Photobiomodulation on In Vivo and In Vitro Wound Models Under Simulated Microgravity for Future Space Travel

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Studies on astronauts in space show that microgravity disrupts the delicate balance of processes required for wound healing, slowing it down or even stopping it completely in space. This presents a serious risk for long-term space travel. In this study, the use of photobiomodulation (PBM), where 600-800nm light is used to stimulate cellular processes, was investigated as a novel means to speed up wound healing in normal and simulated microgravity conditions. Planarians were selected as a model for tissue regeneration and exposed to PBM treatments varied in wavelength and fluence. The results showed a 47.1% increased blastema growth rate when treated with PBM (660nm, 0.36J/cm^2) in normal gravity. To simulate a microgravity environment, a low-cost 3D clinostat was constructed. The procedure was repeated in the 3D clinostat, showing a 95.2% increase in blastema growth rate when exposed to the same PBM treatment. To determine the effectiveness of PBM on human cells, a scratch wound closure assay on cell line DU145 was performed, demonstrating a 29.4% increase in cell migration rate with PBM(660 nm 0.36J/cm^2). PBM treatment outcomes exhibited dose dependence, with an optimal treatment consisting of 5 minutes of 660nm red light exposure(0.36J/cm^2). Fluences of light greater than or less than 0.36J/cm^2 were significantly less effective in both wound models. The results suggested that PBM could be a superior, more economical solution for wound healing in space or even on Earth.