Bone Tissue Regeneration System That Provides Spatial and Temporal Control Over the Release of Growth Factors

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Technology description

Description

A fracture requiring orthopedic treatment occurs approximately every 14 seconds in the United States. Musculoskeletal conditions cost an estimated $254 billion each year in the United States, and bone and joint diseases account for half of all chronic conditions in adults over the age of 50. New treatments for this growing problem are needed.

Regenerating natural bone tissue is a promising approach to bone replacement. Emerging methods for tissue regeneration have focused on delivering growth factors to the site of the fracture or defect, as these biomolecules can promote osteogenesis, the formation of new bone. However, existing passive bone tissue repair or replacement systems do not have sufficient control over the process of new bone formation.

Under physiological conditions, bone tissue regeneration involves a complex interplay of multiple biologically active molecules and stem cells. The biologically active molecules often are presented sequentially in cascades in which each factor has a distinct effect on the cells of a growing bone. Thus, a key issue in designing bone tissue regeneration systems is to temporally control the concentration of these biologically active molecules.

UW–Madison researchers have developed a tissue regeneration system that utilizes porous scaffolds to localize and temporally control the release of multiple growth factors. In this system, porous beta tricalcium phosphate (β-TCP) templates are coated with one or more extracellular matrix layers. The layers include at least one thin, degradable mineral layer that is similar to bone mineral.

Advantages

Because the coating process does not require high temperatures or organic solvents, biologically active growth factors such as vascular endothelial growth factor (VEGF) and bone morphogenetic protein-2 (BMP-2) can be incorporated in the layers.

To control dissolution order, and ultimately, delivery of the biologically active molecules, multiple

distinct layers are deposited on the β-TCP scaffold. Each layer may contain one or more active biomolecules and is designed to dissolve at a separate rate. As the matrix material gradually breaks down, the growth factors are delivered sequentially. This provides temporal control of growth factor signaling, thereby directing the activities of associated cells, to enable the growth of new bone tissue.

Institution

University of Wisconsin