11173 - Antibacterial And Biocompatible Titanium-Copper-Oxide Nanocoating

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Background: Implant-related bone infections account for one of the most common complications in the practice of orthopedic surgery. Several attempts have been made to add antibacterial properties to orthopedic devices; however, none of these approaches have been successfully translated to clinical practice. Copper has been approved as a surface antibacterial material by the Environmental Protection Agency and has superior in-vitro antibacterial performance compared with other metals, while maintaining biocompatibility. The aim of this study is to describe the biological and physicochemical characteristics of a thin film of titanium-copper oxide (TiCuO). We looked specifically at its elusion characteristics, in-vitro cytotoxicity and antibacterial properties.

Methods: One hundred and twenty titanium alloy discs, of the size of a dime, were coated with TiCuO at 4 different concentrations of copper using a sophisticated physical vapor deposition technique. To study the antibacterial properties, an inoculum of S. epidermidis was added to the media containing the discs. After 24 hours, discs were removed, rinsed, vortexed and sonicated. Any cells and biofilms isolated during this process were cultured and quantified. For the elusion part of the study, copper release was measured using an Inductively Coupled Plasma Mass Spectrometer (ICP-MS). Every day, media was changed simulating physiologic fluid turnover. For the in-vitro cytotoxicity part, we investigated the response of two cell lines. We performed MTS assay at 72 hrs. and Annexin/Pi staining at 7 day.

Results: Although biofilm was present in the discs after 24 hours of exposure, the biofilm was markedly less adherent in the copper coated disks when compared to the controls. Furthermore, after sonication, disks containing 80% of copper showed the clearest suspension in comparison with the rest of the discs. Disks containing 80% of copper achieved an average of 2.6 log10 reductions in biofilm forming S. epidermidis which was statistically significant (fig. 1). For all concentrations, release of copper peaked at 24 hours and then decreased. Discs coated with 80% copper had a peak of 280 µmol/L during first 24 hours and minimal values at 28 days (fig. 2). In terms of cytotoxicity, the two cell lines studied did not differ in cell viability after exposure to coated discs compares to the controls (fig. 3).

Conclusion: This pilot study proved that titanium-copper-oxide holds antibacterial properties while remaining biocompatible. Further in-vivo studies are needed to confirm these results.

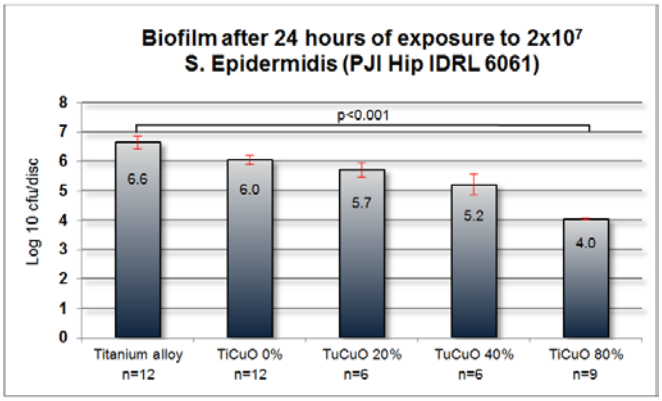

Figure 1: Antibacterial effect.

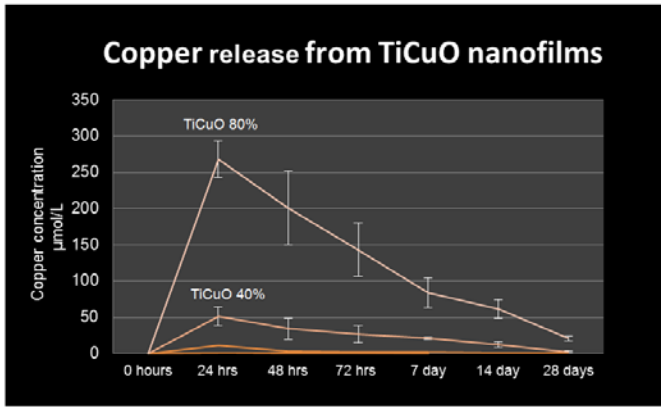

Figure 2: Copper release from discs coated with TICuO nanofilms containing different amounts of copper.

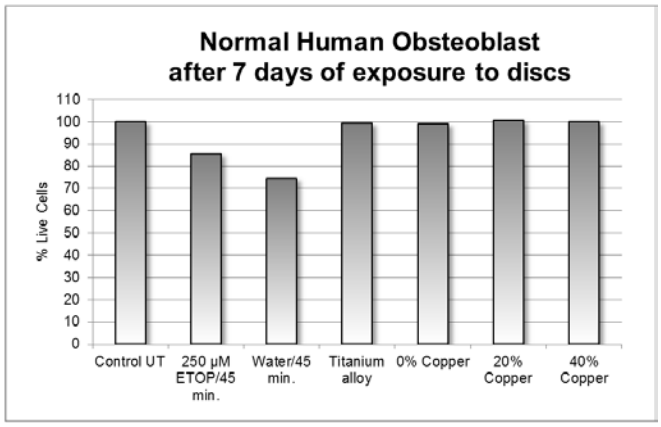

Figure 3: In vitro cellular viability (NHOb) after 7 days of exposure to discs coated with TICuO nanofilms containing different amounts of copper using annexin/PI staining.