Prosthetic Sanitizer and Deoderizer

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Abstract

Prosthetic liners are in close contact with biological tissue and contain potentially harmful or infectious bacteria as well as undesirable odors. There is potential to eradicate this bacteria using ultraviolet radiation and titanium dioxide sanitation methods, a solution with the potential to increase cleansing efficiency. This study investigates the efficacy and practicality of these sterilization methods with the performance of germicidal, degradation, and odor reduction tests.

Background

- Prosthetic liners are layer between skin and prosthesis
- Liners made of silicone material
- Cleaning procedure of liners is tedious and often overlooked, leading to infection
- Ultraviolet light and titanium dioxide proven sterilization and deodorizing methods in other applications
- The effects of ultraviolet light on silicone and its liner cleaning effectiveness not well understood

Figure 1 – Diagram of prosthetic liner in motion

Figure 2 – ALPS prosthetic liners, one of the types used in this design project

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Testing Objectives

- Determine if ultraviolet radiation:
  - Sanitizes liners more effectively than current methods
  - Degrades liners
  - Deodorizes more effective when coupled with titanium dioxide
- Determine the effect of different ultraviolet bulb wattages on liners
- Conduct tests in reproducible manner
- Produce justifiable and accurate results
- Maintain safe working environment

Protocols and Layout

Three tests conducted to evaluate objectives

- **Sterilization Test**
  - Liner samples infected with Staphylococcus epidermidis bacteria
  - Liners sterilized with cleansing techniques of interest
  - Bacterial propagation following sterilization evaluated to determine optimal cleansing methods

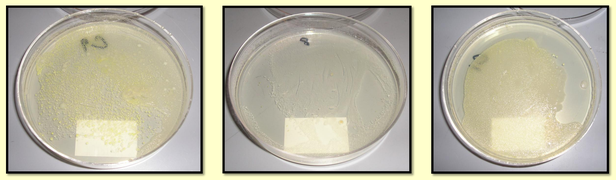

Figure 3 – Agar cultures of Staphylococcus epidermidis used in sterilization testing

- **Liner Degradation Test**
  - Liner samples exposed to ultraviolet radiation for extended time periods
  - Liners stressed to failure in Instron tensile load tester
  - Analysis conducted on stress and strain

Figure 4 – Machine used to apply tensile strain for the liner degradation test

- **Deodorization Test**
  - Liner samples odorized
  - Odorized samples treated with deodorization methods including ultraviolet radiation and titanium dioxide
  - Samples surveyed by 21 unbiased subjects to rate post-cleansing odor

Testing Results

- Sterilization Test
  - Noticeable sterilization with all methods
  - Ultraviolet light shown to be effective sterilization method for liners
- Degradation Test
  - Tensile properties not greatly impacted by UV exposure
  - No effect found on Parydonn liners

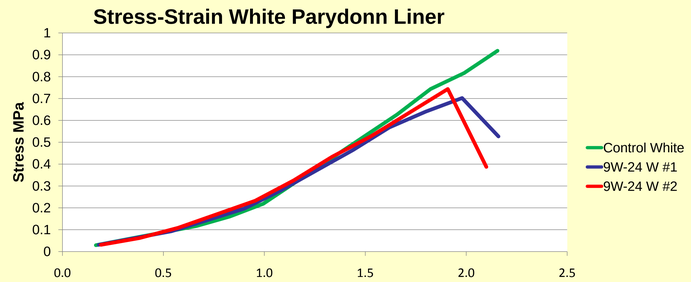

Figure 5 – Graph of stress vs. strain for samples of control and exposed white Parydonn liner

- Odor Test
  - Ultraviolet radiation and titanium dioxide are effective deodorizing agents
  - Ultraviolet radiation found to deodorize through exposure alone
  - Titanium dioxide too expensive to be feasible

Future Work

- Microscopic analysis of possible degradation caused by ultraviolet radiation
- Consumer test of the effect of ultraviolet radiation exposure on comfort
- Repeated large scale sterilization tests
- Pathologist recommendations on the effectiveness of sterilization methods
- Construction of an ultraviolet liner cleansing prototype

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