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Applicability of Low-intensity Vibrations as a Regulatory Factor on Stem and Progenitor Cell Populations

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Abstract

Persistent and transient mechanical loads can act as biological signals on all levels of an organism. It is therefore not surprising that most cell types can sense and respond to mechanical loads, similar to their interaction with biochemical and electrical signals. The presence or absence of mechanical forces can be an important determinant of form, function and health of many tissue types. Along with naturally occurring mechanical loads, it is possible to manipulate and apply external physical loads on tissues in biomedical sciences, either for prevention or treatment of catabolism related to many factors, including aging, paralysis, sedentary lifestyles and spaceflight. Mechanical loads consist of many components in their applied signal form such as magnitude, frequency, duration and intervals. Even though high magnitude mechanical loads with low frequencies (e.g. running or weight lifting) induce anabolism in musculoskeletal tissues, their applicability as anabolic agents is limited because of the required compliance and physical health of the target population. On the other hand, it is possible to use low magnitude and high frequency (e.g. in a vibratory form) mechanical loads for anabolism as well. Cells, including stem cells of the musculoskeletal tissue, are sensitive to high frequency, lowintensity mechanical signals. This sensitivity can be utilized not only for the targeted treatment of tissues, but also for stem cell expansion, differentiation and biomaterial interaction in tissue engineering applications. In this review, we reported recent advances in the application of low-intensity vibrations on stem and progenitor cell populations. Modulation of cellular behavior with low-intensity vibrations as an alternative or complementary factor to biochemical and scaffold induced signals may represent an increase of capabilities in studies related to tissue engineering.

Keywords: Stem cell; biomechanics; mechanobiology; progenitor cell populations; tissue engineering; vibrations.

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