Mechanical Methods in PJI: How Do Pulsatile Lavage & Sonication Brushing Fare Against Mature Biofilm

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INTRODUCTION: Intraoperative irrigation is ubiquitously performed in arthroplasty surgery to clear blood, debris, and microbes from the surgical wound. Recently, mechanical brushing has been recommended to further remove implant biofilm in the setting of periprosthetic joint infection (PJI). Despite this recommendation, little evidence exists regarding how irrigation or brushing affects implant biofilm, and if motorized agitation is effective, as demonstrated in the dental literature. The purpose of the current study was to investigate how application of pulsatile irrigation and sonicated brushing affects mature staphylococcal biofilm established on tibial base plates (TBPs).

METHODS:

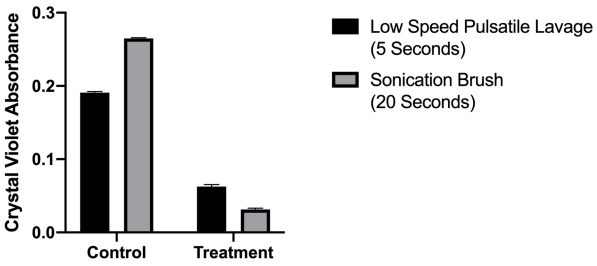
Four never implanted, identically sized TBPs (Persona; Zimmer-Biomet) underwent keel removal with a diamond saw, were passivated in 25% nitric acid, then autoclaved. Pilot experiments were performed to verify that mature (72-hour) MSSA biofilms could be reliably reproduced on TBP surfaces using 45mL of 10^7 CFU/ml inoculations. Subsequently, TBPs with mature biofilm were assigned to control conditions, 5 second treatment with low-speed pulsatile lavage (Pulsavac Plus; Zimmer-Biomet), or 20 seconds of direct contact with a custom sonication brush (minimum 40,000 movements/minute). Irrigation sources were suspended at 5 inches above TBPs. Experiments were performed in triplicate, with a positive control always present. Post-treatment TBPs were either put in a sonication bath to dislodge remaining bacteria to count colony forming units (CFUs), or stained with 0.1% crystal violet to quantify residual biofilm biomass.

RESULTS:

Low-speed pulsatile lavage reduced mature biofilm CFU counts by 51% and biofilm biomass by 67% compared to controls. Sonication brushing reduced CFU counts by 52% and biofilm biomass by 88% compared to controls.

DISCUSSION AND CONCLUSION:

Mechanical methods to remove bacterial biofilm are commonly employed but understudied. Pulsatile irrigation removes biofilm, but simultaneously disperses bacteria within the surgical wound. Sonication brushing shows promise for removing biofilm from topographically complex orthopedic implants in a more controlled manner.



(A) Low Speed Pulsatile Lavage, (B) Control, (C) Custom Sonication Brush