# Nanoscale Mechanical Stimulation of Human Mesenchymal Stem Cells

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**Introduction:**
Mechanical stimulation of human mesenchymal stem cells has demonstrated changes in many cell behaviours such as adhesion, migration, growth and differentiation through mechanotransductive pathways. These include experiments on effect of nanotopography 1, shear stress, stiffness of extracellular matrix 2, strain, stress and acoustic wave energy 3 on cells. In this research we were looking for mesenchymal stem cell responses to nanoscale mechanical vibrations in Z-axis. The changes in cell number and shape, differentiation and genetic changes were compared after stimulation with static control groups.

**Methods:**
A simple protocol for the stimulation of cells in nanoscale Z-axis has been developed for this project (Figure 1). Piezo actuator (type: P-010.00H by PI CeramicÒ) connected to the cell culture dish moves the entire surface up and down. The amount of displacement is dependent on the voltage applied. Attaching an aluminium disk to the base of the Petri dish ensures faithful transfer of the vibration to the cells. Human mesenchymal stem cells from bone marrow (PromoCellÒ) were seeded with 104 cells/dish. After 4 hours seeding and cell settlement, the cells were stimulated for 24 hours, 1 week, and 2 weeks. Experiments were performed in an incubator with optimal temperature 37°C and 5% CO2 concentration. The Petri dish was 60 mm x 15mm standard tissue culture treated polystyrene dish (52mm base diameter) from CorningÒ Incorporated and cell culture media used was MEM alpha modification with L-Glutamine and nucleosides from PAA laboratories (Austria) supplemented with 10% FBS and antibiotics (penicillin and streptomycin).

**Results:**
We observed significant responses after 1 and 2-week stimulations in cell number, cell shapes and phenotypical markers. Microarray was performed for all groups. Cell count showed normal cell growth with stimulation. However, cell surface area, cell perimeter, and arboration after 1-week stimulation showed significant increases. Immunofluorescent studies have showed significant increase in osteocalcin production after stimulation.

**Conclusions:**
Nanoscale mechanical vibration showed significant changes in human mesenchymal stem cell behaviours. Cell morphology changed to become more polygonal and increased expression of the osteoblast markers were noted. These findings with gene regulation changes suggesting nanoscale mechanostimulation has stimulated osteoblastogenesis.

**Keywords:** Mesenchymal, Nanoscale, Stem Cells.

Poster Presentation

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