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Cover story

Chitosan-gelatin-platelet gel composite scaffold for bone regeneration

Although many strategies have been utilized to accelerate bone regeneration, an appropriate treatment strategy to regenerate a new bone with optimum morphology and mechanical properties has not yet been developed. Tissue engineering has been used to construct bone grafts for the healing of large bone defects. Cells, scaffolds and growth factors are the three key constituents for development of substitutes that restore, maintain, or improve tissue function [1]. Natural polymers, such as gelatin and chitosan, have been used in manufacturing scaffolds in bone tissue engineering [2]. In addition, incorporation of growth factors within scaffolds can improve the osteoconductive and osteoinductive properties and, thus, enhance new bone formation. Platelets, as a rich source of angiogenic, mitogenic and osteogenic growth factors, are expected to promote bone regeneration better than a single growth factor [3].

Professor Oryan and his coworkers [4] applied the chitosan-gelatin (CS-Gel) scaffold incorporated with platelet gel (PG) to enhance bone formation, bone volume, and mechanical performance which are comparable to autologous bone grafts. Moreover, the increased mRNA levels of osteogenic and angiogenic differentiation markers measured by real time-PCR indicated that the CS-Gel-PG scaffold stimulated osteoblast differentiation as compared with the control scaffolds. They have shown that the CS-Gel-PG scaffold has high biocompatibility and biodegradability with considerable osteoinductive and osteoconductive potentials. In fact, the CS-Gel composite scaffold acts as a suitable carrier for PG and delivers the growth factors to result in a newly regenerated bone. These observations were consistent with Professor Lu and colleagues [5], who loaded a CS-Gel sponge cross-linked by tannins with autogenous platelet-rich plasma for healing of skin wounds. The covered wounds healed more quickly than those covered with the controls.

The work by the Oryan team shows that the simple CS-Gel loaded with PG can serve as effective bone grafts. The uniqueness of the approach is its simplicity. First, CS and CS-Gel scaffolds were prepared by crosslinking both CS and Gel with glutaraldehyde, followed by freeze drying. Then, CS-Gel scaffolds are suspended in platelet solution to absorb the platelets. Finally, thrombin is added to activate the platelet solution to form a gel. The freeze-dried CS-Gel-PG provides scaffolds for many tissue engineering applications, including bone regeneration. The advantages of this simple approach include introduction of a mixture of growth factors from PG, which can be autologous, allogenic, or xenogenic. The properties of CS-Gel constructs can be easily controlled by adjusting the concentrations of the polymers and the crosslinking density. It will be interesting to find out whether PG can be used for other tissue engineering applications as effectively as bone regeneration.

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