

Matthew B. Bratton

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LSU Health Sciences Center, New Orleans, LA

Jessica Rivera, MD, PhD

LSUHSC, Department of Orthopaedics

“Bromelain as a Source of Debridement for Infected Orthopedic Implants”

BACKGROUND: The growth of biofilms on orthopedic implants is of major surgical concern, with infection rates estimated to be up to 2 percent for all orthopedic procedures. Biofilms are created by a cluster of bacteria that produce extracellular polymeric substance (EPS) which surrounds and protects the colony from host immune cells. Currently, manual scrubbing accompanied with a saline wash is the most common method of eradication. However, enzymatic debridement has emerged as an alternative option. Bromelain is an enzyme derived from pineapple stem and has been previously used in several studies as a method of biofilm dissolution. In addition to its intrinsic antimicrobial properties, bromelain is capable of hydrolyzing the complex carbohydrate shell of EPS and destabilizing the biofilm. As a result, we hypothesized that bromelain may be used for the debridement of infected orthopaedic implants.

METHODS: In our study, 10 mm x 3.5 mm surgical grade cortical bone screws were incubated in methicillin resistant *Staphylococcus aureus* (MRSA) inoculated broth for 120 hours with 10% fetal bovine serum (FBS). Treatment groups were exposed to low dose bromelain solution (200 µg/mL), high dose bromelain solution (1mg/mL), or bromelain powder (3 U/mg) for 20 minutes. The screws were then either rinsed with 1X phosphate buffer saline (PBS) or briefly scrubbed for thirty seconds prior to rinsing. The screws were then stained with 0.25% crystal violet (CV) dye for 25 minutes to determine the amount of biofilm remaining. The stained biofilm was removed from the screws using 33% acetic acid (Figure 1). Resultant effluents were analyzed by optical density (OD) read at 600nm. Optical density means were compared between each treatment group and respective controls with Students t-test. The percent of biofilm dissolution was determined using absolute OD values in the following formula: % BD = [OD Control – OD Treated/OD Control] × 100.

RESULTS: Three screws were used for each group. The average optical densities of the low dose bromelain solution (0.348±0.068) and low dose + scrub (0.061±0.021) groups were no different compared to respective controls (p=0.5610; p=0.1738). The average optical densities of high dose bromelain solution (0.056± 0.009) and high dose + scrub (0.055±0.012) were not different from their respective controls (p=0.0791; p= 0.2234). The average optimal densities for screws in the powder treatment group (0.041± 0.011) trended towards being lower than their respective controls (p=0.0529); and screws treated with powder + scrub did have lower optical densities compared to controls (0.032 ± 0.005; p=0.0002). The powder + scrub treatment resulted in 91% biofilm dissolution (Figure 2)

CONCLUSION: Based on our work, bromelain is a promising alternative option for the debridement of infected orthopedic implants. However, an increased sample size is needed to more accurately assess the reliability of our results. In addition, further investigation is required to assess how different concentrations and exposure times may affect the percent biofilm dissolution. In the future, this experiment should be replicated in vivo to determine if treating infected implants with high dose bromelain yields any toxic side effects to the surrounding tissue