Protein adsorption of sol-gel derived bioactive glasses/collagen composite scaffolds

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Statement of Purpose:

In order to mimic the structure of bone and other mineralized tissues, hydroxyapatite has been compounded with collagen to fabricate composite scaffolds for bone regeneration applications. However, sintered hydroxyapatite is difficult to be absorbed, and do not possess the ability to stimulate cell growth. Previous studies have shown that bioactive glasses have good bioactivity and biodegradability and can stimulate cell proliferation and related gene expression [1,2]. Therefore, it is reasonable to assume that bioactive glasses/collagen composite may possess good bioactivity and used for tissue engineering applications. Interaction between materials and cells is one of the key factors in tissue engineering. It is well known that protein adsorption constitutes one of the earliest events at the biomaterials-tissue interface [3]. Webster et al. have shown that good ability of protein adsorption could enhance the cell adhesion on biomaterials [4]. In this study, sol-gel derived bioactive glasses/collagen composite scaffolds with different bioactive glass/collagen weight ratio were fabricated by phase-separation method and the protein adsorption on the composites was investigated.

Methods:

In this study, nano- and micro-sized 58S bioactive glasses were synthesized by sol-gel method [5], and bioactive glass/collagen composite scaffolds with different bioactive glass/collagen weight ratio were fabricated by phase-separation method. The porous structure of scaffolds and the glass/collagen interface within the scaffolds were characterized by scanning electron microscopy. The protein adsorption assay was performed by incubating the scaffolds in phosphate buffered saline (PBS, 0.1M, pH=7.4) containing 1% bovine serum albumin (BSA) [6] The albumin concentration was then measured by the coomassie brilliant blue-protein interaction [7]. The amount of absorbed proteins was determined by subtracting the amount of proteins left in the BSA/PBS solution after adsorption from the amount of proteins in control BSA/PBS solution (without specimen) under the same incubation conditions.

Results / Discussion:

The results showed that the bioactive glass/collagen composite scaffolds had a continuous structure of interconnected pores and pore diameter was about 100-150μm. The porosity was more than 95%. In the composite, the bioactive glass particles homogenously distributed on the skeleton of the collagen network and bonded tightly to collagen fibrils. The bioactive glass/collagen composite scaffolds showed a excellent protein adsorption property and the adsorption was enhanced with the increase of the amount of bioactive glasses incorporated in collagen matrix, and was higher than that of hydroxyapatite/collagen composites.

Conclusions:

The bioactive glass/collagen composite scaffolds possess good protein adsorption ability and might be used as tissue engineering scaffolds or growth factor delivery systems.

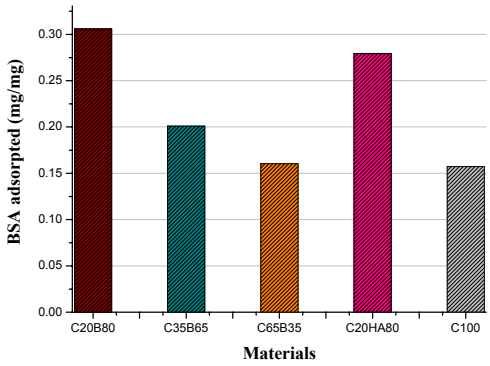

Figure 1. BSA adsorption of composite with different proportion of collagen (C) to bioactive glasses (B) and compared with hydroxyapatite (H) composite.

References:

1. Christodoulou I, Buttery LD, Saravanapavan P, Tai G, Hench LL, Polak JM., Dose- and time-dependent effect of bioactive gel-glass ionic-dissolution products on human fetal osteoblast-specific gene expression. J Biomed Mater Res B Appl Biomater. 2005, 74(1):529-37.
2. Bielby RC, Pryce RS, Hench LL, Polak JM., Enhanced derivation of osteogenic cells from murine embryonic stem cells after treatment with ionic dissolution products of 58S bioactive sol-gel glass. Tissue Eng. 2005, 11(3-4):479-88.
3. Lobel KD, Hench LL, Invitro adsorption and activity of enzymes on reaction layers of bioactive glass substrates, J Biomed Mater Res, 1998, 39:575-579.
4. Webster TJ, Ergun C, Doremus RH, Siegel Rw, Bizios R, Specific proteins mediate enhanced osteoblast adhesion on nanophase ceramics. J Biomed Mater Res, 2000, 51:475-483.
5. Zhong JP, Greenspan DC. Processing and Properties of Sol-Gel Bioactive Glasses. J Biomed Mater Res (Appl Biomater) 2000;53:694-701.
6. Wei G, Ma PX, Structure and properties of nano-hydroxyapatite/polymer composite scaffolds for bone tissue engineering. Biomaterials, 2004, 25: 4749-4757.
7. Kang IK, Kwon BK, Lee JH, Lee HB, Immobilization of proteins on poly(methyl methacrylate) films. Biomaterials, 1993, 14:787-792.