Long-term Effects of Simulated Space Radiation on the Interna Jugular Vein Biochemistry.

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Background

Space travel subjects humans to the spaceflight environment, characterized by:

-Fluctuations in temperature extremes.
-Exposure to deep-space radiation.
-Impact of weightlessness, such as microgravity.

Exposure to these environmental factors triggers physiological adaptations, heightening the likelihood of the crew developing medical conditions, including cardiovascular deconditioning. To evaluate these risks, we conducted a study examining the prolonged and combined impacts of deep space radiation and microgravity on rats.

Our hypothesis involves investigating alterations in blood vessel structure and function resulting from simulated spaceflight exposure.

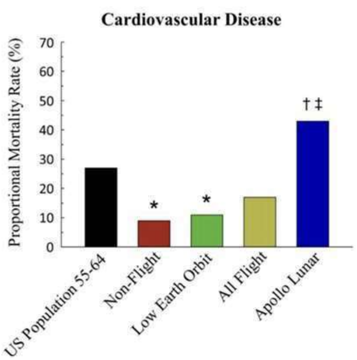


Figure 1: Astronaut mortality rate from spaceflight exposure due to cardiovascular disease. (See reference 1).

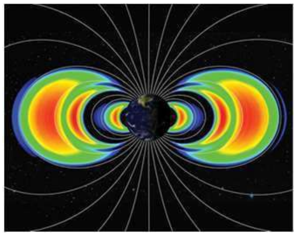


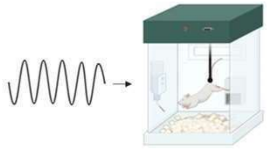
Figure 2. Van Allen Belts, *NASA's Goddard Space Flight Center/Johns Hopkins University, Applied Physics Laboratory*

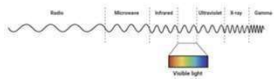
Figure 3. Brookhaven National Laboratory

Methods

Biospecimen samples were collected and processed from the following groups.

Figure 4. Simulated radiation and hindlimb unloading





EXPERIMENTAL GROUPS	Rats/Group
Sham Irradiation	18
Hindlimb Unloading (HLU)	18
Space Radiation - 0.75 Gy	18
Space Radiation - 1.5Gy	18
HLU+Space Radiation, 0.75 Gy	18
HLU + Space Radiation, 1.5 Gy	18
Total Animals	108

Rat internal jugular veins were cryostat sectioned and stained, via immunofluorescence, to quantify structure.

Figure 5. Example image of a cryostat sectioned sample

Figure 6: Example immunofluorescence image for quantifying structure

Results

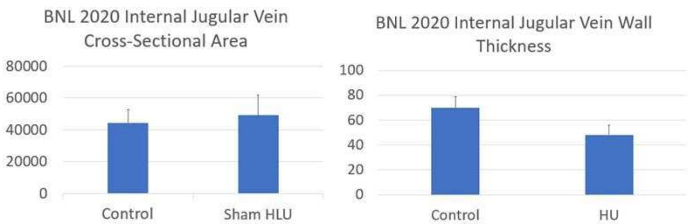


Figure 6. Effects of simulated microgravity on internal jugular vein structure. From simulated microgravity exposure, there are suggestions of vein structural remodeling, including increases in cross sectional area and decreases in wall thickness. These may be due to vessel relaxation from decreased blood pressure and consequent wall thinning. These observations were not statistically different.

Discussion

As our exploration of space expands, more individuals travel and reside in this extraterrestrial environment. Consequently, there is a growing need to comprehend the effects of spaceflight on human physiology.

To investigate human adaptations to the spaceflight conditions, we employed rats as a model organism. These rats were exposed to simulated spaceflight scenarios.

Our observations reveal lasting effects from simulated deep space radiation and microgravity exposure. Specifically, we identified distinct cardiovascular adaptations, particularly in the internal jugular vein. These findings have implications for astronauts' health during space journeys

Future Directions

Ongoing and upcoming studies are examining biochemical and physiological adaptations in the internal jugular vein. Additionally, we investigate various components of the cardiovascular system, including vascular pathways (e.g., endothelial nitric oxide synthase) and oxidative stress pathways (e.g., superoxide dismutase).

References

1. Delp MD, Charvat JM, Limoli CL, Globus RK, Ghosh P. Apollo lunar astronauts show higher cardiovascular disease mortality: possible deep space radiation effects on the vascular endothelium. Scientific reports. 2016 Jul 28;6(1):1-1.

Acknowledgements

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