Antiseptic treatment of infected orthopedic surfaces decreases viable bacteria, but mechanical methods are needed to remove biofilm

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INTRODUCTION: Antiseptic solutions are commonly utilized in arthroplasty surgery to prevent and treat periprosthetic joint infection (PJI). Although mechanical methods such as brushing have been described intraoperatively, their effect on biofilm remains unknown. The purpose of this study was to determine if mechanically cleaning implants with sonication brushing could further reduce biofilm on orthopedic surfaces following treatment with antiseptic solutions.

METHODS: MSSA (Xen36) was grown on porous Ti-6Al-4V screw caps (G7; Zimmer-Biomet), cobalt chrome coupons (Smith & Nephew), and polymethylmethacrylate coupons for 72 hours to establish mature biofilm. Surfaces were then treated for 3 minutes with either an antiseptic solution (1:1 ratio of 10% povidone iodine and hydrogen peroxide, PI+HP; diluted 0.35% povidone iodine, dPI; or Bactisure (Zimmer-Biomet)) or a saline control. Half of the antiseptic treated surfaces were randomly allocated to also receive mechanical treatment involving a 20-second direct contact exposure to a sonication brush (minimum 40,000 movements/minute). All treated surfaces were then sonicated in tryptic soy broth and plated to count colony forming units (CFUs) to quantify viable bacteria. Experiments were performed in triplicate and repeated. Surfaces were also photographed with SEM imaging, to visualize virgin surfaces, 72h biofilm growth and 72h biofilm growth plus irrigant solutions.

RESULTS SECTION**:** SEM imagining clear shows even coverage of biofilm growth. With the addition of irrigation solutions, biofilm appears to be largely unchanged on imaging. On porous titanium, brushing produced an additional 1.5 log reduction in CFU counts when combined with antiseptic solutions tested. On smooth cobalt chrome (CC), an additional 3 log reduction was observed when the method was utilized with dPI but the effect in combination with Bactisure and PI+HP was limited. No additional benefit was observed with brushing applied on the PMMA surface.

DISCUSSION: The sonication brushing works synergistically with antiseptic solutions in removing biofilm from textured orthopedic implants (porous Ti-6Al-4V) while limited efficacy was noted when combined with high-efficacy antiseptic solutions on smooth orthopedic surfaces (cobalt chrome) or on PMMA. Further work to determine optimal protocol based on surface and brush settings is needed.

SIGNIFICANCE/CLINICAL RELEVANCE: Antiseptic treatment and sonication brushing works synergistically in removing biofilm from textured orthopedic implants.

IMAGES AND TABLES:

Figure 1

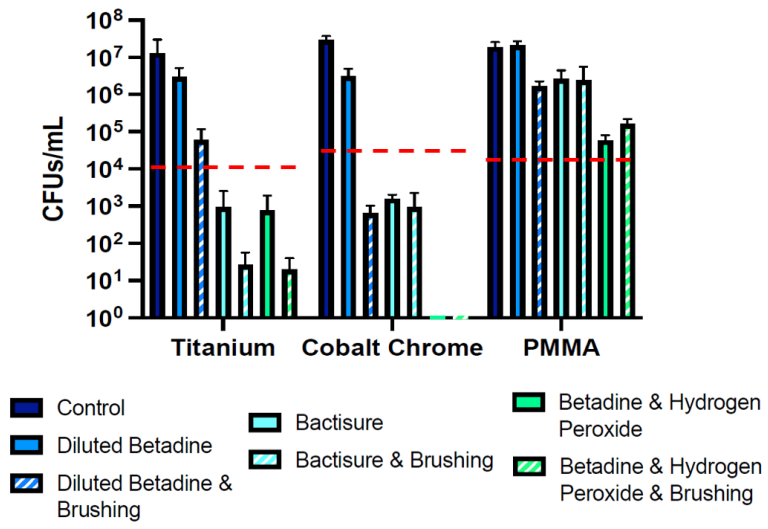

Figure 2

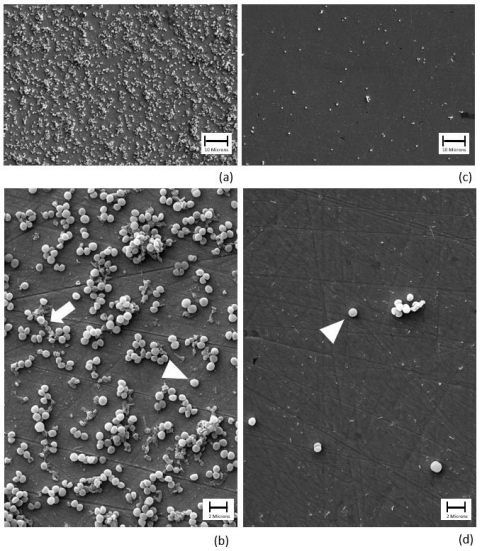

Figure 1. Irrigation solutions and sonication brushing on MSSA biofilm. 72-hour (B) MSSA CFU counts following control, antiseptic treatment, or added sonication brushing treatment. Dotted line represents 3-log reduction threshold for each surface. Bars denote mean values ± standard deviation from triplicate experiments.

Figure 2. Scanning Electron Microscopy imaging of oxidized zirconium following 72-hour inoculation of MSSA (A, B) and following sonication brushing for 20 seconds (C, D). 1-micron spherical staphylococcus aureus (white triangle) clusters are present with interconnecting fibrin links (white arrows). Top row Scale bar = 10 µm, bottom row Scale bar = 2 µm.