Assessing the Efficacy of Silver-doped Antimicrobial Coatings on Prosthetic Liners

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Abstract

Amputations are commonplace in orthopedic surgery as roughly 185,000 patients undergo an amputation each year. This number will continue to rise, as projections call for an estimated 50 percent increase to the amputee population in the next 35 years.1,2 With such a large patient pool, proper care and support for amputees is crucial. One of the leading issues facing amputee patients is late developing antibiotic-resistant bacterial infections in the stump of the patient.3,4 This is especially true with amputees who utilize prosthetic limbs. The enclosed design of the prosthetic socket often causes friction, sweat and debris build-up at the prosthetic-stump interface. Coupled with body heat, these factors result in a favorable condition for skin irritation, bacterial growth and eventual infection. With many of these bacteria having antibiotic resistance, the infections are difficult to treat and can pose serious complications.5 The objective of this study was to assess the antimicrobial properties of a silver-doped matrix coating on seven antibiotic-resistant pathogens correlated with common patient infections.

Methodology

Kirby Bauer Assay: The study utilized a Kirby Bauer Assay with 4 different types of commercially available prosthetic liners for measuring the efficacy of the coatings. 8mm plugs were excised from the liners using a standard biopsy punch. The 8mm plugs were dip-coated in 9 different conditions of coating with differing ratios of titanium isopropoxide to polydimethyl siloxane and differing doping concentrations of silver. Once coated and dried, the liner plugs were plated on a lawn of bacteria with a set concentration of 1E6 CFU per mL. Observations of inhibition were made at 24, 48, and 72 hour time points.

Dose Response Curves: Dose response curves were created in order to assess relative efficacy of the coating against each pathogen independent of the prosthetic liners. Bacteria was grown in liquid media and 200 microliters of dilute (1E7 CFU/ml) bacteria were suspended in the coated well plates. At 24 hours, the CFU of the bacteria was measured for each condition and curves were generated based on this data. Both Kirby Bauer and Dose Response protocols were used for all seven pathogens: Coagulate-Negative Staphylococcus epidermidis, Methicillin-resistant Staphylococcus aureus (MRSA), Propionibacterium acnes, Enterococcus faecalis, Pseudomonas aeruginosa, and Multi-Drug Resistant Acinetobacter baumannii.

Results

• The silver-doped coating has antimicrobial effects on each of the seven pathogens assessed.
• On prosthetic liners, the coating is effective at preventing bacterial growth for at least 72 hours.
• The 95% 10X condition of coating was most effective.
• The 95% condition maintains (and in most cases improves) its antimicrobial effect over the course of 72 hours.

Future Direction

• Testing whether the coating has an effect on the tensile properties of prosthetic liners.
• Field testing of a fully coated prosthetic liner.
• Assessing thermal properties in an effort to increase breathability and further reduce infection.
• Characterizing the release of silver in an aqueous substrate over 72 hours.

References


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Typical Amputee Patient Stump Infections

1. Amputation
2. Sept 2010
3. Assessing thermal properties in an effort to increase
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