Development and Optimization of a 3D Clinostat to Simulate Microgravity

Clary, Joseph (School: Caddo Parish Magnet High School)

Sending experiments to the International Space Station is expensive; therefore, clinostats are used to perform microgravity simulations. Although 3D clinostats provide an accurate simulation, because of their high cost and limited availability, many researchers are unable to use them in experiments. Previously, a 3D printable 3D clinostat was designed, but further development and optimization was required before it could be used in experimentation. An accelerometer was used to determine the time-averaged magnitude at different ring velocity combinations. Rotating the inner and outer rings at 0.625rpm and 0.5rpm, respectively, created a sub-optimal microgravity simulation with a magnitude of 0.033g. To further optimize operating conditions, a python program was used to model the acceleration vector. The optimal simulation predicted a magnitude of 0.0015g when the inner and outer ring rotated at 1.5rpm and 3.875rpm, respectively. When run at these conditions, the resulting acceleration vector paths for both the 3D clinostat and the RPM 2.0 were consistent with the vector path predicted by the computer model. Additionally, the magnitude measured by the RPM 2.0's integrated accelerometer was consistent with the magnitude predicted by the computer model. Although the magnitude recorded on the 3D clinostat was significantly larger than the predicted magnitude, this difference was likely because of issues with sensor sensitivity. A human neuronal-like cell line was subjected to simulated microgravity for 48 hours, resulting in a significant decrease in DNA damage. This needs to be further studied, as it could have implications for astronauts' neuronal function on extended space missions.

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