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Review

Directing bone marrow-derived stromal cell function with mechanics

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ABSTRACT

Because bone marrow-derived stromal cells (BMSCs) are able to generate many cell types, they are envisioned as source of regenerative cells to repair numerous tissues, including bone, cartilage, and ligaments. Success of BMSC-based therapies, however, relies on a number of methodological improvements, among which better understanding and control of the BMSC differentiation pathways. Since many years, the biochemical environment is known to govern BMSC differentiation, but more recent evidences show that the biomechanical environment is also directing cell functions. Using in vitro systems that aim to reproduce selected components of the in vivo mechanical environment, it was demonstrated that mechanical loadings can affect BMSC proliferation and improve the osteogenic, chondrogenic, or myogenic phenotype of BMSCs. These effects, however, seem to be modulated by parameters other than mechanics, such as substrate nature or soluble biochemical environment. This paper reviews and discusses recent experimental data showing that despite some knowledge limitation, mechanical stimulation already constitutes an additional and efficient tool to drive BMSC differentiation.

Contents

1. Introduction

Over the last decades, tissue engineering has been proposed as a method to repair or regenerate a growing number of tissues and organs (skin, bone, heart, pancreas, etc.). This therapeutic strategy consists of transplantation of ex-vivo expanded regenerative cells, sometimes associated with a biomaterial scaffold and/or molecular agents for tissue reconstruction. Many cell types are envisioned as source for those regenerative cells: from organ/tissue specific cells (chondrocytes, skin fibroblast, etc.) to totipotent embryonic stem cells (Muschler et al., 2004). One of the most promising sources of regenerative cells, however, might be the bone marrow. Evidence that bone marrow contains cells having an important proliferation capacity and being able to form bone and cartilage was first showed by Friedenstein et al. (1970) in the late 60s. Since then, many studies have established that these cells can differentiate in vitro into chondrocytes, osteoblasts, adipocytes, and myoblasts (Chamberlain et al., 2007;

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