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Chlorhexidine-based nanoparticles as an antimicrobial coating for dental implants

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Titanium is a major component of many dental implants and, although these have shown to be highly successful, they are prone to infection. Chlorhexidine (CHX) is a broad-spectrum antimicrobial agent, widely used in dentistry. The formation of a CHX-based nanoparticle (NP) means an antimicrobial effect can be administered at the site of bacterial attack; while their small size means coverage is tuneable, leaving the majority of the implant surface available for osseointegration.

Objectives: The aim of this work was to investigate the applicability of chlorhexidine-hexametaphosphate (CHX-HMP) nanoparticles as a coating for titanium dental implants.

Methods: Aqueous solutions (10mM) of chlorhexidine digluconate and sodium hexametaphosphate were combined, under constant stirring, yielding CHX-HMP NPs. Commercially pure grade II titanium substrates were immersed in the rapidly stirred colloidal suspension, followed by a 10s deionised water rinse. Some samples were then soaked in whole human saliva for 2h to deposit a salivary pellicle (Ethics reference number:NJW161213; Saliva bank REC ref:08/H0606/87+5).

Nanoparticle size and surface distribution were investigated using Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM). The release of CHX from NP-coated substrates was monitored using UV-spectrophotometry (UV). The antimicrobial efficacy of these surfaces against *Streptococcus gordonii* and *Porphyromonas gingivalis* was investigated.

Results: The CHX-HMP NPs had a size of~50nm (TEM) which adhered to titanium surfaces, forming porous, micron-sized aggregates, surrounded by bare titanium (AFM, SEM). CHX was shown to elute from these surfaces, into water with and without a pellicle (UV). Adhesion and proliferation of *S. gordonii* and *P. gingivalis* were inhibited within 24h, on the NP-coated surfaces.

Conclusion: CHX-HMP NPs were formed and adhered to clinically relevant titanium substrates. These coated surfaces then exhibited an antimicrobial effect against *S. gordonii* and *P. gingivalis*, in the presence of a salivary pellicle, within 24h.