ANTIBACTERIAL COATINGS AGAINST PERI-IMPLANTITIS: A KIT TO APPLY IN THE DENTIST'S TREATMENT ROOM

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INTRODUCTION

Dental implants have become a highly successful and routine treatment for the loss of teeth.[1] However, despite the high success of these implants, failures do occur,[2] being poor osseointegration and infection the most serious complications leading to implant failures.[3] Infections have also been categorised as early or late.[4] In particular, late dental implant infection generally occurs after more than 1 year of placement and is termed plaque-induced peri-implantitis.[1]

As it is well known, when peri-implant infection has been diagnosed, there are many therapeutic approaches employed in efforts to save the implant and avoid implant removal: biofilm removal from the implant in the peri-implant pocket, antiseptic treatment to decontaminate the implant surface, antibiotic treatment to eliminate infectious bacteria in the surrounding peri-implant tissues and regenerative or access/respective surgery to reestablish the bone-implant interface.[1]

Unfortunately, the infection after surgery reappears in a lot of cases and there is still a challenge to find an efficient procedure to eradicate the bacteria surrounding the implant. To that end we propose the coating of the implant with a material able to release an antimicrobial agent for a long time in an effective dose. Thus, the main aim of this work is the development of an antibacterial hybrid sol-gel coating that can be applied on the infected implant in the dentist's treatment room.

The film must be created in the patient's mouth, so, the whole sol-gel process must be done in a short period of time (10 minutes) and at room temperature. Furthermore, this new material must start to release the antimicrobial agent rapidly.

MATERIALS AND METHODS

Coatings were synthesized by the acid catalysis sol-gel method from a specific mixture of different alkoxysilane precursors. This formulation was functionalized with a notorious antimicrobial molecule during the synthesis process. The concentration of the bactericide in the silica sol was varied as 0, 0.5, 1, 2 and 5 wt %. The selection of the bactericide took into account the high efficiency in the prevention and elimination of bacterial infections together with a low citotoxicity.

The chemical characterization was carried out by Infrared Spectrometry and Nuclear Magnetic Resonance, the adhesion measurement by cross-cut test and the biological evaluation was done with *in vitro* and *in vivo* assays. Other tests were performed to complete the characterization: determination of hydrophobicity/hydrophilicity, hydrolytic degradation test and silicon release test. Finally, the concentration of released drug was measured spectrophotometrically.

RESULTS

The successful obtaining of transparent, homogeneous and uniform coatings where antimicrobial agents are effectively immobilized can be confirmed from the chemical and morphological characterization. Moreover, the molecules incorporation was made without altering the material chemistry.

Although all bioactive molecules can potentially exhibit cytotoxicity against human tissue cells depending on their concentration, in this case no one of the developed materials presented a cytotoxic behaviour, since all of them induced cell viability higher than 70 % as compared to control.

Figure 1 shows the strong bactericidal effect of the coatings charged with different amounts of antimicrobial agent and measured against *Stafilococcus aureus* CECT 86 (ISO 22196). As expected, there is an increasing bactericidal effect related to the amount of bioactive molecules in the coating.

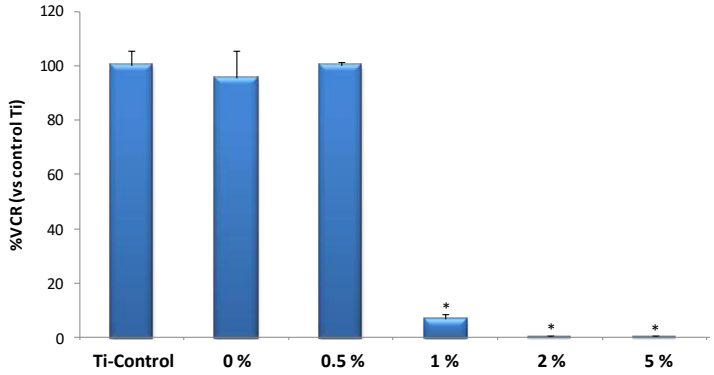

Figure 1. *Cell viability for all the coatings under study expressed as percentage with respect to control*

2 % doped coating was chosen for the final step of this work, where *in vivo* biocompatibility and osseointegration will be tested.

The semi-quantitative analysis of foreign body reaction showed similar values for coatings and titanium control, being all of them classified as slightly irritant materials.

In Figure 2 the comparison between the obtained histomorphometric parameters are presented. Comparing the behaviour of coating and control we can say that both materials present similar trend inducing osseointegration. In addition, all these results combined suggest that the osteoinduction ability of coatings prevails over titanium osteoconduction ability.

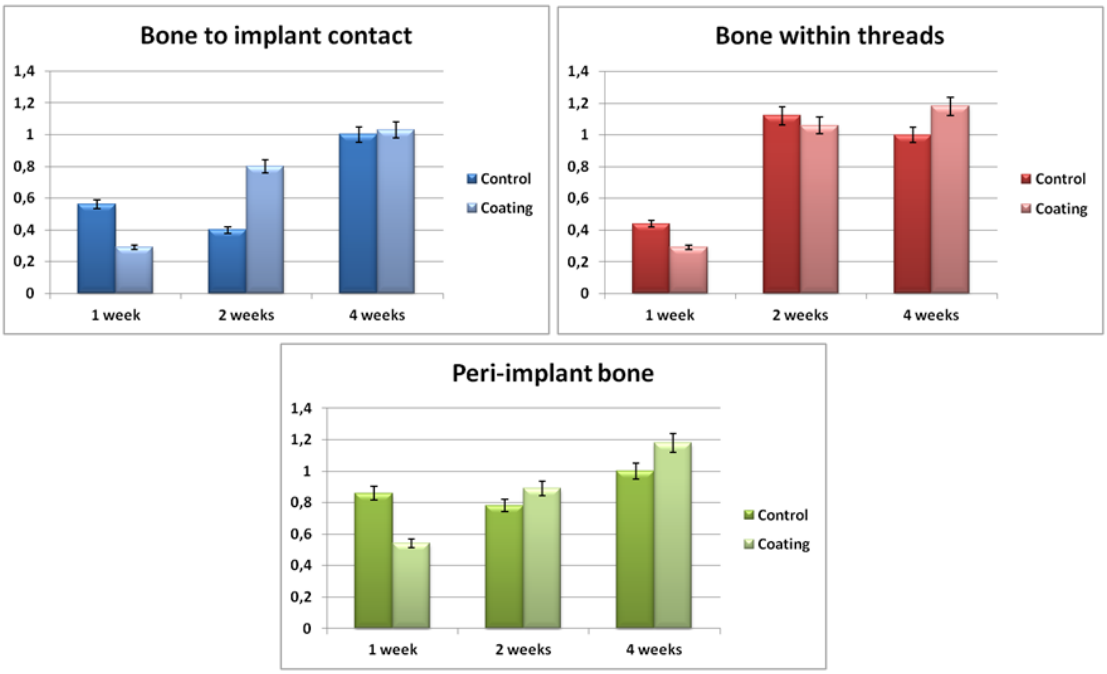

Figure 2. *Obtained histomorphometric parameters for 2 % doped coating and titanium control*

CONCLUSION

The present study has shown that the new doped silica sol-gel coatings are a great contribution to the dental implantology. They provide an environment with antibacterial capacity to prevent and eliminate the peri-implantitis able to be used in the dentist's treatment room.

REFERENCES

1. Norowski PA, Bumgardner JD. Biomaterial and antibiotic strategies for peri-implantitis: A review. *Journal of Biomedical Materials Research Part B: Applied Biomaterials*. 2009;88(2):530-543.

2. Atieh MA, Alsabeeha NH, Faggion Jr CM, Duncan WJ. The frequency of peri-implant diseases: A systematic review and meta-analysis. *J Periodontol*. 2013;84(11):1586-1598.

3. Li Y, Xiong W, Zhang C, et al. Enhanced osseointegration and antibacterial action of zinc-loaded titania-nanotube-coated titanium substrates: In vitro and in vivo studies. *Journal of Biomedical Materials Research Part A*. 2014;102(11):3939-3950.

4. Pye A, Lockhart D, Dawson M, Murray C, Smith A. A review of dental implants and infection. *J Hosp Infect*. 2009;72(2):104-110.