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Antimicrobial efficiency and cytocompatibility of different decontamination methods on titanium and zirconium surfaces

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Abstract

Objectives: The purpose of this study was to investigate the efficiency of different implant-decontamination methods regarding biofilm modification and potential cytotoxic effects. Therefore, the amount of biofilm reduction, cytocompatibility, and elementary surface alterations were evaluated after decontamination of titanium and zirconium surfaces.

Material and Methods: Titanium and zirconium disks were contaminated with a newly developed high-adherence biofilm consisting of six microbial species. Decontaminations were performed using titanium curette, stainless steel ultrasonic scaler (US), glycine (GPAP) and erythritol (EPAP) powder air-polishing, Er:YAG laser, 1% chlorhexidine (CHX), 10% povidone-iodine (PVI), 14% doxycycline (doxy), and 0.95% NaOCl solution. Microbiologic analysis was done using real-time qPCR. For assessment of cytocompatibility, a multiplex assay for the detection of cytotoxicity, viability, and apoptosis on human gingival fibroblasts was performed. X-ray photoelectron spectroscopy (XPS) was used to evaluate chemical alterations on implant surfaces.

Results: Compared with untreated control disks, only GPAP, EPAP, US, and Er:YAG laser significantly reduced rRNA counts (activity) on titanium and zirconium ($p < .01$), whereas NaOCl decreased rRNA count on titanium ($p < .01$). Genome count (bacterial presence) was significantly reduced by GPAP, EPAP, and US on zirconium only ($p < .05$). X-ray photoelectron spectroscopy analyses revealed relevant re-exposure of implant surface elements after GPAP, EPAP, and US treatment on both materials, however, not after Er:YAG laser application. Cytocompatibility was impaired by CHX, PVI, doxy, and NaOCl. CHX and PVI resulted in the lowest viability and doxy in the highest apoptosis.

Conclusions: Within the limits of this in vitro study, air-polishing methods and ultrasonic device resulted in effective biofilm inactivation with surface re-exposure and favorable cytocompatibility on titanium and zirconium. Chemical agents, when applied on implant surfaces, may cause potential cytotoxic effects.

Reference:

Costa RC, Takeda TTS, Dini C, Bertolini M, Ferreira RC, Pereira G, Sacramento CM, Ruiz KGS, Feres M, Shibli JA, Barão VAR, Souza JGS. Efficacy of a novel three-step decontamination protocol for titanium-based dental implants: An in vitro and in vivo study. Clin Oral Implants Res. 2024 Mar;35(3):268-281. doi: 10.1111/clr.14224. Epub 2023 Dec 22. PMID: 38131526.