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System for Mechanical Stimulation of the Mesenchymal Stem Cells Supporting Differentiation into Osteogenic Cells

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Abstract : The aim of this study was to develop a system for mechanical and also electrical stimulation controlling in vitro osteogenesis under conditions more similar to the in vivo bone microenvironment than traditional static cultivation, which would achieve good adhesion, growth and other specific behaviors of osteogenic cells in cultures. An engineered culture system for mechanical stimulation of the mesenchymal stem cells on the charged surface was designed. The bioreactor allows efficient mechanical loading inducing an electrical response and perfusion of the culture chamber with seeded cells. The mesenchymal stem cells were seeded to specific charged materials, like polarized hydroxyapatite (Hap) or other materials with piezoelectric and ferroelectric features, to create electrical potentials for stimulating of the cells. The material of the matrix was TiNb alloy designed for these purposes, and it was covered by BaTiO3 film, like a kind of piezoelectric material. The process of mechanical stimulation inducing electrical response is controlled by measuring electrical potential in the chamber. It was performed a series of experiments, where the cells were seeded, perfused and stimulated up to 48 hours under different conditions, especially pressure and perfusion. The analysis of the proteins expression was done, which demonstrated the effective mechanical and electrical stimulation. The experiments demonstrated effective stimulation of the cells in comparison with the static culture. This work was supported by the Ministry of Health, grant No. 15-29153A and the Grant Agency of the Czech Republic grant No. GA15-01558S.

Keywords : charged surface, dynamic cultivation, electrical stimulation, ferroelectric layers, mechanical stimulation, piezoelectric layers

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