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Mini Review

Mini review: Angiogenic Osteogenic Coupled Stents

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Abstract

Bone defect refers to the loss of bone structure caused by trauma, tumor, congenital deformity and other reasons. Bone defect repair is a difficult problem in orthopedics clinic. Bone tissue engineering has brought hope for the repair of bone defects. However, the clinical integration of bone tissue engineering scaffolds is still very low. The major obstacle is the lack of accompanying vascularization of the engineered bone construct, resulting in cell necrosis and bone failure in the area within the implant material. This small review briefly summarizes the novel bone tissue engineering scaffolds with good curative effect in repairing bone defects.

Keywords: Bone defect; Bone vascularization; Bone tissue engineering

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Introduction

Bone defects caused by various causes are very common in clinical practice. How to effectively promote bone repair has been a major challenge for people. At present, there are various repair methods, such as autologous bone graft, allograft bone graft and artificial bone graft. The gold standard in clinical practice is autologous bone graft, but another operation area will increase additional pain and the repair scope of the defect is limited. Allograft bone implantation has certain risk of rejection. The osteogenic effect of artificial bone transplantation is poor [1]. At present, the application of bone tissue engineering in bone defect repair has a bright prospect. The combination of the obtained seed cells with scaffold materials provides a biological microenvironment containing growth factors, which can promote bone formation and bone repair. However, the lack of vascular formation in tissue engineering structures, and the slow penetration of host blood vessels in large-scale engineered bone tissue grafts is considered to be one of the main obstacles in current bone tissue engineering [2]. Studies have shown that [3] bone is a highly vascularized tissue, angiogenesis is a highly coupled process with bone formation, and good blood supply is a prerequisite for bone tissue regeneration. This brief review briefly summarizes the bone tissue engineering scaffolds with good effect on osteogenesis and angiogenesis in repairing bone defects in recent years.

Biomimetic Layered Scaffold for Bone Immunoregulation

Studies have shown that the process of bone regeneration involves not only bone related cells and bone system, but also multicell and multi-system. Bone immune regulation can promote bone immune balance by mediating the interaction between immune cells and bone cells [4,5]. Therefore, materials with good bone immunomodulatory properties can mediate favorable, bone immune microenvironment promotes bone tissue regeneration. Jin Zhang

et al. [6] prepared a biomimetic layered scaffold composed of nanoparticles, nanosheets, hydrogels and polylactide/hydroxyapatite. In addition to mimicking cortical and cancellous bone tissue, the scaffold is filled with soft hydrogel that mimics the extracellular matrix of natural bone. Studies have confirmed that after implantation of bone immunomodulatory scaffold, it can dynamically regulate the bone immune microenvironment in the host by activating the immune system, thus enhancing bone binding under physiological conditions. In vitro studies showed that DMGP scaffold significantly up-regulated macrophage M2 polarization, accelerated HUVEC migration, promoted the generation of mineralized matrix, and up-regulated the expression of ALP, Runx2, Col I, OPN and other osteoblast-related genes. Based on a large number of data in vivo and in vitro, this kind of bone immunoregulatory scaffold has considerable potential in clinical bone defect repair.

HAp/MAE-LDH stent

Wang G et al. [7] found that the surface functionalization of MAE-LDHs nanosheets on the porous hydroxyapatite HAp scaffold could significantly improve the surface roughness, specific surface and hydrophilicity of the scaffold, thus effectively promoting cell adhesion, and thus enhancing angiogenesis and osteogenic differentiation. More importantly, MAE-LDHs nanosheets on HAp scaffoldings can continuously release Mg2+ and Eu3+, which promote bone repair and angiogenesis. In vivo studies further showed that HAp/MAE-LDH scaffolds had 3.18-fold and 2.21-fold increases in new bone mass and mineral density, respectively, compared to the original HAp scaffold. Transcriptome sequencing analysis showed that HAp/MAE-LDH scaffold could activate the Wnt/ β-catenin signalling pathway, thereby promoting angiogenic osteogenic ability.

Prospects

The reconstruction of extensive bone defects is still a huge challenge in medicine, society and economy, and the traditional methods of bone defect repair still have some limitations. Bone tissue engineering technology has opened a new way to repair bone injury, which has a profound influence on modern medicine. The lack of angiogenesis in tissue engineering structures is considered to be one of the major obstacles in bone tissue engineering. Tissue engineering bone vascularization is the basis to ensure the survival of grafts and is also the key technology of bone tissue engineering. However, the current bone tissue engineering has not been combined with the cutting-edge innovation of vascular tissue engineering, and to realize the transformation of vascular bone tissue engineering scaffolds requires constant exploration and innovation.

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