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Biology of the orthodontic tooth movement – using collagenase 3 (MMP-13, matrix metalloprotease 13) as a working model

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Abstract

Orthodontic tooth movement demands bone remodeling around the root area. The remodeling includes the pressure resorption and the tension apposition sites adjacent to root. While bone deposition mechanism has been studies extensively, the bone resorption mechanism, the limiting step to tooth movement remains unclear. Thus, it is essential to investigate the bone resorption mechanism induced by the orthodontic force.

Collagenase 3 is used as a model in our study. Collagenase 3, synthesized and secreted by osteoblasts, is a metalloprotease (MMP-13) that cleaves the intact collagen I on the 3/4 site. Only when the intact collagen being degraded can the residing enzymes start digesting the remnants. Briefly, osteoblasts were grown to confluence, subjected to serum depletion over night before receiving a bi-directional stretch for 30 minutes. At first, the respondent MMP-13 was identified. The induced MMP-13 gene belongs to an immediate early responsive gene family. Then, the MMP-13 gene expression was examined at the transcription and the translation level. Last, the MAPK signaling participates in MMP-13 induction. Even though PDGF is known to induce MMP-13, its receptor PDGFR-alpha is not a mechano-sensor in osteoblasts. Moreover, the tyrosine kinase C-delta activates and regulates PDGFR-alpha. The pharmacological means and the dominant negative mutants of the molecules were used to define the signaling pathway leading to the MMP-13 expression induced by mechanical force. Taken together, the knowledge of the mechanical induced MMP-13 expression may shed light on the understanding of the bone resorption mechanism in the biology of tooth movement.

Biography

Dr. Chou Bing Wu received his MSD and Orthodontic certificate at Case Western Reserve University, Cleveland, OH, and his PHD at Northwestern University, Chicago, IL, USA. He has been teaching and practicing Orthodontics. Currently, also serves as a director in the MEM Dental Technology Co. Ltd, Taiwan. His research involves the matrix-mediated bio-mineralization mechanism in bone and dentin, mechanical loading to the bone cells, and orthodontics. The works were reported in Journal of Dental Research, Journal of Biological Chemistry, and others. He also reviewed for Journal of Orthopedic Research, Bone, etc. and orthodontic related journals.