Post-implantation Evaluation and Damage Characterization of Retrieved Dynamic Antibiotic Cement Spacers

+[1]Jaekel, D J; [2]Klein, GR; [1,3]Day J, M; [2]Levine, HB; [1]Shah P, [1]Cohen A, [1]Patel H, [1,3]Kurtz, S M
+[1]Drexel University, Philadelphia, PA; [2]Hackensack University Medical Center, Hackensack, NJ; [3]Exponent, Inc., Philadelphia, PA

Introduction: Periprosthetic infection is a leading reason for revision of total joint replacement [1]. A commonly accepted treatment is a two-stage revision during which a dynamic antibiotic-loaded bone cement (ABC) spacer is temporarily implanted into the joint. A dynamic ABC spacer is fashioned with articulating surfaces that replicate the geometry of a total joint replacement to facilitate patient mobility during recovery. These spacers minimize the chance of bacterial adherence, and allow knee motion and partial weight bearing for short-term implantation. However, the clinical performance of these bone cement arthroplasties remains poorly understood. The purpose of this study was to characterize the surface damage, homogeneity, and clinical performance of dynamic bone cement spacers used in the treatment of knee infection.

Methods and Materials: Starting in October 2007, we expanded our established implant retrieval program to include bone cement spacers removed at revision surgery. Five patients subsequently consented to donate their dynamic ABC spacers to the IRB-approved retrieval program. Four sets of spacers were prepared (GK and HL) using StageOne Spacer Knee molds (Biomet, Inc) with either Palacos™ (Zimmer, Inc) or Cobalt™ (Biomet, Inc.) bone cement, and a variety of antibiotic doses (Table 1). One of the spacers (UP34) was premolded (Interspace, Exactech, Inc.) and cemented with Cemex™ (Exactech, Inc). The five sets of spacers were implanted for, on average, 3.6 months (range: 3.1 to 4.6 months, Table 1). Upon retrieval, 4/5 patients completed a UCLA activity level survey [2].

The articulating surfaces of the tibial and femoral components for each spacer were evaluated under up to 40x magnification for 7 modes of surface damage using the Hood method [3]. Each component was evaluated for pitting, embedded debris, scratching, delamination, surface deformation, burnishing, and abrasion on 8 regions of the articulating surface. The spacers were then scanned using MicroCT (Scanco, Inc.) and evaluated to observe the internal cement structure and possible defects.

Table 1. Clinical Data for Retrieved Dynamic Spacers

ID #	Age/ Gender	Weight (lbs)	Duration (days)	Cement Brand	Antibiotics	Antibiotic Load (%)
HUMC 073	62/M	220	92	Cobalt	Gentamicin	Unknown
HUMC 125	67/F	168	112	Palacos	Tobramycin/ Vancomycin	11.2%
HUMC 136	75/F	196	100	Palacos	Tobramycin/ Vancomycin	8.7%
HUMC 137	79/M	210	137	Palacos	Tobramycin/ Vancomycin	12.2%
UPENN 34	68/F		98	Cemex	Gentamicin	2.5%

Results: The maximum activity level score for the patients was 6, corresponding to a moderate activity (Table 2). The patient activity ranged between 2 and 7.

There was burnishing on the bearing surface of the retrieved tibial and femoral components (Figure 1). Burnishing was associated with a "wear polishing" of the surface. Scratching or abrasion of the surfaces was also observed. There was no evidence of delamination, embedded debris, or surface deformation. It was difficult to distinguish between pitting and porous nature of the bone cement. Pitting or porous areas of the surface were prevalent in the burnished regions of the spacer.

MicroCT analysis revealed that internal structure of the spacers was porous and highly inhomogeneous (Figure 2). Regions of radiopaque material deposits as well as a zone of irregularly mixed cement, which bordered within 3 mm of the articulating surface, were detected. We also observed open cavity defects bordering the articulating surface. However, we found no evidence of fracture or subsurface cracking in the retrieved spacers.

Discussion: There are limited number options available for the treatment of periprosthetic infections. Dynamic spacers deliver antibiotics directly to the joint while allowing knee motion and partial weight bearing, which should theoretically improve patient mobility during treatment of infection. Some studies have shown that knee motion after dynamic spacers is greater than their static counterparts [4]. Data from the present study suggests that patients were able to resume moderate activity levels. Despite the porous internal structure, inhomogeneous mixing, and cavity forming defects, burnishing was the only prevalent damage mode that could be consistently classified on all retrieved spacers. Additional retrievals are necessary to confirm the generality of these findings. Further research will also be needed to correlate the bone cement architecture and clinical performance of these short-term bone cement arthroplasties.

References: [1] Bozic et al, AAHKS 2008; [2] Zahiri et al, *JOA* 1998; [3] Hood et al, *JBMR* 1983; [4] Lombardi, et al *Orthopedics* 2007.

Acknowledgement: NIH Grant R01 AR47904.

Table 2: Retrieved Spacer Activity & Surface Damage

ID#	Max. UCLA Activity	Total Burnishing Score	Total Scratching Score
HUMC073	6	21	1
HUMC125	6	14	0
HUMC136	2	11	2
HUMC137	3	12	6
UP034	N/A	14	10

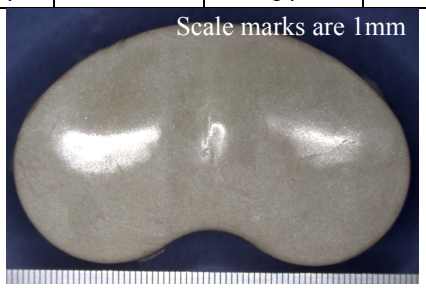

Figure1: Example of burnishing on HUMC136

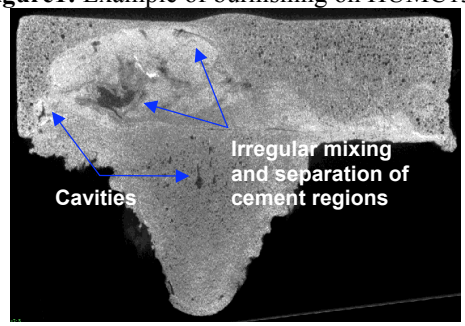

Figure2: MicroCT generated section of HUMC073