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Case report

Mechanically assisted crevice corrosion of the head-neck taper in a large head metal-on-metal total hip arthroplasty

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ABSTRACT

Taper corrosion of the head-neck junction is a potentially significant and devastating problem facing orthopedic surgeons. We present a case of a 53 year old male who presented for routine follow up for a left, large head, metal on metal total hip arthroplasty five years out. The patient was asymptomatic at the visit. X-rays at the time demonstrated a large amount of medial calcar osteolysis. Serum ion levels revealed a mildly increased cobalt and normal chromium level and hip aspiration revealed brownish fluid. At the time of revision surgery, corrosion of the head-neck taper was found with a normal appearing bearing surface leading to the diagnosis of mechanically assisted crevice corrosion of the head-neck taper with medial calcar osteolysis.

Introduction

Corrosion of the head-neck taper is a potentially significant problem facing orthopedic surgeons. Metal debris from the bearing surface of metal-on-metal (MoM) total hip arthroplasties has been well described [1], however the problem of metal debris generated from the head-neck taper has recently been reexamined [2,3]. The clinical presentation of trunnion fretting and corrosion appears different than bearing wear metallosis and laboratory as well as clinical findings have not shown a consistent pattern in its diagnosis [4,5].

There is also a concern in particular with the head-neck taper of large head implants which are more commonly used with MoM hips. These larger heads have led to the promise of increasing range of motion, decreasing the dislocation rate, and potentially lowering metal ion and corrosion debris due to less linear wear [6,7]. Larger heads in some studies, however, have been shown to increase the risk of trunnionosis due to increased stress and torque on the head-neck taper [8,9]. Large heads may enhance the effect of mechanically assisted crevice corrosion (MACC) between dissimilar metals causing adverse local tissue reactions (ALTR) and potentially aseptic lymphocyte-dominated vasculitis associated lesion (ALVAL).

We present the following case to show an example of the clinical, radiological, and laboratory findings of mechanically assisted crevice corrosion of the head-neck taper in a large head, MoM total hip arthroplasty. IRB approval was obtained for this case report.

Case history

A 53 year old African American male (BMI 30, UCLA activity level 6) presented to the clinic with end stage osteoarthritis of the left hip (Fig. 1). He underwent an uncomplicated left total hip arthroplasty in November of 2009 using primary, cementless components with a MoM articular bearing surface (Summit [DePuy, Warsaw, IN] titanium alloy stem size 8 high offset with a 12/14 taper, a Pinnacle modular 62 mm cup with a neutral cobalt chrome liner, 44 mm cobalt-chrome head, +1.5 neck length). He had an uneventful inpatient post operative course and was discharged home on post operative day 2. The patient was seen at 2 weeks, 6 weeks, and one year without complications. X-rays were taken at each visit showing no change from post-operative x-rays (Fig. 2). The patient was instructed to followup yearly; however he did not show until his 3 year anniversary in December of 2012. He was without complication and x-rays were benign (Fig. 3).

He was once again lost to followup until his 5 year anniversary October 2014 at which he denied any pain or instability of his left

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Figure 1. Pre-surgical anteroposterior pelvis radiograph showing arthritic left hip.

Figure 3. 3 year post-operative anteroposterior radiograph.

hip. X-rays at this visit did show extensive medial calcar erosion and what appeared to be soft tissue swelling around the prosthesis (Fig. 4). Diagnostic workup included a MARS MRI of the left hip which showed a large joint effusion with particulate debris, however no soft tissue mass was seen. The abductor complex appeared intact. Plasma Ion levels were collected showing a cobalt level of 2.0 ppb (normal 0.1–0.4 ppb) and a chromium level of 0.1 ppb (normal 0–1.4 ppb). Aspiration of the left hip was performed by a musculoskeletal radiologist, who was able to aspirate approximately 85 cc of brownish-black fluid (Fig. 5). Aerobic and anaerobic cultures of the hip aspirate were negative. Given the patients x-ray, elevated serum cobalt level, and abnormal MRI, the decision was made to proceed with a revision of his left total hip arthroplasty due to increased calcar osteolysis with a MoM bearing surface.

At the time of the revision surgery, a large amount of brownish-black fluid and inflamed synovium was encountered within the capsule. There was a moderate to large soft-tissue mass and some surrounding tissue damage noted around the implant. The pseudocapsule was hypertrophic, somewhat blackened, and avascular appearing. Pathology specimens showed areas of tissue necrosis consistent with ALTR. No frozen sections were obtained. The head-neck taper showed discoloration consistent with fretting and/or corrosion over both the male and female taper ends (Fig. 6). In evaluation of the metal liner and head, there did not appear to be any scratches or imperfections in the articulation. On examining the front and back side of the liner there were no areas of discoloration consistent with corrosion. The medial calcar did show significant osteolysis as seen on x-ray, however there was a large amount of circumferential bony ingrowth and minimal osteolysis around the remainder of the stem. The abductor mechanism was found to be completely intact with no gross soft tissue destruction or necrosis. Cultures were taken which were found to be negative. At this time the decision was made to clean the taper, replace the liner with a high molecular weight polyethylene liner (Pinnacle Altrex size 62 mm with 44 mm inner diameter [DePuy, Warsaw, IN]), and exchange the head with a ceramic head with a titanium sleeve (Biolox Delta TS size 44 mm with +5 neck [Depuy, Warsaw, IN]).

After surgery, the patient was then admitted to the post-operative orthopedic floor and was discharged on post-operative

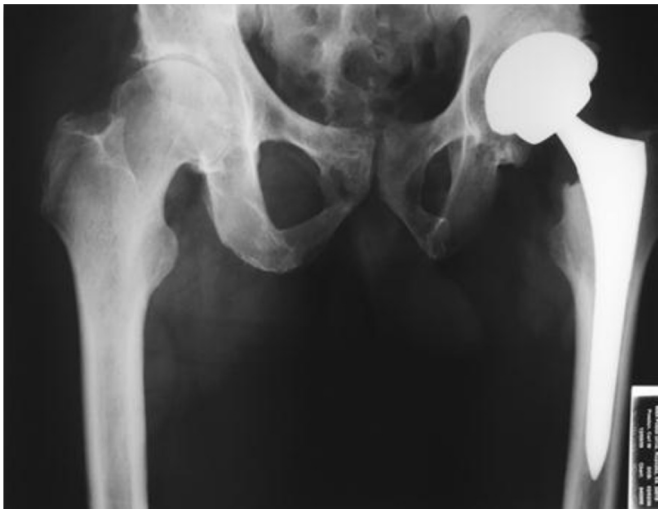

Figure 2. 2 week post-operative anteroposterior radiograph showing left MoM THA.

Figure 4. 5 year post-operative anteroposterior radiograph showing extensive osteolysis of the medial calcar.

Figure 5. Photograph showing brown-tinged aspirate from the left hip.

day one to home. He was seen in the clinic at two and six weeks post-surgery with no complications. At the time of this case report the patient was approximately three months from surgery. He is ambulating unlimited distances without an assistive device or a limp, minimal pain on his operative side with activities, and has no difficulty with stairs.

Discussion

Adverse local tissue reactions associated with reaction to metal ions, corrosion products, and particulate debris is a growing concern for orthopedic surgeons [2,3,5]. There is increased concern that metal debris is not only generated from the bearing surface articulation, but that debris and corrosion products are also produced from implant tapers. Research has pointed to looking at cobalt to chromium ratio in diagnosis of taper corrosion, particularly in neck-body tapers in modular stems. Clinical data has shown wear debris from the articulating bearing surface may be tolerated at higher Co and Cr levels with the levels being closer to a 1:1 ratio. The pseudotumors also seem to be more clinically asymptomatic [10]. This, however, is in contrast to corrosion and wear debris from MACC which is usually associated with more subtle and variable osteolysis, more often presents with avascular thickening of the pseudocapsule, and presents with a Co:Cr ratio of around 4–6:1 [2,4]. These ions may lead to local soft tissue destruction and osteolysis [3,10]. Our patient was not seen for two years in the clinic setting and when he returned, it was to be evaluated for right hip pain, completely asymptomatic on the left side. This case highlights the need for close follow up and serial x-rays on patients with this type of implant.

Surgeons routinely use larger femoral heads during hip arthroplasty as this allows for greater range of motion and increased stability, however there is concern that these large femoral heads may contribute to MACC [9]. MoM articulation allows for larger femoral heads in more situations due to the smaller thickness needed for the liner [7]. Studies have shown, however, that increasing the size of the femoral head leads to higher stresses at the head-neck taper, causing increased torque and motion [5]. It is believed that this increased torque placed on the taper leads to a higher incidence of corrosion [9]. Our patient had a 44 mm MoM femoral head which may have contributed to the increase in corrosion and particulate debris generated. Given that MoM hips allow for larger femoral heads compared to a standard metal on polyethylene articulation, this issue becomes more of a concern for this type of implant [7,11].

Corrosion may also be accelerated due to the metal alloys used in the taper at the head neck junction. Dissimilar alloy metals may lead to galvanic corrosion due electrical coupling in the in-vivo environment [12,13]. In our report, the stem and neck used was a titanium alloy and the femoral head was cobalt-chrome, possibly allowing this type of corrosion to accelerate the generation of metal debris.

There is growing information presently in the literature regarding the definitive diagnosis of taper corrosion. While metallosis from MoM bearing surface wear has been documented in the literature recently, taper corrosion is only recently being examined [2,3,10]. One theory is that due to galvanic corrosion of the dissimilar metals, chromium is precipitated out as a chromium orthophosphate, leaving the more soluble cobalt present in the serum [14]. These low and inconsistent numbers, however, leads to difficulty in setting up guidelines for diagnosing taper corrosion based off of laboratory studies alone. Medial calcar and trochanteric erosion has also been suggested as an association with MACC as it is believed to be related to a more direct route from the source of the debris [3,15]. Concentrated levels of cobalt, chromium, and titanium ions around the medial calcar and trochanter inhibit osteoblasts and attract osteoclasts leading to osteolysis [10,16]. These areas of osteolysis may be underestimated with plain radiographs as well [3]. Our patient presented with calcar erosion as well as minimally elevated ion levels, including a higher cobalt level.

Summary

In summary we present a case of taper corrosion and osteolysis in an asymptomatic patient with a large head MoM total hip

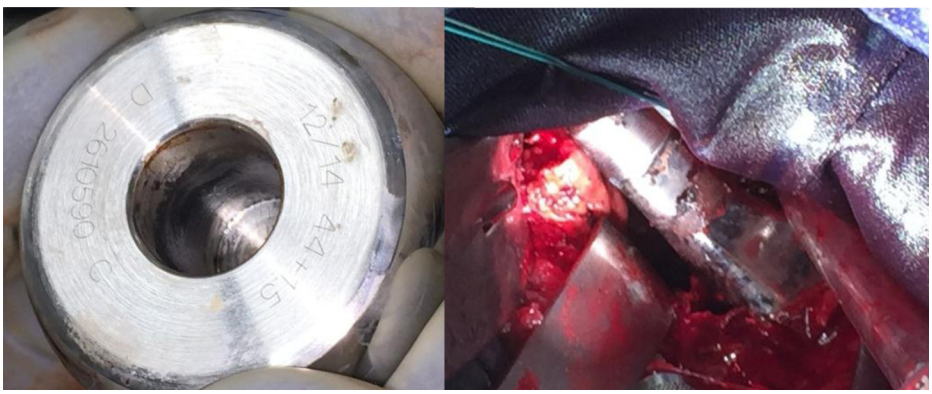

Figure 6. Photographs showing discoloration consistent with fretting and/ or corrosion of the female and male head-neck taper.

arthroplasty. This case raises the question of the source of toxic metallic debris in modular MoM hip replacements. It appears that at least a portion of the modular by-products are from mechanically assisted crevice corrosion at the head–neck junction of the femoral component. This highlights the need for further research on this subject.

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