A Covalently Bound Surface Coating of Methacryloyloxydodecyl Pyridinium Bromide (MDPB) Reduces Microbial Surface Contamination in an in vitro Model

Despite numerous countermeasures, the operating room remains an unsterile environment with bacteria and other microbes residing in the ambient environment. The bacterial contamination of an implant from this environment, prior to implantation, may lead to deep infection involving the metal implant, which can be devastating. Studies have shown that implants inoculated with very low levels of bacteria, prior to implantation, may lead to a deep periprosthetic infection. In order to address this ambient bacterial colonization of an implant, a covalently bound, non-eluting methacryloyloxydodecyl pyridinium bromide (MDPB) coating has been developed and applied to cobalt chromium alloy (CoCr) surface in order to reduce pathogen contamination.

An in vitro test method based on ASTM E2149 has been developed to determine the ability of the MDPB treatment to reduce bacterial contamination of surrogate CoCr test specimens under dynamic contact conditions. This dynamic shake flask test was developed for routine quality control and screening because classical antimicrobial test methods to evaluate substrate-bound antimicrobials are ineffective in evaluating non-eluting treatments. The method has been modified to allow for evaluation of many different substrate types and microorganisms. Surface antibacterial activity is determined by quantitatively comparing reduction of bacterial colony forming units on treated samples to untreated samples (controls). This in vitro test method was then applied to bacterial strains that are common to orthopedic periprosthetic implant infections - including Methicillin-sensitive S. aureus (MSSA), Methicillin-resistant S. aureus (MRSA), E. Coli among others.

As reduction of microbial surface contamination may play an important role in reducing deep periprosthetic infections a fundamental question must be answered: Does surface treatment with MDPB reduce bacterial contamination of a metal implant?

Results of the modified ASTM E2149 test demonstrated greater than 99.99% reduction of Methicillin-sensitive S. aureus (MSSA), Methicillin-resistant S. aureus (MRSA), E. Coli and other pathogens on MDPB coated CoCr test specimens as compared to uncoated controls.

The MDPB treatment employs a mechanical means of killing bacteria that come into contact with the coated metal implant. A perforation of the cell membrane causes bacterial death and an overall reduction of bacterial count. As the MDPB coating is covalently bound and conformal to the entire surface area of a metal substrate, a vast majority of bacteria that come into contact with this surface treatment are compromised and rendered non-viable. Reduction of viable bacteria that may deposit on metal implants during surgery may provide a clinical benefit to patients undergoing orthopedic procedures. Reducing bioburden to this level can enable the patient's own immune system and/or perioperative antibiotics to eliminate the few remaining residual bacteria that may remain on metal implants.

This novel non-eluting anti-microbial treatment shows significant promise as a prosthetic protection product that will decrease bacterial contamination all while being safe to mammalian cells in this ex-vivo experiment.