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Skeletal Tissue Engineering with Biomaterials Based on Modular Protein Engineering

Lev Chekhov*

Department of Orthopedic Surgery, University of Hamburg, Hamburg, Germany

Description

Biomaterials are necessary for tissue engineering, which is an important part of the repair of skeletal tissue. However, biomaterials that are currently in use, such as chemically produced polymers and animal extracts, lack bioactivity and safety. In recent years, the number of modular protein engineering-based MPE biomaterials made of polypeptides generated through molecular cloning and protein synthesis has significantly increased [1]. These biomaterials have a lower variance from batch to batch, prevent dangerous infections, and, most importantly, are sequence-tenable. This paper provides a brief overview of the characteristics of various MPE biomaterials that are categorized according to the structural domains of polypeptides, as well as methods for editing the polypeptide sequence and creating MPE biomaterials at will. After that, we'll take a look at how skeletal tissue engineering can benefit from bio-designed MPE biomaterials. The structural domains of polypeptides can be used by themselves or in combination [2].

During *in vivo* skeletal tissue repair, MPE biomaterials' cytocompatibility, influence on cell fate and ECM formation, mechanical properties, and functions would all be determined and guided by their sequence protein modules. In addition, we suggest a number of bio-design approaches and potential routes for the creation of MPE biomaterials with the goals of faster skeletal tissue regeneration and improved skeletal tissue engineering. Material science and protein engineering could work together to solve the problems in regenerative medicine. A comprehensive review of skeletal tissue engineering using polypeptide sequence-guided biomaterials and MPE biomaterials is provided in this article. The biomechanical and physiological functions of our bodies are dependent on the skeletal system. This system is a frequent target of injury due to trauma, infection, tumor excision, and other skeletal disorders. Massive bone regrowth is absent from bone fractures, despite the fact that a gradual healing process can be observed [3].

Due to its lack of cellularity, nerve tissues, and blood supply, cartilage is practically incapable of self-repair. This has made it hard to find current treatments for diseases related to the skeleton, so regenerative medicine related to the skeleton needs to be done right away. Autologous bone grafting, allogenic bone grafting, and metallic devices have all been used frequently for bone repair for a long time. However, it is associated with a number of clinical outcomes, as well as an increase in postoperative morbidity and costs for surgery at the donor site. Non-surgical treatments for cartilage repair include bracing, anti-inflammatory medications, and other methods. Operational procedures include periosteal transfer and a microfracture of the subchondral bone. However, despite the fact that these methods work for short-term pain, their long-term effects frequently remain elusive. By simulating native tissue, filling in injured tissue, and creating a microenvironment that encourages tissue repair through cell-material and body-material interactions, advances in tissue engineering have opened up new avenues for the treatment of skeletal conditions.

Biomaterials play a crucial role in the engineering of skeletal tissue. The most common chemically generated materials for skeletal tissue engineering are ceramics and synthetic polymers. Calcium phosphate ceramics are hard but brittle, with Young's moduli around and brittleness around, whereas polymers like polylactic acid, polyethylene glycol, and poly-caprolactone have good mechanical properties but may have toxic or dangerous degradation products. Because it is difficult to replicate native tissues using chemically produced materials, researchers prefer to produce biomaterials from naturally sourced extracellular matrix, such as animal-derived collagens. However, animal-derived ECM may present significant issues when utilized as biomaterials. Biomaterials may include unknown components or pathogenic pathogens of any variety. Mass production without batch-to-batch variation is difficult to achieve without sacrificing a large number of animals. The polypeptide sequence of the ECM derived from animals cannot be altered, which is significant [4].

Advances in genetic engineering and solid phase peptide synthesis methods enable researchers to create novel protein-based biomaterials that have never been seen in nature or to construct modular protein engineering-based biomaterials that match the sequence and structures of native ECM. MPE biomaterials that are extremely pure, chemically defined, and functionalized can also be produced on a large scale with this innovative method. Consequently, extensive *in vitro* and *in vivo* testing has been conducted on the materials. The characteristics of various MPE biomaterials utilized in the engineering of skeletal tissue. How to synthesize a variety of MPE biomaterials is discussed. The application of MPE biomaterials to skeletal tissue engineering will be the next topic of discussion. Additionally, we offer suggestions for upcoming bio-design endeavors and other subjects [5].

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Conflict of interest

None

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***Address for Correspondence:** Lev Chekhov, Department of Orthopedic Surgery, University of Hamburg, Hamburg, Germany; E-mail: levchekhovlev@gmail.com*

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