Silica Xerogel-Chitosan Hybrid Coating on Porous Hydroxyapatite Scaffold for BMP Loading

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Statement of Purpose: Hydroxyapatite scaffolds are widely used as bone substitutes in order to reconstruction of bone defects and bone healing. The biological properties of the scaffolds can be enhanced through the use of bioactive agents such as growth-factors. Bone morphogenetic protein (BMP) is well known to improve osteoinductivity for bone tissue engineering; however, it has *in vivo* instability due to rapid protein degradation by enzymes. It is therefore necessary to develop coating materials for sustained release of them as well as protection against degradation [1-2]. In our previous study, the coating material which composed of the silica xerogel and the chitosan was found to improve the biological property of implantable materials. The hybrid also has advantage of delivering growth-factors due to mesoporous structure of the silica xerogel and their room-temperature process [3]. This research was aimed on the development of a BMP loaded silica xerogel/chitosan hybrid coating, in order to improve osteoinductivity of implantable hydroxyapatite scaffold.

Methods: Silica xerogel-chitosan hybrid sol for coating was prepared by sol-gel process at room-temperature. The silica sol was mixed with chitosan sol of 50 vol % until homogeneous sol obtained, and then 40 μg of BMP was added to 1 ml of the hybrid sol as an *in situ* manner. Hydroxyapatite scaffold in disk form (8 mm in diameter and 2 mm in height) was fabricated by a freeze casting method [4]. The average pore diameter and porosity of the scaffold were 120 μm and 70 %, respectively. The prepared HA scaffolds were dipped into the BMP loaded hybrid sol for 3 h and dried for 24 h at 37 °C. BMP-GFP was used to visualize the growth factor in the hybrid coating. The BMP release test was performed in 2 ml PBS at 37 °C for 28 days (n=5).

Results: The hybrid coating with the silica xerogel and chitosan on hydroxyapatite scaffold was observed by SEM and CLSM, as shown in Figure 1. The hybrid coating layer with BMP covered the surface of porous structure completely. Figure 1 (b) also showed homogenous distribution of BMP-GFP into the hybrid coating, by observing green fluorescence of the growth-factor. The release behavior of BMP in PBS was measured as a function of the release time, as presented in Figure 2. The hybrid coating revealed continuous and long-term release behaviors of BMP for up to 35 days (n=5).

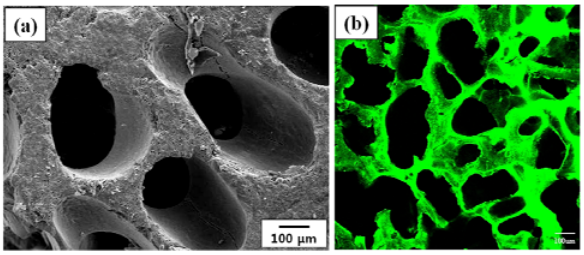

Figure 1. (a) SEM micrograph of BMP loaded hybrid coating and (b) confocal laser scanning microscopy image of BMP-GFP loaded hybrid coating on hydroxyapatite.

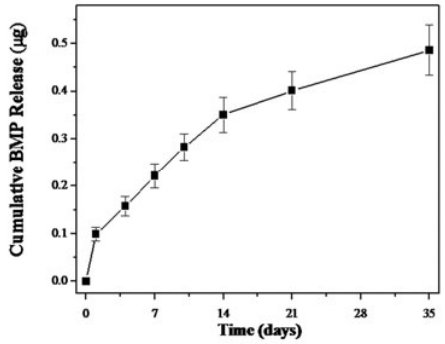

Figure 2. Cumulative amounts of BMP released from the hybrid coating on HA scaffold as a function of time (n=5).

Conclusions: Porous hydroxyapatite scaffolds were coated with the BMP loaded silica xerogel/chitosan hybrid by dipping-drying process. The growth factor has homogenous distribution in the hybrid coating layer, as observed by SEM images and fluorescence of BMP-GFP. The BMP was continuously released from the coating layer in PBS for 35 days. These results indicated that the hybrid coating which composed the silica xerogel and chitosan is a suitable material as delivery of BMP was for delivering growth factors.

References:

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