Mechanical stimulation of adipose tissue derived mesenchymal stem cells

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Introduction:

Mesenchymal stem cells (MSCs) are a widely used cell source in tissue engineering and regenerative medicine due to their ability to be expanded and differentiated easily in vitro as well as in vivo. MSCs can be obtained from a variety of tissues including adipose tissue. This is easy to obtain and it is capable of yielding cell numbers substantial enough to obviate extensive expansion in culture. Static cell culture with the aim of tissue engineering applications has been proven to be disadvantageous since constructs grown in static cell culture lack the mechanical stability native tissue exhibits. Mechanical stimulation has therefore become a substantial tool in tissue engineering to accustom cells to their future physically active environment. Moreover, differentiation of stem and progenitor cells has been proven to be supported by mechanical strain.

Materials and Methods:

Adipose tissue derived mesenchymal stem cells (adMSCs) were subjected to a cyclic mechanical strain with frequency of 1 Hz and an elongation of 5\%. Time schemes of strain were varied and included 15 min, 60 min, 2 h, 4 h and 8 h and a repetitive strain of thrice 15 min, 60 min, 2 h, 4 h and 8 h with each having an intermission of double the strain time (i.e., 30 min, 60 min, and 4 h, 8 h and 16 h respectively). Osteogenic marker expression (collagen I, cbfa1/runx2, bone sialoprotein 2, Osteopontin, bone morphogenetic proteins 2 and 4, osteocalcin, alkaline phosphatase) after strain was monitored via reverse transcriptase polymerase chain reaction. Collagen III expression was monitored as indication for repair mechanisms induced by the cells after cell damage.

Results:

Osteogenic marker expression was unique after each applied time scheme. Considerable differences of osteogenic marker expression compared to control cells were determined after thrice 15 min and once 60 min of strain. Repetition of strain resulted in lower collagen III expression compared to singular strain indicating cellular accustomization.
Discussion and Conclusions:

Mechanical strain was shown to have distinct effects on the osteogenic differentiation status of adipose tissue derived mesenchymal stem cells. Different time schemes were applied reaching from singular short time strain to a repeated long time strain. It was shown that strain duration has to be considered carefully for each experimental setup keeping in mind that mechanical load effects cellular processes including differentiation.