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Diagnosis and Management of Adverse Local Tissue Reactions Secondary to Corrosion at the Head-Neck Junction in Patients With Metal on Polyethylene Bearings

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ABSTRACT

We reviewed 27 patients who underwent revision for an adverse local tissue reaction (ALTR) secondary to corrosion at the head-neck junction with MoP bearings. Serum cobalt and chromium levels were elevated in all cases, with a mean cobalt of 11.2 ppb and chromium of 2.2 ppb. Patients underwent modular bearing exchange, including a ceramic head with a titanium sleeve in 23 of 27 cases with only one recurrence of ALTR in one of the four patients not treated with a ceramic head. The diagnosis of ALTR secondary to corrosion is associated with cobalt levels of >1 ppb with cobalt levels elevated above chromium. Retention of a well-fixed stem and modular exchange to a ceramic head leads to resolution of symptoms and decreases in metal levels.

Modular components offer numerous advantages to surgeons, including greater intraoperative flexibility, decreased implant inventory, and the ability to remove the femoral head at the time of revision surgery allowing for improved exposure or isolated exchange of the bearing surface [1–4]. With the advent of modularity in total hip arthroplasty (THA) during the early 1980s and its use over the past two decades, modularity at the head neck junction has become standard for almost all hip implants. However, recent reports of complications related to this modular junction have renewed concerns over the potential for fretting and crevice corrosion at the modular head-neck junction [5–10].

Corrosion and the subsequent metal debris released may potentially lead to adverse local tissue reactions (ALTR) requiring revision surgery. ALTR can range from mild metal staining of surrounding tissues, to fluid collections, soft tissue destruction and the formation of "psuedotumors". Periprosthetic osteolysis and necrosis of the surrounding soft-tissue and bone have also been described [3,5,6,9]. Although historically corrosion arising from the head-neck junction has been identified largely through retrieval analysis [1,11–14] or case reports [15–17], the ultimate biologic consequences and definitive treatment options remain poorly understood. While there have been sporadic reports and a few smaller cohort studies reporting on head-neck taper corrosion associated with elevated metal levels or particulate disposition with ALTR [7,9,10], the diagnosis and outcomes of treatment of symptomatic ALTRs secondary to corrosion products have not been described in a larger cohort of patients. The purpose of the present report is to describe our experience with the diagnosis and treatment of patients with a metal-on-polyethylene (MOP) bearing, who presented with symptomatic ALTRs secondary to corrosion at the modular head-neck junction.

Materials and Methods

Twenty-seven patients who underwent revision THA for an ALTR resulting from corrosion at the modular femoral head-neck taper junction and had an MOP bearing were reviewed. All revisions were performed at our institution by one of four surgeons between January 2009, and December 2013. The study group consisted of eight men (30%) and 19 women (70%) with a mean age of 63.4 years old (range, 41–75 years old) and average body mass index (BMI) of 29.2 kg/m^2 (range, 19.7–40.4 kg/m^2). Approval was obtained from our institutional review board prior to initiation of this study.

Twenty-five of the primary arthroplasty procedures were performed at our institution and two at outside hospitals. The surgical approach of the index THA included a posterior approach in twenty-two cases and an anterolateral approach in five cases. The bearing surface was highly cross-linked polyethylene articulating with a metal femoral head in all patients. All of the acetabular components were modular, cementless

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Table 1
Primary THA Components.

Case	Femoral Component	Femoral Head Size	Taper Neck Length	Acetabulum Component
1	Zimmer Versys Beaded FullCoat	32	+3.5	Zimmer Trilogy
2	Zimmer Versys Beaded FullCoat	28	+10.5	Zimmer Trilogy
3	Zimmer Versys Beaded FullCoat	36	+7	Zimmer Trilogy
4	Zimmer Versys Beaded FullCoat	28	+10.5	Zimmer Trilogy
5	Zimmer Versys Beaded FullCoat LHC	32	+3.5	Zimmer Trilogy
6	Zimmer Versys Beaded FullCoat Revision	32	+10.5	Zimmer Trilogy
7	Zimmer Versys FiberMetal Taper	32	−3.5	Zimmer Trilogy
8	Zimmer M/L Taper, Kinectiv Modular Neck	32	0	Zimmer Trilogy
9	DePuy Bantam AML Full Porocoat	28	+5	Zimmer Trilogy
10	Stryker Accolade	36	+0	Stryker Trident PSL
11	Zimmer Versys Beaded FullCoat LHC	40	+7	Zimmer Trilogy
12	Zimmer Epoch FullCoat	36	0	Zimmer Trilogy
13	Zimmer Versys Beaded FullCoat LM	32	0	Zimmer Trilogy
14	Zimmer Versys Beaded FullCoat	28	+3.5	Zimmer TM Modular
15	Zimmer Versys Beaded FullCoat LHC	32	+7	Zimmer Trilogy
16	Emperion Stem Full coat	32	0	S&N MR3
17	Zimmer Versys Beaded FullCoat LM	40	0	Zimmer Trabecular metal
18	Zimmer Versys Beaded FullCoat LHC	36	+3.5	Zimmer Trilogy
19	Zimmer Versys Beaded FullCoat	36	7	Zimmer Trilogy
20	Depuy Prodigy AML	32	13	Duraloc Marathon
21	Zimmer Versys Beaded FullCoat	32	0	Zimmer Trilogy
22	Zimmer Versys Beaded FullCoat LHC	32	3.5	Zimmer Trilogy
23	Depuy Tri-Lock	32	13	DePuy Pinnacle
24	Zimmer Versys Beaded FullCoat LHC	32	3	Zimmer Trilogy
25	Zimmer Bias Porous Coated stem	32	0	Zimmer HG2
26	Stryker Accolade	32	8	Stryker Tritanium
27	Zimmer Versys Beaded FullCoat	32	0	Zimmer Trilogy

titanium cups except for one that had trabecular metal coating (Table 1). Nineteen of the 27 stems (70%) were cobalt chrome alloy fully porous coated stems and the remaining eight were titanium alloy stems including one dual modular neck stem (Kinectiv, Zimmer, Warsaw, IN) and one with a modular metaphyseal sleeve (Emperion, Smith & Nephew, Memphis, TN). There were four 28 mm femoral heads (14%), sixteen 32 mm heads (59%), five 36 mm heads (19%) and two 40 mm heads (7%). Ten of the constructs (37%) used a femoral head length of 7 mm or greater.

An erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), were obtained preoperatively in 22 of the 27 patients. Preoperative fluoroscopy guided hip aspiration was performed preoperatively in 21 of the 27 hips. Frozen sections and intraoperative cultures were obtained in all hips at the time of revision. Plain radiographs were obtained in all hips preoperatively and magnetic resonance imaging (MRI) scans were performed in twelve and computed tomography (CT) scans in two patients. Utilizing analytical methodology previously described [18], serum metal levels were obtained preoperatively at a specialized trace-metal-analysis laboratory for 26 of the 27 patients.

Revision arthroplasty was performed at a mean of 5.3 years after primary surgery (range, 0.5–26 years). After the modular head was uncoupled, the taper was examined and noted to have gross evidence of corrosion in all cases (Fig. 1). It was then manually cleaned to remove gross debris and visually inspected to ensure that the physical integrity of the taper was intact. In 23 of the 27 patients, a BIOLOX delta ceramic femoral head (CeramTec, Plochingen, Germany) with a titanium-alloy adapter sleeve (CeramTec) was utilized including six 28-mm, five 32-mm, nine 36-mm, and three 40-mm heads (Fig. 2). The remaining four patients received metal femoral heads at the time of revision; two 28-mm, one 36-mm, and one 40-mm. Two patients had a new metal head placed early in our experience and in two cases a ceramic head with an option taper was not available for the well-fixed stem that was in place. A constrained liner was utilized in eleven patients, secondary to severe damage of the abductor musculature. The femoral component was retained in all patients and the acetabular component was concomitantly revised in two patients. Postoperatively, patients were evaluated clinically using the Harris hip score [19] and were monitored for any complications including recurrence of ALTR.

Statistical Analysis

Mean blood serum levels of cobalt and chromium prior to and after revision surgery were calculated. Nonparametric tests were used on the basis of the results of a Shapiro–Wilk test. A Wilcoxon signed-rank test was used to compare the degree of elevation between preoperative cobalt and chromium levels. Both variables were tested for normality and due to the skewed nature of the data, a log transformation was applied after which the data were not grossly non-normal (Kolmogorov–Smirnov test for normality). This test was also applied to the longitudinal comparison of Harris hip scores and serum metal levels, assuming a two-tailed *P*-value of 0.05 was significant.

Results

Patients initially presented with new onset pain at a mean of 4.3 years (range 0.4–25.1 years) after their index surgery. On physical exam the patient's presenting symptoms were mixed, including groin and thigh pain (four patients), lateral hip pain (four patients), generalized hip pain and weakness (four patients), buttock pain (three patients),

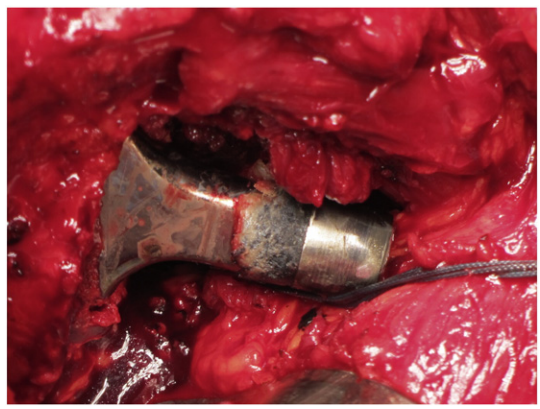

Fig. 1. Gross corrosion as seen at the modular taper visualized as black scaly material.