b-FGF Encapsulating in Silica Xerogel/Chitosan Hybrid Coating for Controlled Release

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Statement of Purpose: Basic fibroblast growth factor (b-FGF) is well known to facilitate the adhesion of osteoblast cells, but their short-life time limits their application for hard tissue engineering [1-2]. For continuous release of b-FGF, encapsulation of growth factors into the coating has been attempted in recent researches. In our previous work, we developed the coating materials which composed of the chitosan and the silica xerogel in order to enhance the biological properties of substrate [3]. This silica xerogel-chitosan hybrids are also expected to be promising bioactive coating materials containing b-FGF because the mesoporous silica xerogel allow the b-FGF to be encapsulated. Therefore, in this study, we aimed to fabricate the hybrid coating incorporating the b-FGF and evaluate the biological properties of the hybrid coating containing b-FGF.

Methods: The silica sol which contains Ca (15 wt %) and P (8 wt%) was prepared by the sol-gel process at room-temperature. That sol was mixed with different volume ratios of the chitosan sol (0, 30, 50 %) until obtained homogeneous sols [3], and then b-FGF (100 μg/ml) was added to the hybrid sols. The hybrid sols containing b-FGF was spin-coated on Ti substrate (1 x 1 mm) at 3000 rpm for 1 min. The *in vitro* release test of b-FGF was conducted in 2 ml PBS at 37 ℃ for 28 days (n=5). The released b-FGF was detected at 220 nm by UV-spectrophotometer. The cellular responses of the hybrid coatings containing b-FGF were investigated in terms of cell viability and ALP activity, and compared to those of the pure hybrid coating (n=3).

Results: The coating layer of the pure silica xerogel and hybrid coating on Ti substrate were observed by SEM. The hybrid coatings with and without b-FGF were showed a uniform morphology and the thickness of that was about 1.5 μm, as shown in figure 1. b-FGF release profiles with different compositions for 28 days are presented in figure 2. The pure xerogel and hybrid coatings revealed continuous and long-term release patterns of b-FGF. The amount of b-FGF released from the coatings was reduced with increase of the chitosan contents in the hybrid coatings. The *in vitro* cell tests were performed to evaluate the effect of b-FGF on the biological properties of the hybrid coating, using the silica xerogel/30 % chitosan hybrid coating which has highest bioactivity in comparison with other composition of the hybrid coating. The hybrid coating with b-FGF has higher levels of proliferation than those without b-FGF for 3 and 5 days. Moreover, the ALP activity of the hybrid coating containing b-FGF was significantly improved compared with the hybrid coating without b-FGF.

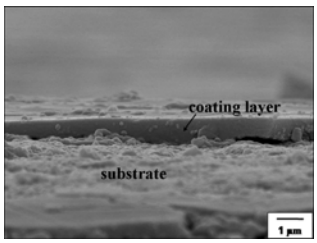

Figure 1. Typical cross-section SEM micrograph of hybrid coating with b-FGF.

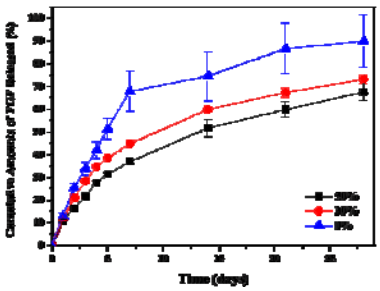

Figure 2. Cumulative b-FGFs released as a function of immersion time (days) and chitosan compositions in hybrid coating in PBS.

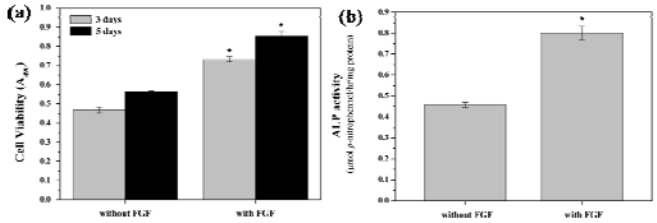

Figure 3. (a) Proliferation and (b) differentiation levels of the MC3T3-El cells on the silica xerogel/chitosan hybrid coating with and without b-FGF after culturing (a) up to 3, 5 and (b) 10 days (n=3) (* $p < 0.01$).

Conclusions: The silica xerogel/chitosan hybrids containing b-FGF were coated uniformly on Ti substrates. All of coatings continuously released b-FGF for 28 days and the amount of b-FGF released from the coatings were controlled by chitosan contents in hybrids. The biological properties of hybrid coating with b-FGF, including the cell viability and ALP activity, were improved compared with those of the hybrid coating without b-FGF.

References:

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