The Efficacy of Silver Carboxylate Coatings on Prosthetic Liners

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INTRODUCTION

Prosthetic-using amputees are particularly susceptible to skin irritation and infection. The closed, warm, moist environment at the liner-skin interface encourages bacterial and fungal growth and the release of by-products within the prosthetic socket, which increase the likelihood of local skin breakdown, irritation, inflammation and potential for infection of the residual limb. Unlike the skin of palms and soles, the altered skin of a patient's residual limb is not physiologically adapted to withstand the repetitive pressure, shear force, and compressive friction that results from patient ambulation. This compromised condition of the skin can be exacerbated by inherent scars, invaginations, and bony protrusions left from the amputation procedure. These issues are combined with the disturbance to the patient's vasculature and lymphatic system, and compromise the residual limb's local immune system (Buikema, 2014). Among this patient population, microbial-related complication is common, as 74% of prosthetic-bearing amputees report some sort of residual limb skin disease following amputation, ranging from mild dermatitis to antibiotic-resistant bacterial infection (Wanivenhaus, 2016). Skin cultures of amputees who utilize a prosthetic device show an altered bacterial flora with both a heightened colonization and stronger virulence of strain-type (Köhler, 1989).

Another consequence of bacterial and fungal metabolic by-products is malodor. Independent of infection, roughly 70% of all prosthetic-bearing amputees in the United States complain of strong accompanying odor with use of their prosthetic device (Lake, 1997).

This study assessed the efficacy of a silver carboxylate complex used in Apocrine™ Prosthetic Liner Coating (BI Medical, Coventry, RI) against bacteria frequently encountered at amputation sites including Coagulase-Negative *Staphylococcus epidermidis*, Methicillin-sensitive *Staphylococcus aureus* (MSSA), *Enterococcus faecalis*, and Multi-Drug Resistant *Acinetobacter baumannii*.

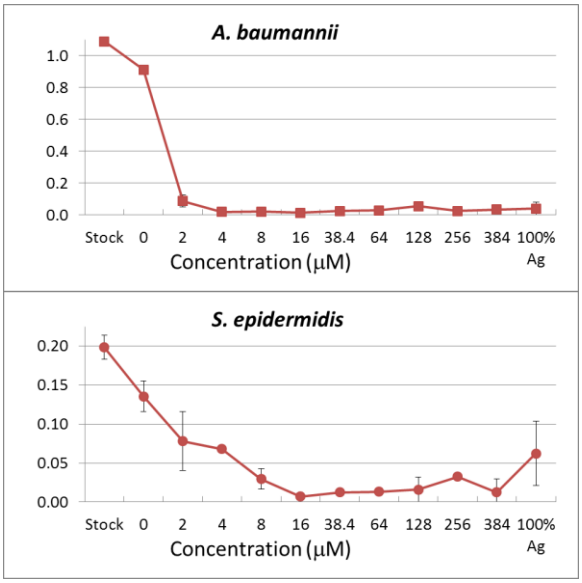
METHOD

Kirby Bauer assay used 8 mm samples taken from Keasy® and Alpha® Silicone liners. Samples were coated with titanium oxide/silicone precursors doped with increasing levels of silver carboxylate in polar and non-polar solvents. The "zone of inhibition," was measured at 24, 48, and 72 hrs.

For dose response curves, solutions above were coated on 96 well plates and inoculated with bacteria, while growth was monitored using optical density measured in a plate reader for 24 hrs.

RESULTS

There was a rapid reduction in bacteria from coated compared to non-coated liners as a function of silver carboxylate concentration as presented in graphs below of OD vs Concentration.



A zone of bacterial growth inhibition was evident around coated liners, which increased with small additions of silver carboxylate to cleaner solutions.

DISCUSSION

Mixed solvent based coatings clean liners to remove microbial by-products, skin, debris, sweat and sebaceous secretions that cause liner discomfort and odor. Titanium oxide/silicone/silver carboxylate residual films address issues related to bacteria strains found on the skin and liners (Tran 2015).

CONCLUSION

Silver carboxylate coatings were effective against certain bacteria frequently encountered at amputation sites and prosthetic liners.

CLINICAL APPLICATIONS

Regular decontamination of liners and the use of coatings with long lasting residual activity are a new approach for improving patient experience and hygiene at the skin interface and for addressing issues related to bacteria, comfort and odor.

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American Academy of Orthotists & Prosthetists
45th Academy Annual Meeting & Scientific Symposium
March 6-9, 2019