The Effects of Mechanotransduction on MSC Differentiation

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The increase in the number of osteochondral defects and joint replacements performed each year places a demand on doctors and engineers to improve the available diagnostic, preventative, and treatment options for orthopedic conditions. The field of tissue engineering has emerged to address this need particularly through mesenchymal stem cells (MSCs) and engineered substrate scaffolds. The ultimate goal of these methods is to develop an implant to treat orthopedic diseases that can promote specific MSC differentiation, support tissue generation, and withstand physiologically relevant forces and stresses. Mechanotransduction underlies the ability of MSC differentiation to be influenced by the substrate stiffness, the application of a mechanical load, and the substrate composition, all of which is complicated by paracrine cell signaling.

Based on an extensive literature review of MSC mechanotransduction and initial moduli values of human MSCs seeded in a hyaluronic acid scaffold, a dynamic compression machine for soft tissue biomechanical analysis has been designed to be used in future studies. This machine will allow for a thorough investigation to be conducted regarding the effects of dynamic loading, substrate stiffness, and substrate composition on human mesenchymal stem cell (hMSC) differentiation into bone and cartilage tissue.