The Journal of Arthroplasty 30 (2015) 1265–1268

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

A High Prevalence of Corrosion at the Head–Neck Taper with Contemporary Zimmer Non-Cemented Femoral Hip Components

Brian J. McGrory, MD [a,b,c], Johanna MacKenzie, BA [c], George Babikian, MD [a,b,c]

[a] Tufts University School of Medicine, Boston, Massachusetts
[b] Maine Joint Replacement Institute, Portland, Maine
[c] Maine Medical Center Division of Joint Replacements, Falmouth, Maine

ARTICLE INFO

Article history:
Received 22 December 2014
Accepted 12 February 2015

Keywords:
metal-on-polymer
adverse local tissue reaction
THA
hip
failure

ABSTRACT

Mechanically assisted crevice corrosion (MACC) occurs at metal/metal modular junctions in which at least one of the components is fabricated from cobalt–chromium alloy and may lead to adverse local tissue reaction (ALTR) in patients with metal-on-polyethylene (MoP) total hip arthroplasty. This type of reaction has been previously described in hips with head/neck modularity, but the prevalence is unknown. We found a prevalence of 1.1 percent in a consecutive series of 1356 contemporary Zimmer non-cemented femoral hip components followed for a minimum of 2 years. The average time to presentation was 3.7 years (range, 9–105 months); delay in treatment led to irreversible soft tissue damage in three patients. We recommend usage of ceramic heads until this problem is further understood.

Serious adverse local tissue reactions (ALTR) have become associated with metal-on-metal (MoM) joint failures, modular femoral neck components and more recently, tribocorrosion at the taper interface of metal-on-polyethylene (MoP) total hip arthroplasties [1,2]. These reactions encompass the spectrum of pathologies from local tissue metallosis through to bone and soft tissue necrosis with pseudotumor and aseptic lymphocytic vasculitis-associated lesions (ALVAL). They are caused by a combination of solid and soluble wear debris, as well as corrosion products from mechanically assisted crevice corrosion (MACC).

We present here a consecutive series of contemporary Zimmer (Zimmer, Inc., Warsaw, IN) non-cemented femoral hip components followed for a minimum of 2 years, with analysis of all failures specifically for MACC. This is the first report, to our knowledge, that describes the prevalence of MACC in contemporary MoP hip arthroplasty.

Methods

A complete database for a single surgeon using Zimmer (Zimmer, Inc., Warsaw, IN) non-cemented femoral hip components was used to analyze the prevalence of failures for MACC. All post-operative patients were followed at 1 year, 2 years, 5 years, and 5 year intervals thereafter, unless symptoms arose. This study was approved by our institutional review board.

Inclusion was made only for non-septic failures due to increasing or new pain, stiffness, and/or limping and also had serum cobalt (Co) level of 1.6 ng/mL or greater. Although there is no agreed cut-off for Co serum ion level known to be pathological, we used a Co of 1.6 ng/mL, based on the lowest inclusion level in the description of this phenomenon in a cohort of patients after contemporary THA [1]. This is reasonable based on long-term data on well-functioning hip arthroplasties, where Co levels are less than 0.8 ng/mL at up to ten years post-operatively [3].

Each patient who has undergone revision surgery (12 of 15 diagnosed as of manuscript submission) had visible corrosion at the head neck junction [4] with soft tissue pathology of varying degrees [5]. The phenomenon was not understood for the first patient who presented with ALTR (patient 2), so metal ion levels were not obtained in his case. However, in that patient, retrospective review of the hip aspiration, computerized tomography (CT) scan, and tissue biopsy was consistent with ALTR; therefore he was included in this series.

Radiographic imaging (anteroposterior and lateral views) was performed on all patients and Metal Artifact Reduction Sequence (MARS) Magnetic Resonance Imaging (MRI) was performed on all but two patients. Radiographs were used to assess osteolysis [6]. Patient 2 had a CT scan, as MARS MRI was not available at our institution in 2009.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2015.02.019.

Investigation performed at the Division of Joint Replacements, Maine Medical Center, Portland, Maine.

Reprint requests: Brian J. McGrory, MD, Maine Medical Center Division of Joint Replacements, 5 Bucknam Road, Suite 1D, Falmouth, ME 04105.

E-mail address: mcgrob1@mmc.org (B.J. McGrory).

http://dx.doi.org/10.1016/j.arth.2015.02.019
0883-5403/

Table 1
Prevalence of Failure of Zimmer (Zimmer, Inc., Warsaw IN, USA) Primary Non-Cemented Total Hip Arthroplasties With Metal-on-Polymer Bearing Surface for Mechanically Assisted Crevice Corrosion (MACC) Over a 10 Year Period.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
M/LT	0/0	0/0	0/0	0/4	0/97	1/98	5/150	3/176	1/116	1/118	11/759 (1.5%)
FMT	0/0	0/0	0/7	1/72	0/32	0/8	0/9	0/7	0/24	0/3	1/162 (0.6%)
FMM	0/63	1/133	0/130	1/50	0/6	0/4	0/0	0/2	0/1	0/0	2/389 (0.5%)
TM	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/9	1/9 (11.1%)
EPOCH	0/1	0/1	0/2	0/2	0/7	0/9	0/3	0/1	0/6	0/5	0/37 (0.0%)
	0/64	1/134	0/139	2/128	0/142	1/119	5/162	3/186	1/147	2/135	15/1356 (1.1%)

Stem types: M/LT = M/L Taper; FMT = VerSys Fiber Metal Taper; FMM = VerSys Fiber Metal Midcoat; FMT = VerSys Fiber Metal Taper; FMM = VerSys Fiber Metal Midcoat; TM = Trabecular Metal Primary Hip Prosthesis; EPOCH = VerSys Epoch FullCoat Hip.

Patient 13 could not tolerate an MRI because of pain. Serum Co, serum chromium (Cr), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and complete blood count (CBC) were obtained for all patients (except patient 2). If ESR, CRP, or WBC was abnormal, hip aspiration with analysis of cell count and differential, as well as aerobic and anaerobic cultures were obtained. All bacterial cultures were negative—both at the time of aspiration (if performed) and at the time of revision surgery (if revised). Pathology specimens were obtained in all surgical patients.

At revision surgery, soft tissue damage was graded based on Nawabi et al [5] by the first author (B.J.M.) using a four-point system (zero to three), with grade 3 damage most serious. Composite fretting and corrosion damage at the modular Co alloy head and metal stem interfaces were characterized using a previously published four-point scoring technique [4], with a score of four for severe corrosion attack and abundant corrosion debris.

Prevalence is reported in percent, and data were summarized with mean and standard deviation, where applicable.

Results

The prevalence of MACC (defined as a serum Co if 1.6 ng/mL and new-onset, otherwise unexplained hip pain, stiffness, and/or limping) for contemporary Zimmer (Zimmer, Inc., Warsaw, IN) stems with a 12/14 taper is 1.1 percent, and that of the M/LTaper style stem (Zimmer, Inc., Warsaw, IN) is 1.5 percent, at a minimum of 2 year follow-up (Table 1).

A description of demographic and initial surgical data is presented in Table 2 and perioperative and x-ray data are presented in Table 3 in 15 patients with MACC diagnosis. Of note, time to presentation was 3.7 years (range 9–105 months), and presentation time to revision surgery was 1.6 months (range 4–43 months) in patients who have undergone revision. X-ray findings of osteolysis were variable and subtle with nine of fifteen patients demonstrating some lytic lesion. Lesions included "punched out" defects (2/11), leading edge lucencies (7/11), and retroacetabular lucencies (2/11). Two patient had a femoral lesion only, 5 patients had an acetabular lesion only, and 2 patients had both. The soft tissue damage was most severe (Grade 3 [5]) in the three patients with the longest time to treatment after presentation (37, 43, and 34 months).

Discussion

Corrosion at the head/neck junction of total hip arthroplasties was described decades ago [7], as was a case of ALTR associated with use of a modular MoP cobalt–chromium–molybdenum prosthesis [8]. Until recently [9], soft-tissue reactions have been reported only sporadically, and are thought to occur when ionic and molecular products are produced when mechanically assisted crevice corrosion (MACC) occurs at metal/metal modular junctions in which at least one of the components is fabricated from cobalt–chromium alloy [2]. A recent systematic literature review concluded that "a noticeable increase in ALTR as a reason for revision surgery did not start until 2010" [9] but the prevalence is unknown [10]. We found a corrosion prevalence of 1.1 percent in a consecutive series of contemporary Zimmer (Zimmer, Inc., Warsaw, IN) non-cemented femoral hip components followed for a minimum of 2 years. We can only confirm ALTR in those patients who have undergone revision surgery (twelve of fifteen). Of the remaining three

Table 2
Demographic and Initial Surgical Data.

Patient	Age at Surgery (yr)	Sex	Body Mass Index (kg/m^2)	Year of Surgery	Side	Approach	Stem	Stem Size	Stem Offset	Neck/ Body	Head Size (mm)	Neck Length	Acetabulum Liner	THA to Onset (Months)/ Symptom Onset to Revision Surgery (Months)
1	60	M	26.5	2004	L	Posterior	FMM	16	Extended	Standard	32	+3.5	60 mm Trilogy/neutral	105/4
2	73	M	23.5	2006	R	Posterior	FMT	14	Extended	Standard/ LM	32	0	58 mm Trilogy/neutral	24/37
3	66	F	31.1	2006	L	Posterior	FMM	12	Extended	Standard/ LM	32	0	52 mm Trilogy/neutral	52/43
4	54	M	34.2	2008	R	Posterior	M/LT	13.5	Standard	Standard	32	0	58 mm Trilogy/neutral	59/5
5	46	M	30.4	2009	R	Posterior	M/LT	11	Standard	Standard	36	0	58 mm Trilogy/neutral	64/6
6	56	F	24.4	2009	R	Posterior	M/LT	12.5	Standard	Standard	32	0	56 mm Trilogy/neutral	69/NA
7	71	M	28.1	2009	R	Posterior	M/LT	13.5	Extended	Standard	36	−3.5	58 mm Trilogy/neutral	61/8
8	54	F	26.6	2009	R	Posterior	M/LT	12.5	Standard	Standard	32	−3.5	52 mm Trilogy/neutral	38/NA
9	63	M	21.2	2009	R	Posterior	M/LT	12.5	Extended	Standard	32	−3.5	56 mm Trilogy/neutral	36/24
10	54	M	39.6	2010	L	Posterior	M/LT	15	Extended	Standard	36	0	60 mm Trilogy/neutral	52/NA
11	61	M	30.4	2010	L	Posterior	M/LT	12.5	Standard	Standard	32	0	60 mm Trilogy/neutral	53/3
12	73	M	30.4	2010	R	Anterolateral	M/LT	12.5	Extended	Standard	32	0	58 mm Trilogy/neutral	17/34
13	70	F	25.3	2011	L	Anterolateral	M/LT	7.5	Standard	Reduced	32	+3.5	52 mm Trilogy/neutral	14/8
14	70	F	32.1	2012	L	Posterior	TM	14	Standard	Standard	32	0	56 mm Trilogy/10 degree	9/11
15	65	M	22.2	2012	L	Anterolateral	M/LT	17.5	Extended	Standard	36	0	60 mm Trilogy/neutral	14/9

All tapers were 12/14; all countersurfaces were longevity highly crosslinked HMWP; P, pending; NA, not applicable; LM, large metaphyseal.
Stem types: M/LT = M/L Taper; FMT = VerSys Fiber Metal Taper; FMM = VerSys Fiber Metal Midcoat; FMT = VerSys Fiber Metal Taper; FMM = VerSys Fiber Metal Midcoat; TM = Trabecular Metal Primary Hip Prosthesis; EPOCH = VerSys Epoch FullCoat Hip.