Novel Orthopaedic Implant with Antimicrobial Properties and Reverse Phase Medium

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Statement of Purpose: The Center for Disease Control estimates that infection rates for orthopaedic surgery are as high as 20%, with 20% to 22% being surgical site infections (1). An ideal orthopaedic implant would possess antimicrobial characteristics to minimize surgical site infections. Currently available osteoconductive bone graft substitutes do not incorporate antimicrobial properties and are not approved for use with antibiotics. In addition to antimicrobial properties, it is important to prevent deformation or migration from the implanted site. Dissolution of the implant can lead to migration and can affect other areas in the body, resulting in decreased tissue growth at the site and possible infection elsewhere. A novel method of fabricating a scaffold with intrinsic antimicrobial and reverse phase hardening properties has been developed. This study examines the dissolution and antimicrobial characteristics of a chitosan/tri-calcium phosphate anti-microbial scaffold.

Methods: A chitosan polymer (OsteoMEM™, Advanced Biologics, Ladera Ranch, CA) was prepared with the addition of a tri-calcium phosphate (TCP). To test for dissolution properties, a malleable putty was fabricated and rolled into 5cc balls and placed into 60mL containers. The putty and the containers were weighed individually and recorded. The putty samples were fully submerged in phosphate buffered saline (PBS) in the containers and tightly capped. Samples (n=10) were incubated at 37°C on an orbital shaker at 120 rpms for a total of five days to simulate in vivo conditions. Containers filled with only saline (n=10) were used as a control.

After five days, the containers were observed for debris and the putty balls were removed, patted dry, and weighed. Containers containing PBS were weighed for an indication of debris remaining and recorded.

Additionally, the chitosan/TCP putty was tested to characterize the antimicrobial properties against a wide variety of hospital born organisms. A Kirby Bauer susceptibility test was executed and pictures of the zone of inhibition were taken.

Results: Data demonstrated that the putty weight after 5 days slightly deviated from its initial weight, weighing an average of 99.78% +/- 2.00% of its original weight. In comparison the PBS weight decreased by an average of 2.49% +/- 1.00%.

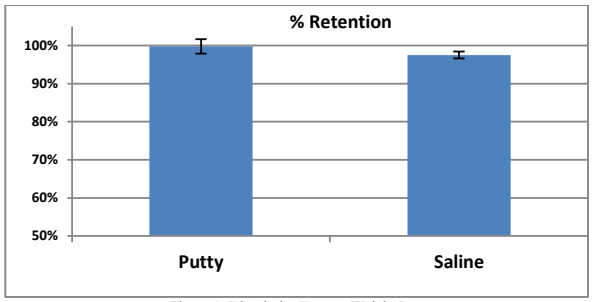

Figure 1: Dissolution Percent Weight Loss

Putty tested against the organisms listed in Table 2 were found to have a percent reduction of 99.9% or greater.

Organism	Reduct
Staphylococcus aureus (MRSA) ATCC 33591	>99.99%
Enterococcus faecalis (VRE) ATCC 51299	>99.99%
Acinetobacter baumanii ATCC 15308	>99.99%
Escherichia coli ATCC 8739	>99.99%
Klebsiella pneumoniae ATCC 4352	>99.99%
Streptococcus pyogenes ATCC 19615	>99.99%
Staphylococcus epidermidis ATCC 12228	>99.99%
Salmonella choleraesuis ATCC 10708	>99.99%
Pseudomonas aeruginosa ATCC 9027	99.99%
Enterococcus faecalis ATCC 700802	>99.99%
Serratia marcescens ATCC 13880	99.99%
Stenotrophomonas maltophilia ATCC 12714	>99.99%
Streptococcus mutans ATCC 25175	>99.99%
Clostridium difficile ATCC 9689	>99.99%
Streptococcus pneumoniae ATCC 10015	99.99%
Shigella species ATCC 11126	>99.99%
Enterobacter aerogenes ATCC 13048	>99.99%
Proteus mirabilis ATCC 4630	>99.99%
Proteus vulgaris ATCC 12454	>99.99%
Citrobacter freundii ATCC 8090	>99.99%
Enterobacter cloacae ATCC 13047	>99.99%
Moraxella catarrhalis ATCC 8193	>99.99%
Micrococcus luteus ATCC 49732	99.99%
Vibrio cholerae ATCC 11558	>99.99%

Table 2: Organisms tested and percent reduction

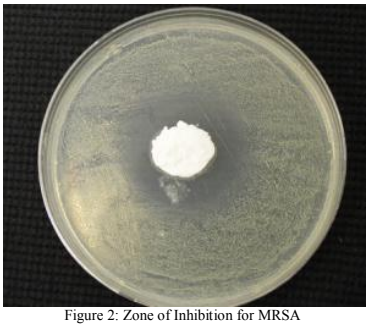

Figure 2: Zone of Inhibition for MRSA

Conclusions: The implant showed little to no dissolution, deformation, or migration in silmulated body fluid at 37°C. . The putty also showed excellent antimicrobial characteristics, resulting in at least 99.9% reduction against a wide variety of hospital born organisms. With the unique antibacterial properties and the resistance to deformation and migration, the implant presents many distinctive advantages to other currently available surgical alternatives.

References: 1. Moucha C, Evans R, et al. Orthopaedic infection Prevention and Control AAOS Annual Meeting 2010.