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Review

Mechanisms of Mechanotransduction in Bone Remodeling

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ABSTRACT

Clinical observations indicate that mechanical loading can inhibit bone resorption and increase bone formation. However, the mechanisms of such physiological phenomena were not clear until the past decade. Results obtained from numerous in vivo and in vitro studies show that mechanotransduction plays an important role in bone modeling and remodeling. Osteocytes are the major sensor cell for mechanical shear stress caused by fluid flow in the lacuno-canalicular network. Several types of molecules, such as PGE_2, c-AMP, and Ca^{2+}, were found to be secondary messengers in the pathway of mechanotransduction. These signal molecules can transmit to the bone surface through both the gap junction between cellular processes and extracellular fluid. An increase in isulin-like growth factors simulated produced by signal molecules can stimulate cellular DNA of bone cells and activate the process of remodeling and proliferation. (N. Taipei J. Med. 2001; 3:218-224)

INTRODUCTION

Bone is the hard part of connective tissue which constitutes the majority of the skeleton of the human body. It consists of an organic component and an inorganic or mineral component. It provides support for the body against external forces, and supplies protection for vital internal organs. The growth and repair of bone in a maturing skeleton occur through the process of remodeling. Bone remodeling is defined as the process by which bone mass is maintained or decreases.[1] Bone remodeling in both cortical and trabecular bone occurs at basic multicellular units (BMU) on all bone surfaces throughout life. In 1870, based upon observations concerning cancellous bone structure, Wolff found that the process of bone remodeling was influenced by the environmental load on the bone.[2] He proposed that mechanical stress is responsible for determining the adaptation of bone by a mathematical law. It is now known as Wolff's law, which is the most important basis on which to discuss the phenomenon of bone remodeling. However, the exact mechanisms of Wolff's law were not clear until the last decade.

Effects of the Mechanical Environment on Bone Modeling and Remodeling

Results obtained from numerous experimental and clinical studies show that the process of fracture healing in long bone depends upon the mechanical enviroment.[3,4] A significant improvement in healing was found to be associated with application of controlled micromovements. That is, mechanical stimulation can

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