Composite chitosan-bioactive glass membranes for direct pulp-capping

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1. Introduction - The soft dental pulp tissue can become exposed to the external environment *via* deep caries, trauma or iatrogenic activity [1]. In direct pulp-capping, the exposed pulp is covered with a biomaterial to protect and promote the healing of the soft tissue and, ideally, to stimulate the repair of the dentine. A restorative cement is then placed over the biomaterial to seal the cavity. Dentine is a bone-like matrix comprising hydroxyapatite (HA), $Ca_5(PO_4)_3OH$, collagen and water. Certain 'bioactive' pulp-capping materials are able to promote the regeneration of dentine to form a protective bridge over the previously exposed pulp [1]. The standard pulp-capping material is calcium hydroxide; although, hydraulic calcium silicate cements, bioactive calcium phosphosilicate glasses and hydroxyapatite are also gaining popularity [1-3]. Particulate pulp-capping materials are prone to wash-out and present a challenge for the placement of the final restorative cement. In this study, composites of the biocompatible biopolymer, chitosan, and particulate bioactive glass were prepared with a view to their application in direct pulp-capping.

2. Experimental - Bioactive glass (BG) particles (< 125 μm) in the system $CaO\text{-}Na_2O\text{-}P_2O_3\text{-}SiO_2$ were prepared by the sol-gel method [4]. Bioactive glass and chitosan were blended in 1% aqueous acetic acid solution at mass ratios of 1:10 and 3:10 (to produce composites, CBG1 and CBG3). The solutions were cast on to polycarbonate surfaces and dried in air at 40 °C. The *in vitro* bioactivity of the composite membranes was evaluated by monitoring hydroxyapatite (HA) formation on their surfaces in simulated body fluid (SBF) at 1, 3, 7 and 14 days [5]. HA was confirmed by Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) with energy dispersive X-ray analysis (EDX).

3. Results and Discussion - The characteristic sharp doublet of crystalline hydroxyapatite at 570 - 605 cm^{-1} was present in the FTIR spectra (not shown) of the composite membranes following a residence time of 1 day in SBF. The presence of HA, which continued to develop up to 14 days, was additionally confirmed by SEM (Image 1) and EDX analysis. Conversely, the pure chitosan control membrane did not elicit the precipitation of HA. Further work is now underway to appraise the biocompatibility of these membranes with respect to dental cell lines.

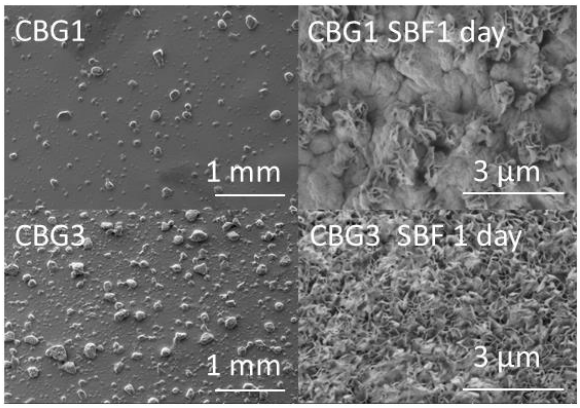

Image 1. SEM images of CBG1 and CBG3 prior to and after exposure to SBF for 1 day

4. Conclusions - The rapid *in vitro* formation of HA on the surfaces of the chitosan-bioactive glass membranes indicates that these materials are highly bioactive and have the potential for dentinogenesis in direct pulp-capping applications.

5. References

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