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SIMULATED MICROGRAVITY STUDIES OF STEM CELLS AND ENGINEERED-TISSUE

Abstract

Space flight results in almost all human physiological systems, with bone loss, anemia, skeletal muscle atrophy and immune alterations commonly seen. Among the total, microgravity, as one of mechanical factors, has been recognized as a major environmental factor, which causes many of the above mentioned problems at cellular level. Because of the cost effectiveness and limited access to space flight, simulating microgravity on Earth is widely utilized in space life research. Here, we summarize current knowledge about the effects of simulated microgravity on stem cells growth and engineered-tissue formation. The major affected cellular activities and parameters of microgravity on stem cells are proliferation, differentiation, apoptosis, DNA damage repair, etc. The studies on the effect of microgravity on adult stem cells such as rat bone marrow mesenchymal stem cells, human mesenchymal stem cells, human hematopoietic progenitor cells, human epidermal stem cells and human periodontal ligament stem cells have been reported by several groups. The results of these studies were helpful to understand the pathogenesis of the abnormalities such as bone loss, anemia and immunodeficiency observed in space. More recently, simulative microgravity culture conditions were successfully used to culture mouse embryonic stem cells in feeder-free, serum-free media and leukemia inhibitory factor-free systems and induce the proliferation and differentiation of embryonic stem cells to mature hepatocyte. Tissue engineering is also emerging as one of the most feasible applications of microgravity. Studies have shown that the simulated microgravity biological reactor system provides mechanical stimuli that imitate the microenvironment in vivo including shear force, hydrostatic pressure, and joint compression force. It is possible to engineer artificial tissues, structures or organs with the help of simulated microgravity. Researchers mainly focused on growth of individual cells into functional three-dimensional aggregates similar to native tissues. At present, the simulated microgravity bioreactor system has been used for the reconstruction of a variety of engineered tissues, including bone, cartilage, liver, and epidermis structures. Totally, it was demonstrated that gravity is an important factor that affects the growth of stem cells and reconstruction of engineered-tissue. Greater insight into simulated microgravity studies of stem cells and engineered-tissue is crucial for developmental biology, tissue engineering and regenerative medicine. KEYWORDS: microgravity; stem cells; tissue engineering