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Profiling the patterns of miRNAs and transcriptome of human vasculature under micro-gravity: A template study using space science for solving health problems on the Earth

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Abstract

Microgravity (MG) offers a unique condition, which promotes cellular growth and functions. MG can yield three-dimensional tissue specimens mimicking natural growth and easier self-association of cells unlike traditional cultures. The vascular system is capable of remodeling its structure surprisingly in short time frame and adaptation to new environment. Treatment of endothelial monolayer and embryo vascular plexus with simulated MG resulted in an increase in tube formation and angiogenesis. Our findings indicate that simulated MG driven angiogenesis was mediated by iNOS-cGMP pathway. Further, we checked whether microgravity sensitization maintained the functionality of endothelial cells. Towards this, we performed the tube formation assay of microgravity-treated endothelial cells. Microgravity-stimulated endothelial cells have shown to form more tubes as compared to cells under gravity.

Next, we explored possibilities for the applications. We hypothesized that microgravity sensitized endothelial cells may prove to hasten wound healing process by re-establishing rapid angiogenesis at wound site. We examined the effect of microgravity on wound healing using rat model and observed that microgravity hastens the wound healing process as second degree burn wounds implanted with microgravity sensitized endothelial cells have shown to heal faster in rat model.

Finally, we performed deep sequencing of miRNA followed by genome wide transcriptome sequencing of microgravity sensitized endothelial cells to unravel the mechanism of microgravity induced angiogenesis. An extensive analysis of the data including differential miRNA expression profile, heatmap showing relative expression of miRNA, comparative expression profile between miRNA and their mRNA targets detected under microgravity condition, were performed. The analysis documented up-regulation of miRNAs related to angiogenesis and their related pathways.

Present study infers that microgravity sensitized endothelial cells promotes angiogenesis, which can be used as a primer to ensure an efficient wound healing process. An in-depth deep sequencing study confirms that microgravity sensitizes the genome of human endothelial cells to promote angiogenesis and thereby wound healing.

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