



Case report

A case of bone necrosis with pseudotumor following metal-on-metal total hip arthroplasty

Masahiro Hasegawa, MD, PhD^{*}, Hiroki Wakabayashi, MD, PhD, Akihiro Sudo, MD, PhD

Department of Orthopaedic Surgery, Mie University Graduate School of Medicine, Tsu, Mie, Japan

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ABSTRACT

A case of bone necrosis with a pseudotumor following metal-on-metal total hip arthroplasty is presented. The patient showed no abnormal magnetic resonance findings 2 years postoperatively, but serum metal ion levels were elevated. The patient developed hip pain 3.5 years postoperatively, and bone necrosis with a pseudotumor was found. The present patient emphasized the fact that tissue necrosis associated with failed metal-on-metal bearing hip might not be limited to soft tissues, but bone necrosis could occur.

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Introduction

A major complication that occurs after metal-on-metal (MoM) resurfacing or total hip arthroplasty (THA) is the development of pseudotumors. These lesions are the result of tissue reactions to metal debris with lymphocyte infiltration and soft tissue necrosis; however, their pathogenesis remains unclear. Recent studies demonstrated that pseudotumors can occur in asymptomatic hips after MoM hip resurfacing or THA [1–3]. Magnetic resonance imaging (MRI) provides sensitive screening of pseudotumors following MoM THA. MRI is ideally suited for assessment of these patients and complements standard clinical evaluation [4].

A prominent perivascular lymphoid infiltrate, commonly termed aseptic lymphocyte-dominated vasculitis-associated lesion, is frequently seen in the periprosthetic tissues around MoM hip implants [5,6]. Extensive necrosis is also seen in periprosthetic soft tissues.

The case of a patient who underwent MoM THA and developed a pseudotumor with not only periprosthetic soft tissues necrosis, but

also bone necrosis, is presented. The patient was informed that data concerning her case would be submitted for publication, and she consented.

Case history

A 68-year-old woman was referred to our institution for evaluation and treatment of right hip pain. Her body mass index was 26.5 kg/m², and she had a history of hypertension and hyperlipidemia. She had undergone an uncomplicated primary MoM THA for end-stage osteoarthritis in July 2009. The arthroplasty was done with a 48-mm Cormet cup, a 40-mm metal head, and a proximally coated CTill stem (Corin, Cirencester, UK). The inclination angle of the cup was 41°. The patient's postoperative recovery was uneventful, and she was asymptomatic until 2 years postoperatively. Her activity level was moderate, and she had no muscle weakness. Her Harris Hip Score was 97 points. Follow-up radiograph showed no abnormality. We prospectively perform MRI to detect pseudotumors in all patients after MoM THA [3]. The patient showed no abnormal MRI findings 2 years postoperatively. Serum cobalt levels were assayed using inductively coupled plasma mass spectrometry (Perkin-Elmer SCIEX Elan 6100 DRC ICP-MS system; Perkin-Elmer Instruments, Norwalk, CT) at Mayo Medical Laboratories (Rochester, MN), and chromium levels were assayed using a graphite furnace atomic absorption spectrometer (Z-5700; Hitachi Ltd, Tokyo, Japan) with polarization—Zeeman

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^{*} Corresponding author. 2-174 Edobashi, Tsu, Mie 514-8507, Japan. Tel.: +81 59 231 5022.

E-mail address: masahase@clin.medic.mie-u.ac.jp

absorption at Mitsubishi Chemistry Medicine Corporation, Ltd. (Tokyo, Japan) [3]. Serum metal ion levels showed an increased cobalt level (16.0 ppb [parts per billion]), but the serum chromium level was not elevated (0.6 ppb).

The patient developed pain in her right hip 3.5 years post-operatively, and she was referred to our institution. Radiograph showed severe acetabular osteolysis with pubic and ischial fractures. Femoral osteolysis was also found. It was decided that revision THA was needed, and the patient waited for admission. One month later, she felt severe right hip pain and was suddenly unable to walk. Radiograph showed hip dislocation with cup loosening (Fig. 1). MRI showed a pseudotumor (Fig. 2). The patient had no history of allergy to metal jewelry. A lymphocyte stimulation test was conducted before revision surgery, showing no reactivity to cobalt and chromium; however, nickel sensitivity was demonstrated. The serum cobalt ion level decreased to 5.2 ppb, and the chromium level increased to 3.6 ppb.

The patient underwent revision surgery in February 2013. Fluid and cyst wall cultures failed to grow bacteria. Because the femoral stem was well fixed, the stem was retained, and the head was exchanged for a new metal head. The dislocated acetabular shell was removed, and the new trabecular metal cup with a highly cross-linked polyethylene liner (Zimmer, Warsaw, IN) was implanted. Macroscopic examination showed surface damage on the retrieved metal liner and head, with corrosion of the trunnion and taper with metal debris attachment.

All samples of the pseudotumor were fixed in 10% neutral buffered formalin prior to processing and embedding in paraffin wax. Resected bone was fixed in neutral buffered formalin, decalcified in ethylenediaminetetraacetic acid, and embedded in paraffin. Sections were stained with hematoxylin and eosin and examined by light microscopy. Sections of the pseudotumor were also analyzed by immunohistochemistry using antibodies to T lymphocytes (CD3; DAKO, Glostrup, Denmark), B lymphocytes (CD20; DAKO), and macrophages (CD68; DAKO) to characterize the immunophenotype. Histology showed extensive necrosis and lymphocytic infiltration in periprosthetic tissues of the hip, with perivascular lymphocytes and diffusely distributed lymphocytes. There was not only soft tissue necrosis, but also bone necrosis (Fig. 3). Immunohistochemical examination suggested more CD20-positive B lymphocytes than CD3-positive T lymphocytes.

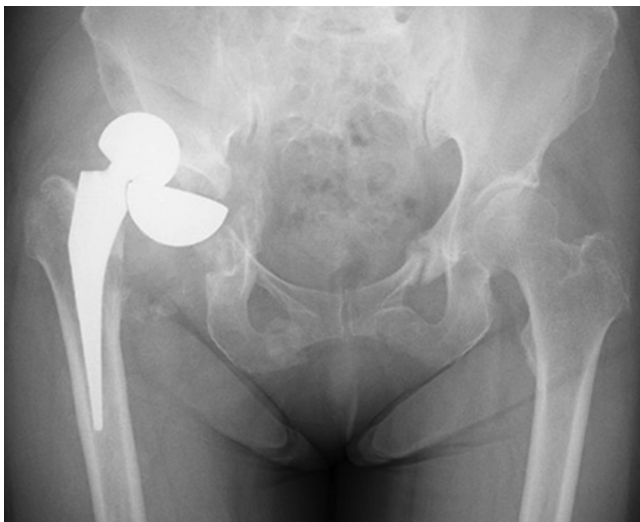


Figure 1. Radiograph shows hip dislocation with cup loosening, as well as severe acetabular osteolysis with pubic and ischial fractures.

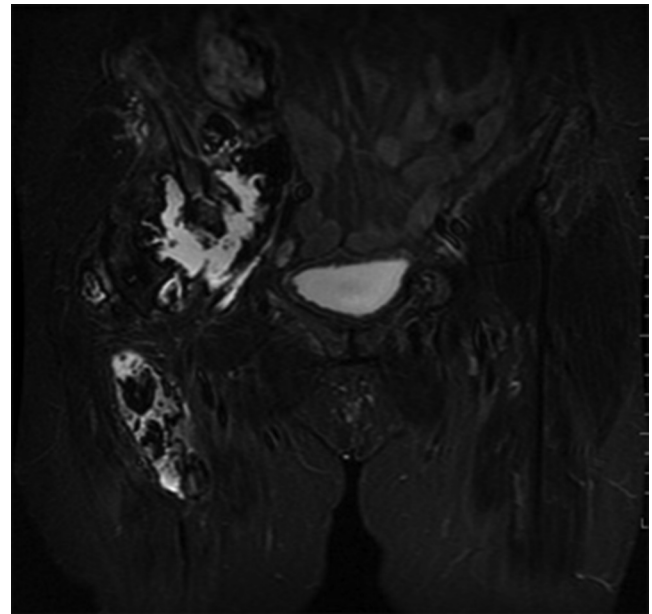


Figure 2. Coronal short tau inversion recovery magnetic resonance image shows a pseudotumor.

CD68-positive macrophage infiltration was also found. Post-revision serum cobalt and chromium levels decreased to 1.5 and 0.6 ppb, respectively. Three years postoperatively, the patient reported substantial resolution of pain and could walk without a limp. Her Harris Hip Score was 96 points. Radiographs showed no evidence of loosening. The femoral osteolysis was repaired spontaneously (Fig. 4).

Discussion

The present case highlights the fact that tissue damage occurring with MOM bearing hips can involve bone in addition to soft tissue. Hips with aseptic lymphocyte-dominated vasculitis-associated lesion have demonstrated soft tissue necrosis; however, acetabular bone necrosis has not been reported, to our knowledge. Only 2 cases with greater trochanteric necrosis were reported after MoM THA, although histological analysis was not included [7].

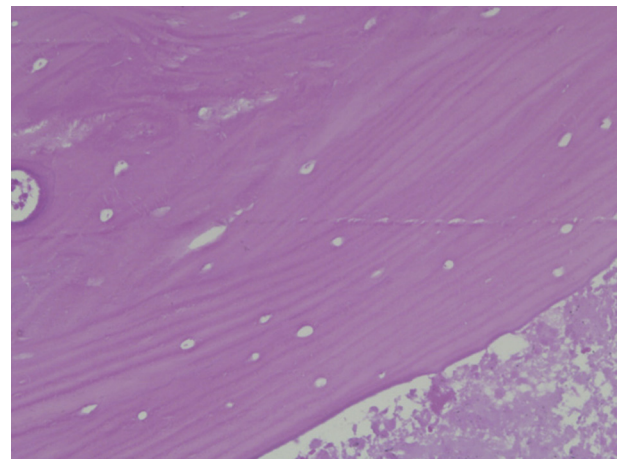


Figure 3. Histology shows bone necrosis (hematoxylin and eosin staining, original magnification $\times 100$).



Figure 4. Radiograph shows no loosening without osteolysis progression after 3 years following revision surgery.

Screening for pseudotumors was performed using MRI after a large-diameter MoM THA. The natural history and longitudinal imaging findings of pseudotumors have yet to be fully analyzed. In the present case, no pseudotumor was found 2 years postoperatively. Follow-up MRI was not performed, but a pseudotumor developed 3.5 years postoperatively.

A previous study showed that serum cobalt and chromium ion levels were significantly higher in patients with a pseudotumor than in patients without a pseudotumor [3]. Numerous studies have demonstrated that patients with MoM bearings have increased serum cobalt and chromium ion levels. Increased wear at the bearing surfaces and corrosion at the head and stem taper interface are the 2 main sources of metal ion debris. Serum metal levels showed greater elevation of cobalt than chromium in the hips with adverse local tissue reactions secondary to corrosion at the modular neck-body junction [8,9]. In the present case, the cobalt level increased after 2 years, suggesting corrosion of the head-neck junction.

The Medicines and Healthcare Products Regulatory Agency (UK) has suggested that patients with levels of cobalt or chromium ions above 7 ppb should be further investigated and have ion measurements repeated as part of closer follow-up. However, measurements may also need to be repeated in asymptomatic patients with levels between 3 and 7 ppb, particularly in those with large-diameter MoM THA [10]. Griffin [11] recommended that an ion level greater than 4.5 ppb may serve as a threshold when abnormal wear is occurring, and it is suggested as a trigger for an MRI scan. Metal ion levels have been shown to reliably predict abnormal function of the bearing surface with increased wear, but ion levels should not be used alone as a trigger when to proceed with revision surgery with MoM articulations. In the present case, serum cobalt level was very high (16.0 ppb) 2 years postoperatively; however, the patient showed no abnormal MRI findings at that time. It is hard to find the reason why the cobalt level decreased as the adverse local tissue reactions increased. But, high serum cobalt:chromium ratio was found. Intra-articular levels of mechanically assisted crevice corrosion (MACC) patients were reported to be 100 times greater than serum levels [11]. Risk stratification strategies help determine which patients should be

monitored more closely with serial ion levels, cross-sectional imaging with MRI, or proceed on to revision [12]. A single MRI study in the clinical decision-making process should be avoided, and a longitudinal study of pseudotumors with MRI should be performed, especially in patients with high metal ion levels [13]. Surgeons should consider revision surgery before acetabular bone necrosis occurs.

Patients with implants exhibited elevated lymphocyte reactivity to metals and these patients might become sensitized to metal after implantation of metal prostheses. A metal-specific adaptive immune response occurred in these patients [14]. In the present case report, the pseudotumor itself might have caused the bone necrosis or perhaps the metal sensitization to nickel played a role as well. A higher incidence level of enhanced lymphocyte reactivity to nickel was found in patients with MoM hip resurfacing compared to the patients without MoM implants, reflecting exposure and immune reactivity [15].

At the time of revision surgery, we selected to retain the stem without loosening, and the head was exchanged for a new metal head. A ceramic head could decrease corrosion products from MACC at the trunnion and taper interface. MACC occurred at the head-neck and neck-stem taper junction in which at least one of the components is fabricated from cobalt-chromium alloy [9,16,17]. The retained stem had no option of a titanium sleeve for the use of a new ceramic head. We could not use a new ceramic head with the retained trunnion for preventing ceramic fracture. If we revised the stem, we might use a new ceramic head to prevent MACC.

Adverse local tissue reactions are the primary cause of failure of MoM hip implants, and fewer but not negligible number cases of nonmodular metal-on-polyethylene (MoP) implants. Adverse local tissue reactions in MoP systems have been highly necrotizing lesions that seem to have a similar development to the reactions in MoM [16]. Serum cobalt and chromium ion levels have been used to diagnose taper corrosion. Metal artifact reduction sequence MRI is an excellent diagnostic tool for evaluation of patients with elevated serum cobalt after MoP THA [11,16–18]. In the present case, we used MoP articulation at the time of revision surgery and careful follow-up is required for MACC to occur.

Summary

The present case report emphasizes the fact that tissue necrosis associated with failed MoM bearing hip might not be limited to soft tissues, but bone necrosis may also occur. High metal ion levels were predictive of the development of an adverse local tissue reaction in the present case.

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