require any further treatment. A 58-mm Conserve[®] Plus acetabular component and a 52-mm Conserve[®] Plus femoral head (Wright Medical Technology, Inc., Memphis, TN) were used. The patient remained asymptomatic

until August 2006 when he presented with progressively symptomatic pain in the right groin area.

In May 2007, plain radiographs showed progressive neck narrowing with no evidence of implant loosening. The acetabular cup abduction angle measurement was 53° (Fig. 1a). A joint aspiration was performed and the cultures were negative for bacterial growth. At that time, serum cobalt (Co) and chromium (Cr) levels were 3.02 and 2.0 ppb, respectively. Conversion to a THR due to ongoing pain was offered but the patient declined.

The patient returned for follow-up a year later, in May 2008, with worsening pain. On physical examination, he was afebrile and had no other clinical symptoms apart from an irritable and painful hip. Updated inflammatory markers including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were normal. Computed tomography (CT) imaging demonstrated a complex periarticular fluid collection with periarticular soft tissue thickening (Fig. 1b). Metal hypersensitivity was considered to be the cause of the persisting symptoms and revision surgery was planned.

At the time of surgery, a large amount of gray fluid along with thickened periprosthetic tissue was encountered in the hip joint. This tissue was debrided and samples were sent for culture, which were subsequently negative for bacterial growth. The surgical pathology report indicated the presence of dense fibrous tissue with chronic inflammation, fibrosis and degenerative changes, with no evidence of dysplasia, neoplasia or malignancy. The acetabular and femoral components were both solidly fixated. Both components were removed with good preservation of bone stock. A 56-mm uncemented titanium Trident® PSL acetabular cup with a highly crosslinked polyethylene acetabular insert (X3) was used on the acetabular side. On the femoral side, a proximally hydroxyapatite-coated, uncemented titanium alloy Accolade® stem was implanted (all components manufactured by Stryker Orthopaedics, Mahwah, NJ). The plan was to utilize a ceramic head but due to the need for a +10 mm neck length, a 32-mm CoCrMo alloy head was

implanted instead, as the maximum available ceramic neck length was +4 mm.

The patient did well for about a year and a half. He then returned to our institution for follow-up at 2 years with increasing pain in the groin area. On physical examination, he was afebrile with no palpable masses around the hip. Plain radiographs demonstrated a well-positioned THR (Fig. 2a). A hip joint aspiration showed dark cloudy fluid with negative bacterial cultures. Magnetic resonance imaging (MRI) demonstrated a non-enhancing soft tissue thickening surrounding the trunnion (Fig. 2b). Serum metal ion levels demonstrated a more than twofold increase for Co (6.44 ppb) but a decrease for Cr (0.32 ppb) when compared to the previous levels.

In light of the clinical and MRI findings, a pseudotumor recurrence was suspected and a second revision was scheduled. At the time of surgery, a thickened avascular periarticular mass, similar to the one observed at the time of the first revision, was observed and excised. Multiple tissue samples were sent for histological analysis and culture. Histology revealed extensive necrosis and, in some tissue samples, dense perivascular lymphocytic aggregates (Fig. 3). All cultures were negative. The trunnion of the femoral stem showed evidence of corrosion with blackened staining (Fig. 4). Both components were well fixated. The plan was to revise the implant to an all ceramic articulation, which required removal of the stem due to unavailable neck lengths in ceramic heads with the current stem. Both components were extracted with minimal bone loss. The reconstruction was completed with a 60-mm Lineage® uncemented titanium acetabular component with a 36-mm inner diameter alumina ceramic insert and a Profemur® Z titanium monoblock stem. A 36-mm alumina ceramic head, zero neck length was utilized (all components manufactured by Wright Medical Technology, Inc., Memphis, TN). The postoperative course was uncomplicated. The patient has remained symptom-free since his last surgery and his Co serum ion level had decreased to 0.33 ppb when last measured at 2.5 years post-revision. His Cr level remained unchanged, at 0.37 ppb.

Fig. 1. **a** Pelvic radiograph about 3.5 years after a metal-on-metal hip resurfacing arthroplasty, showing a slightly vertical cup without evidence of loosening. Moderate neck narrowing is evident. **b** Hip computed tomography (CT) scan showing a large fluid collection with a thickened lining distending the joint measuring $7 \times 4.5 \times 2.3$ cm.

Fig. 2. **a** Pelvic radiograph showing well-positioned components of a metal-on-polyethylene total hip replacement without evidence of loosening. **b** T1-weighted axial magnetic resonance imaging (MRI) illustration showing a thickened soft tissue mass at the level of femoral neck of the total hip replacement. Both images (**a** and **b**) were taken 18 months following revision surgery.

Discussion

This patient initially presented with a symptomatic complex periarticular fluid collection with soft tissue thickening as depicted by CT imaging, about 3.5 years following implantation of a MM hip resurfacing. These clinical findings appeared to indicate the formation of a pseudotumor. Although the origins of pseudotumors after MM HRA remain unclear, excessive wear and metal hypersensitivity have been reported as possible causes [3, 14, 15]. Higher acetabular abduction and anteversion angles have been associated with higher serum Co and Cr levels, probably due to edge wear [2, 11, 12]. The cup inclination of the primary HRA in the present case was slightly elevated at 53° at 2.5 years follow-up, and serum Co and Cr levels were 3.02 ppb and 2.0 ppb, respectively, with Co level being slightly higher than the average level usually seen with this implant [9]. The initial HRA was revised to a MPE THR. Since previous studies on metal ion measurements showed lower levels of

both Co and Cr ions after MPE THRs compared to MM bearings [5] as well as a decrease in serum metal ion levels after the removal of MM THRs [4], a decrease in ion levels would have been expected after removal of the MM HRA in the present case. Surprisingly, the Co level of the patient continued to increase and more than doubled after conversion to the MPE THR. At the time of the second revision, there was evidence of significant corrosion at the junction of the Morse taper. This has been previously reported to be a source of metal ions [1, 8, 10, 16] and could thus possibly explain the increase in Co serum level in this patient despite the removal of his MM hip resurfacing. Because this occurred in an already metal pre-sensitized patient, it may have triggered a stronger adaptive immune response, leading to the re-formation of a local mass (thickened tissue) around the joint, suggesting the recurrence of a pseudotumor. The most recent serum Co levels, taken 2.5 years after the second revision with a ceramic-on-ceramic implant, showed a decrease that may have been a consequence of interrupting the corrosion source.

Fig. 3. Hematoxylin and eosin-stained section of periprosthetic tissue harvested at the time of the second revision and demonstrating perivascular lymphocytic aggregates (×100).

Fig. 4. Blackened staining at the trunnion depicting corrosion.

Very few studies have been reported on the incidence of pseudotumor recurrence after revision surgery. Grammatopoulos et al. reported that five of 16 cases initially revised because of a pseudotumor requiring a secondary revision for instability and loosening [6]. In three of these cases, there was evidence of pseudotumor recurrence at the time of the second revision. The authors did not report if the recurrences occurred in patients who received a CoCrMo head or a ceramic head. There are currently no published results or treatment recommendations for these recurrences.

In order to avoid the potential risk of pseudotumor recurrence in previously metal-sensitized patients, we recommend avoiding the implantation of any CoCrMo material at the time of revision, especially at any implant component junction or interface. This includes the Morse taper junction, modular head-neck and neck-stem junctions, and metallic ceramic head adaptors made of CoCrMo. Thus, only ceramic heads articulating on polyethylene or ceramic liners along with non-CoCrMo containing stems and shells should be used for the new implant and bearing surfaces in these patients.

Disclosures

Conflict of Interest: Alejandro Zylberberg Serman, MD, Isabelle Catelas, PhD and Luca Gala, MD have declared that they have no conflict of interest. Paul R Kim, MD, FRCSC reports personal fees from Stryker, outside the submitted work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was obtained from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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