The Effects of Long-Term Recovery from Simulated Microgravity and Deep Space Radiation on the Rat Basilar Structure and Biochemical Properties

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Background

Space exploration exposes humans to the space environment, which includes extreme temperature variations, space radiation, and microgravity.

When the human body is exposed to these conditions, physiological adaptations occur. These adaptations increase the risk of developing cardiovascular medical conditions (e.g. spaceflight associated neuro-ocular syndrome (SANS]).

In order to assess these risks and improve the health of astronauts, we conducted a rodent study of the single and combined effects of the spaceflight environment. Our hypothesis was that the exposure to microgravity and radiation will cause changes with blood vessel structure.

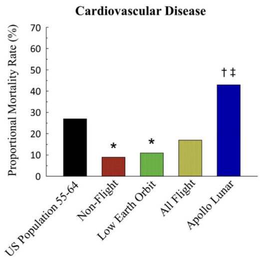


Figure 1. Astronaut mortality rate from spaceflight exposure due to cardiovascular disease*(1)*.

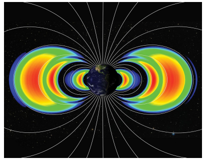


Figure 2. Van Allen Belts, *NASA's Goddard Space Flight Center/Johns Hopkins University, Applied Physics Laboratory*

Methods

Samples were collected and processed from the following experimental groups.

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

Figure 4. Simulated radiation and hindlimb unloading

Rat basilar arteries were cryostat sectioned, stained, and measured for structural adaptations.

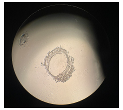


Figure 5. Example image of a cryostat sectioned sample

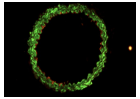
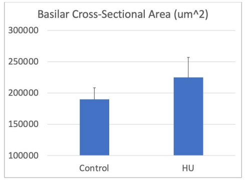


Figure 6: immunofluorescence image for quantifying structure

Results



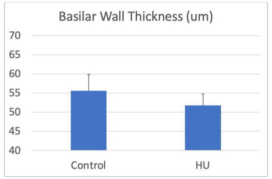


Figure 6. Cross sectional areas and wall thickness of the rat basilar arteries are shown here. After exposure to simulated microgravity, the cross sectional area increased and wall thickness decreased. This is indicative of a structural adaptation, likely in response to pressure and/or blood volume changes from simulated spaceflight exposure.

Discussion

With more individuals traveling into space, it is more imperative to understand the effects of spaceflight on human physiology. As a means of studying this, rats were subjected to simulated spaceflight conditions.

Our results support exposure to deep space radiation and/or microgravity can cause distinctive structural adaptations with the basilar artery. These preliminary findings suggest there may be long-term structural alterations with the basilar artery that could have implications for the health of individuals after they have traveled to space.

Future Directions

We continue to complete experiments to further assess the biochemical and physiological changes in the basilar artery, as well as other elements of the cardiovascular system. This includes studying vascular pathways like endothelial nitric oxide synthase and oxidative stress.

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 them vascular endothelium. Scientific reports. 2016 Jul 28;6(1):1-1.

Acknowledgements

This study was supported by a NASA Space Biology Postdoctoral Fellowship (SAN), NASA Space Biology grant NNX16AC28G, and the FSU Center for Undergraduate Research & Academic Engagement (CRE) for undergraduate student authors.