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Case report

Pseudotumor in ceramic-on-metal total hip arthroplasty

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ABSTRACT

The increasing demand for total hip arthroplasty (THA) in relatively young, high-demand patients has led to the use of hard-on-hard bearing surfaces. Adverse local tissue reaction/pseudotumor and elevated serum metal ion levels are commonly reported complications encountered in metal-on-metal THA, while audible articulation and rim fracture are reported in ceramic-on-ceramic THA. For this reason, ceramic-on-metal THA was implemented as an ideal hard-on-hard bearing combination. In this report, we describe a case of bilateral simultaneous ceramic-on-metal THA in a 69-year-old woman who presented 7 years postoperatively with unilateral hip pain associated with underlying pseudotumor and elevated serum cobalt and chromium ion levels. Pre-revision workup, intraoperative findings, and postoperative evaluation are included and suggest acetabular malposition as a potential source for complication.

Introduction

Before the 21st century, metal-on-ultra-high-molecular-weight polyethylene bearing surfaces had been the preferred bearing couple for total hip arthroplasty (THA) [1]. Although primary THA outcomes were good to excellent, with >80% 25-year survivorship noted in some series, increased life expectancy coupled with younger, healthier, and higher-demand patients led to consideration of alternative THA bearing surfaces [2].

Alternative bearing combinations were developed or modified and included metal-on-metal (MoM), ceramic-on-ceramic (CoC), metal-on-highly-cross-linked polyethylene, and ceramic-on-highly-cross-linked polyethylene (CoXP). While MoM and CoC bearings are desirable due to markedly decreased wear rates, the former is associated with increased local/systemic metal ion levels and adverse local tissue reactions (ALTR), and the latter with increased risk of head or liner fracture and audible noise generation. The often-insidious biologic effects of a MoM bearing include the development of ALTR, also referred to as adverse reaction to metal debris, which were originally histologically described as aseptic lymphocytic vasculitis-associated lesions [3]. These tissue reactions can manifest as an effusion, local tissue necrosis, periprosthetic osteolysis, or pseudotumor, which may be solid and/or cystic [4]. Histopathologically, pseudotumors are described as cell-mediated (type IV) hypersensitivity reactions characterized by perivascular lymphocytic infiltrate, fibrinous exudate, macrophage accumulation, and tissue necrosis [5]. Clinically, pseudotumors may present in a number of ways, including pain, presence of a palpable lump, skin changes/rash, spontaneous instability/dislocation, deep vein thrombosis, and/or neurologic examination changes due to underlying nerve palsy [6,7]. Given these associated complications, ALTR often leads to revision THA, and revision THA for ALTR have been reported to have worse outcomes when compared to revision THA for other causes [8].

With the potential complications of MoM and CoC bearings, ceramic-on-metal (CoM) THA was thought to represent an optimized combination of bearing surfaces without the added risk of ceramic fracture, acoustic noise, or the damaging effects of local/systemic elevated metal ion levels. However, metal ions are not normal following CoM THA, presumably secondary to by-products of mechanically assisted crevice corrosion at modular junction points, such as taper corrosion at the head-neck junction [9]. Cadossi et al [10] reported a series of 49 patients (20 CoM THA and

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Figure 1. Anteroposterior (AP) pelvis radiograph at time of presentation to our clinic (7 years s/p simultaneous bilateral CoM THA) without signs of osteolysis or loosening.

29 MoM THA) with an average of 3 years follow-up and noted that both chromium and cobalt levels were elevated postoperatively in both groups, although they were less elevated in the CoM group. Interestingly, despite the elevated metal ions found in the CoM THA population, there is a paucity of CoM cases involving ALTR reported in the literature. Unlike previous case reports with aseptic loosening, this case presents a patient with prior simultaneous bilateral CoM THA, unilateral symptoms, and ALTR without aseptic loosening of either the femoral or acetabular components [11,12].

Case history

A 69-year-old woman 7 years after simultaneous bilateral THAs initially presented to our clinic in August 2015. Symptoms included right worse than left lower back and gluteal pain for over 1 year. She experienced a popping sensation in her right hip. Radiographs demonstrated bilateral THAs with hard-on-hard bearings. Implant positioning appeared adequate, and there was no osteolysis or radiographic signs of loosening (Fig. 1). She had a body mass index (BMI) of 26.2 kg/m^2, walked with a normal gait (no Trendelenburg), demonstrated painless full range of motion of both hips, and had mild tenderness of bilateral greater trochanters. Her neurovascular examination was normal. Radiographs and magnetic resonance imaging (MRI) of her spine revealed degenerative scoliosis of the lumbar spine, facet arthropathy, and foraminal stenosis of L4-L5 and L5-S1. She continued with intermittent symptoms and returned in February 2016. A metal artifact reduction sequence/multi-acquisition variable-resonance image combination MRI of bilateral hips and serum cobalt and chromium ion levels were ordered. When the patient returned in August 2016, her pain had worsened and now included persistent right groin pain, which was associated with nontender, palpable swelling. A copy of the operative report, which was provided by the patient, revealed bilateral DePuy Pinnacle Sector II acetabular shells with Pinnacle cobalt-chrome (CoCr) inserts and DePuy Summit Stems with Biolox Delta ceramic heads (DePuy Synthes Joint Reconstruction, Warsaw, IN). The multi-acquisition variable-resonance image combination MRI demonstrated atrophy of the right hip abductors with a large right hip effusion and extension of the fluid collection along the iliopsoas bursa measuring 11.6 cm × 3.0 cm (Fig. 2). A small left hip effusion was present as well. Serum cobalt and chromium levels (February 2016) were 24.4 and 19.2 ppb, respectively. Inflammatory markers were within normal limits with erythrocyte sedimentation rate 2 mm/h (normal <30 mm/h), C-reactive protein <0.1 mg/dL (normal 0.0-0.8 mg/dL), and interleukin 6 <5 pg/mL (normal <5 pg/mL).

A revision right THA was performed. Before exposure, an aspiration of the joint removed 10 mL of gray/green and cream-colored fluid consistent with discoloration from the presence of metal debris. The fluid was sent for cell count and culture. The gluteus medius and minimus tendons were intact. The pseudocapsule was thickened, gray and green in color, and excised along with surrounding scar tissue surrounding the femoral neck (Fig. 3). The ceramic head showed metal transfer but no corrosion was encountered on the trunnion (Fig. 4). The femoral component was in appropriate anteversion and confirmed to be well fixed. The acetabular cup was operatively in approximately 45° of inclination and 30°-35° of anteversion. We did not appreciate any evidence of corrosion or fretting between the metallic liner and titanium shell. After removal of the liner, the cup was confirmed to be well fixed. The pseudotumor was dissected along the iliopsoas tendon sheath and excised. Approximately 200 mL of green and cream-colored fluid under pressure drained from this cystic structure. A DePuy highly cross-linked +4-mm lateralized polyethylene liner for a 52-mm cup with an inner diameter of 36 mm was inserted. The trunnion was cleaned and dried, and a Biolox delta ceramic head, size 36 mm +1.5 with a titanium sleeve was installed. The hip was reduced and was stable with a Ranawat angle of approximately 60°.

The postoperative course was uneventful. Intraoperative cultures were negative for infection. Pathology report described the specimen

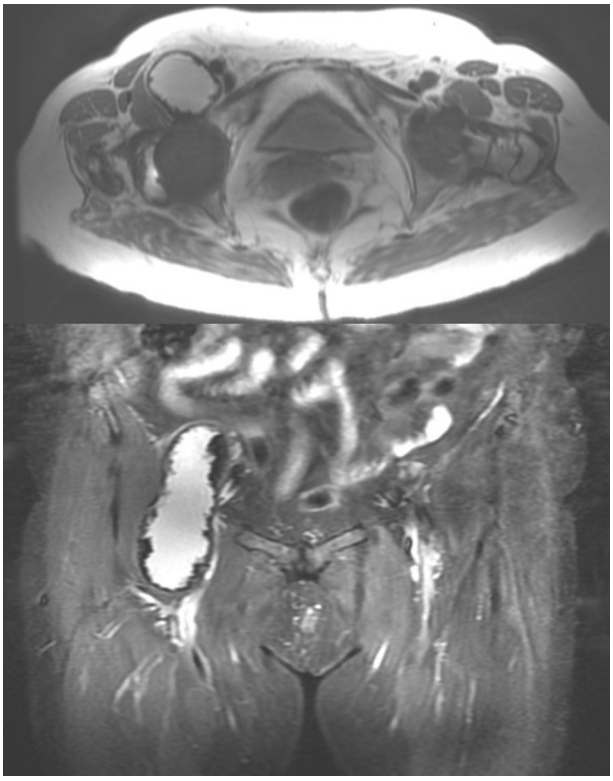

Figure 2. Axial (T1) and coronal (T2) metal suppression magnetic resonance images of patient now 7.5 years out from simultaneous bilateral CoM THA notable for unilateral (right) cystic lesion (T1 and T2 hyperintense, pseudocapsular disruption, tracking anteriorly/proximally).

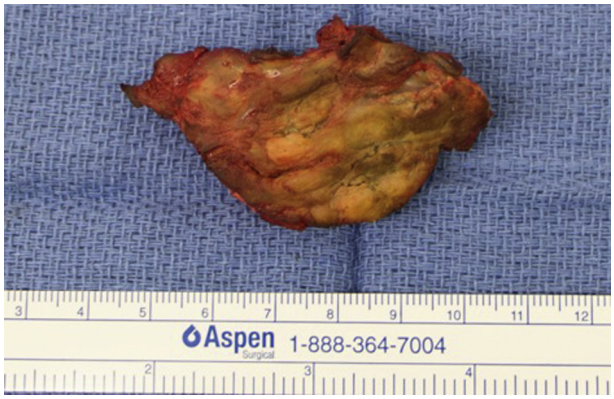

Figure 3. Intraoperative photograph of excised pseudocapsule and scar (taken surrounding area of femoral neck).

as sclerotic fibrous tissue with abundant fibrin, pigmented macrophages, and focal foreign body giant cell reaction. At 6 weeks postoperatively, the patient's pain was improved from her pre-revision level and radiograph was within normal limits (Fig. 5). At 3-month follow-up, she continued to do well but still reported lower back pain with intermittent radiation into her right groin. A computed tomography (CT) scan of the pelvis was obtained to better evaluate the radiologic position of the components in bilateral hips. The inclination angles of the right and left acetabular cups were 52° and 40°, respectively (Fig. 6), and the anteversion angles were 45° and 27°, respectively (Fig. 7). At 6 months postoperatively, she obtained another MRI of the pelvis which demonstrated a small residual right hip pseudotumor sheath with minimal fluid. The left hip effusion was slightly larger in size compared to her prior MRI but there was no sign of pseudotumor formation, muscle atrophy, or destruction (Fig. 8). At nearly one year after her right hip revision (June 2017), the serum cobalt and chromium levels had decreased to 2.0 and 5.9 ppb, respectively. At this most recent visit, the patient was notified of merits of present report and provided informed consent for participation.

Discussion

MoM and CoC bearings were reintroduced for THA because of the theoretical advantages of lower volumetric wear rates and larger femoral heads leading to increased range of motion and improved stability [13]. With over 1 million MoM THA implanted worldwide, this combination of bearing surfaces has been associated with significant complications [3,13,14]. Increased serum cobalt and chromium metal ions, ALTR, osteolysis, and failure rates 2 to 3 times that associated with metal-on-ultra-high-molecular-weight polyethylene have been well described [13,15]. In extreme cases, cobalt poisoning can result in neurologic injury, such as permanent hearing and vision loss, and even in death from cardiac cobalt toxicity [14,16]. The potential for increased local and systemic cobalt and chromium metal ions and ALTR exists whenever there is corrosion of a CoCr implant [16]. Sources include the head-neck junction (trunnionosis) with a CoCr head, modular necks, and backside wear of modular metal cup liners, including CoM [3,17-22].

CoM gained popularity when in vitro studies demonstrated decreased wear rates and decreased serum metal ion levels when compared to MoM [22]. However, presently there are several early to midterm in vivo studies demonstrating elevated serum cobalt and chromium levels when compared to normal values, albeit lower than MoM serum levels [23-25]. Hill et al. [24] found that 12.5% and 11.1% of the CoM THAs in their study had serum cobalt and chromium levels >2 ppb, respectively. Other studies failed to demonstrate a difference in metal ion levels between MoM and CoM. Engh et al. [26] found no statistically significant difference between the serum metal ion levels in MoM and CoM at 5 years, and no difference in revision rates at 4 years, although there was a trend toward increasing metal ions in the MoM group. Therefore, Engh et al. cautioned against the use of CoM as long-term data were unavailable. In their series of 278 CoM THAs (mean follow-up of 34 months), Hill et al. [24] reported 8% with >5 mm radiolucent lines in at least 1 Gruen zone and a 5-year revision rate of 3.8%.

In our case, the patient had simultaneous bilateral CoM THAs. There were potentially multiple sources of metal corrosion that could have contributed to the ALTR in the right hip. Although trunnionosis occurs with ceramic heads, this corrosion should not have caused an increase in cobalt and chromium serum levels given that the stem was titanium [20,27]. The corrosion products from a titanium stem are thought to be much less cytotoxic than cobalt and chromium ions and therefore less of a contributor to ALTR formation [28]. Other potential sources of cobalt and chromium ions were from backside corrosion of the metal acetabular liner and the ceramic on CoCr bearing surface itself [19,23-26,29]. Agne et al. [19] demonstrated that CoCr acetabular liners had quantifiable material loss from backside corrosion and this could be a potential

Figure 4. Intraoperative photographs of ceramic head with marked metal transfer on articulating surface and no significant corrosion/transfer noted in bore.

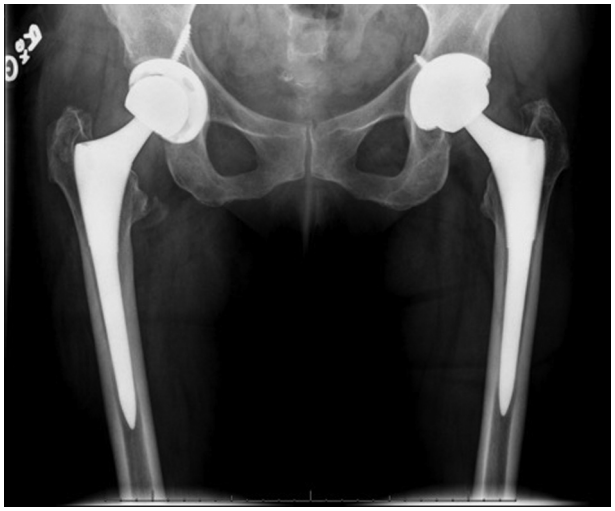

Figure 5. AP pelvis radiograph at 6 weeks s/p revision right THA with no obvious complication.

source of serum cobalt and chromium ions. Hothi et al. [29] also studied backside corrosion of CoCr acetabular liners. They compared the specific liner used in our patient (DePuy Pinnacle) with that of another manufacturer (Smith and Nephew R3; Smith & Nephew, Inc., Andover, MA) and found backside corrosion in both liners, although it was significantly less in the former liner. However, the liners studied in their article were loose, which potentially resulted in increased corrosion compared to a patient with a well-engaged liner as described in this case [29].

There is also data suggesting that both BMI and acetabular component position are associated with higher metal ion levels in MoM and CoM THA [4,23,28]. Inclination specifically has a strong correlation with increased metal ions, while excessive anteversion has a positive, but weaker correlation [4,30]. While our patient had a BMI of 26.2 kg/m^2, her cup inclination and anteversion were noted to be increased intraoperatively. CT measurement of the inclination angle of the right and left acetabular cups were 52° and 40°, respectively, while anteversion of the right and left acetabular cups were 45° and 27°, respectively. This asymmetry is significant given vertically inclined cup mechanics lead to edge loading while excessive anteversion may lead to impingement, subluxation, and/or dislocation [4,30]. Decreased tolerance for acetabular

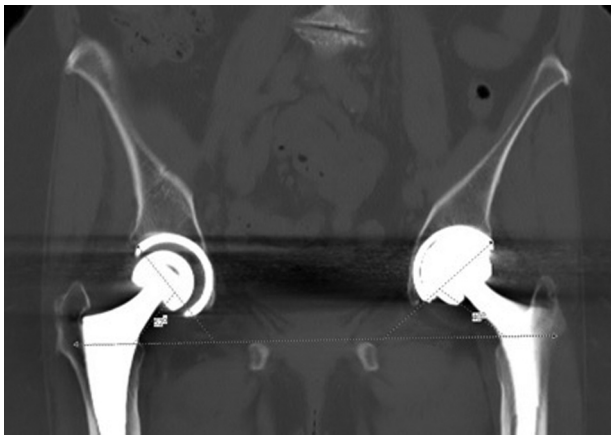

Figure 6. Coronal CT at 12 weeks s/p revision right THA, acetabular inclination 52° on right and 40° on left.

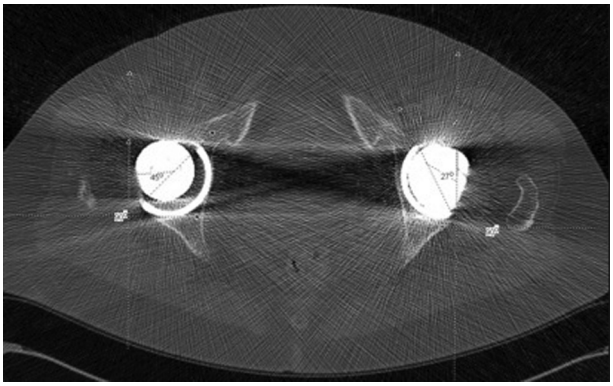

Figure 7. Axial CT at 12 weeks s/p revision right THA, acetabular anteversion 45° on right and 27° on left.

component malpositioning leading to failure with MoM has been previously described in the literature [30]. A right CoM acetabular component with increased inclination and anteversion most likely caused the elevated serum ion levels and ALTR in our patient.

Summary

A 69-year-old woman 7 years status post (s/p) simultaneous bilateral CoM THA presented with unilateral right hip symptoms, elevated serum cobalt and chromium ion levels, and ALTR. At

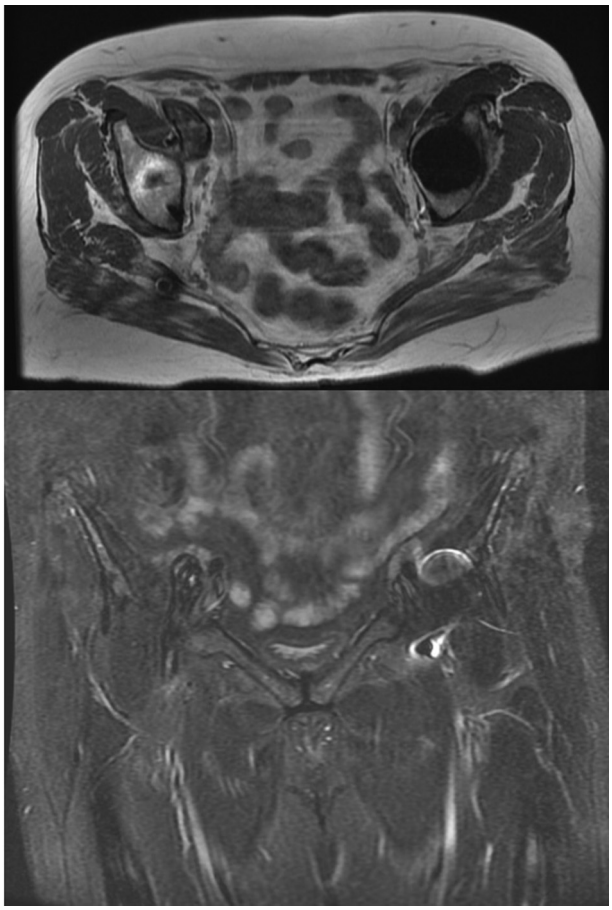

Figure 8. Axial (T1) and coronal (T2) metal suppression magnetic resonance images 6 months s/p revision right THA notable for small residual pseudotumor sheath with no fluid accumulation of the right and modestly enlarged left hip effusion.

revision surgery, there was metallosis and a large pseudotumor. All components were well fixed and she was converted to a CoXP bearing. Although there is an abundance of reports in the literature describing pain, elevated metal ion levels, and ALTR in MoM THA, there is little information regarding these findings in a well-fixed CoM THA [13,15]. The potential complications of increased metal ion levels, osteolysis, aseptic loosening, and ALTR in people with MoM and now CoM bearings warrant an understanding of the probable failure mechanisms. In this case, we hypothesize the patient developed an isolated ALTR on the right CoM THA secondary to increased inclination and anteversion angles of the acetabular cup, confirming the low tolerances for component malpositioning with hard-on-hard bearings. This patient ultimately did well after conversion to CoXP, as demonstrated by resolution of her symptoms, absence of pseudotumor on repeat advanced imaging, and significantly decreased serum ion levels 1 year after revision surgery.

References

[1] Rajaee SS, Theriault RV, Pevear ME, Smith EL. National trends in primary total hip arthroplasty in extremely young patients: a focus on bearing surface usage from 2009 to 2012. J Arthroplasty 2016;31(9 Suppl):63.

[2] Berry DJ, Harmsen WS, Cabanela ME, Morrey BF. Twenty-five-year survivorship of two thousand consecutive primary Charnley total hip replacements: factors affecting survivorship of acetabular and femoral components. J Bone Joint Surg Am 2002;84-A(2):17.

[3] Carli A, Reuven A, Zukor DJ, Antoniou J. Adverse soft-tissue reactions around non-metal-on-metal total hip arthroplasty - a systematic review of the literature. Bull NYU Hosp Jt Dis 2011;69(Suppl 1):S47.

[4] Liow MH, Kwon YM. Metal-on-metal total hip arthroplasty: risk factors for pseudotumours and clinical systematic evaluation. Int Orthop 2017;41(5):885.

[5] Willert HG, Buchhorn GH, Fayyazi A, et al. Metal-on-metal bearings and hypersensitivity in patients with artificial hip joints. A clinical and histomorphological study. J Bone Joint Surg Am 2005;87(1):28.

[6] Pandit H, Glyn-Jones S, McLardy-Smith P, et al. Pseudotumours associated with metal-on-metal hip resurfacings. J Bone Joint Surg Br 2008;90(7):847.

[7] Davis DL, Morrison JJ. Hip arthroplasty pseudotumors: pathogenesis, imaging, and clinical decision making. J Clin Imaging Sci 2016;6:17. eCollection 2016.

[8] Grammatopoulos G, Pandit H, Kwon YM, et al. Hip resurfacings revised for inflammatory pseudotumour have a poor outcome. J Bone Joint Surg Br 2009;91(8):1019.

[9] Hussenbocus S, Kosuge D, Solomon LB, Howie DW, Oskouei RH. Head-neck taper corrosion in hip arthroplasty. Biomed Res Int 2015;2015:758123.

[10] Cadossi M, Mazzotti A, Baldini N, Giannini S, Savarino L. New couplings, old problems: is there a role for ceramic-on-metal hip arthroplasty? J Biomed Mater Res B Appl Biomater 2016;104(1):204.

[11] Pulley BR, Trinh TQ, Bentley JC, Politi JR. Adverse reaction to metal debris in a patient with acetabular shell loosening 8 years after ceramic-on-metal total hip arthroplasty. Arthroplasty Today 2015;1(4):93.

[12] Valentí JR, Del Río J, Amillo S. Catastrophic wear in a metal-on-ceramic total hip arthroplasty. J Arthroplasty 2007;22(6):920.

[13] Bolognesi MP, Ledford CK. Metal-on-metal total hip arthroplasty: patient evaluation and treatment. J Am Acad Orthop Surg 2015;23(12):724.

[14] Steens W, von Foerster G, Katzer A. Severe cobalt poisoning with loss of sight after ceramic-metal pairing in a hip—a case report. Acta Orthop 2006;77(5):830.

[15] Lombardi Jr AV, Barrack RL, Berend KR, et al. The Hip Society: algorithmic approach to diagnosis and management of metal-on-metal arthroplasty. J Bone Joint Surg Br 2012;94(11 Suppl A):14.

[16] Martin JR, Spencer-Gardner L, Camp CL, Stulak JM, Sierra RJ. Cardiac cobaltism: a rare complication after bilateral metal-on-metal total hip arthroplasty. Arthroplasty Today 2015;1(4):99.

[17] Gibon E, Amanatullah DF, Loi F, et al. The biological response to orthopaedic implants for joint replacement: Part I: metals. J Biomed Mater Res B Appl Biomater 2017;105(7):2162.

[18] Cooper HJ. Diagnosis and treatment of adverse local tissue reactions at the head-neck junction. J Arthroplasty 2016;31(7):1381.

[19] Agne MT, Underwood RJ, Kocagoz SB, et al. Is there material loss at the backside taper in modular CoCr acetabular liners? Clin Orthop Relat Res 2015;473(1):275.

[20] Tan SC, Lau AC, Del Balso C, et al. Tribocorrosion: ceramic and oxidized zirconium vs cobalt-chromium heads in total hip arthroplasty. J Arthroplasty 2016;31(9):2064.

[21] Mistry JB, Chughtai M, Elmallah RK, et al. Trunnionosis in total hip arthroplasty: a review. J Orthop Traumatol 2016;17(1):1.

[22] Tan SC, Teeter MG, Del Balso C, Howard JL, Lanting BA. Effect of taper design on trunnionosis in metal on polyethylene total hip arthroplasty. J Arthroplasty 2015;30(7):1269.

[23] Zeng Y, Zheng B, Shen B, et al. A prospective study of ceramic-on-metal bearings in total hip arthroplasty at four-year follow-up: clinical results, metal ion levels, inflammatory factor levels, and liver-kidney function. J Orthop Sci 2015;20(2):357.

[24] Hill JC, Diamond OJ, O'Brien S, et al. Early surveillance of ceramic-on-metal total hip arthroplasty. Bone Joint J 2015;97-B(3):300.

[25] Yi Z, Bo Z, Bin S, et al. Clinical results and metal ion levels after ceramic-on-metal total hip arthroplasty: a mean 50-month prospective single-center study. J Arthroplasty 2016;31(2):438.

[26] Engh Jr CA, Sritulanondha S, Korczak A, et al. No difference in reoperations at 2 years between ceramic-on-metal and metal-on-metal THA: a randomized trial. Clin Orthop Relat Res 2016;474(2):447.

[27] Kurtz SM, Kocagöz SB, Hanzlik JA, et al. Do ceramic femoral heads reduce taper fretting corrosion in hip arthroplasty? A retrieval study. Clin Orthop Relat Res 2013;471(10):3270.

[28] Kocagoz SB, Underwood RJ, MacDonald DW, Gilbert JL, Kurtz SM. Ceramic heads decrease metal release caused by head-taper fretting and corrosion. Clin Orthop Relat Res 2016;474(4):985.

[29] Hothi HS, Ilo K, Whittaker RK, et al. Corrosion of metal modular cup liners. J Arthroplasty 2015;30(9):1652.

[30] Hart AJ, Ilo K, Underwood R, et al. The relationship between the angle of version and rate of wear of retrieved metal-on-metal resurfacings: a prospective, CT-based study. J Bone Joint Surg Br 2011;93(3):315.