The Long-Term Effects of Simulated Spaceflight on the Internal Jugular Vein

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Background

The cardiovascular system adapts in extreme conditions, such as spaceflight.

The spaceflight environment includes extreme temperature variations, exposure to deep-space radiation, and changes in gravity. These environmental changes lead to crew adaptations and increased risk developing adverse medical conditions.

This investigation assesses cardiovascular disease risk from the long-term single and combined effects of deep space radiation and microgravity exposure on rats.

Our hypothesis includes spaceflight environmental factor exposure leads to vascular structure and function changes, predisposing astronauts to increased risk of developing cardiovascular disease.

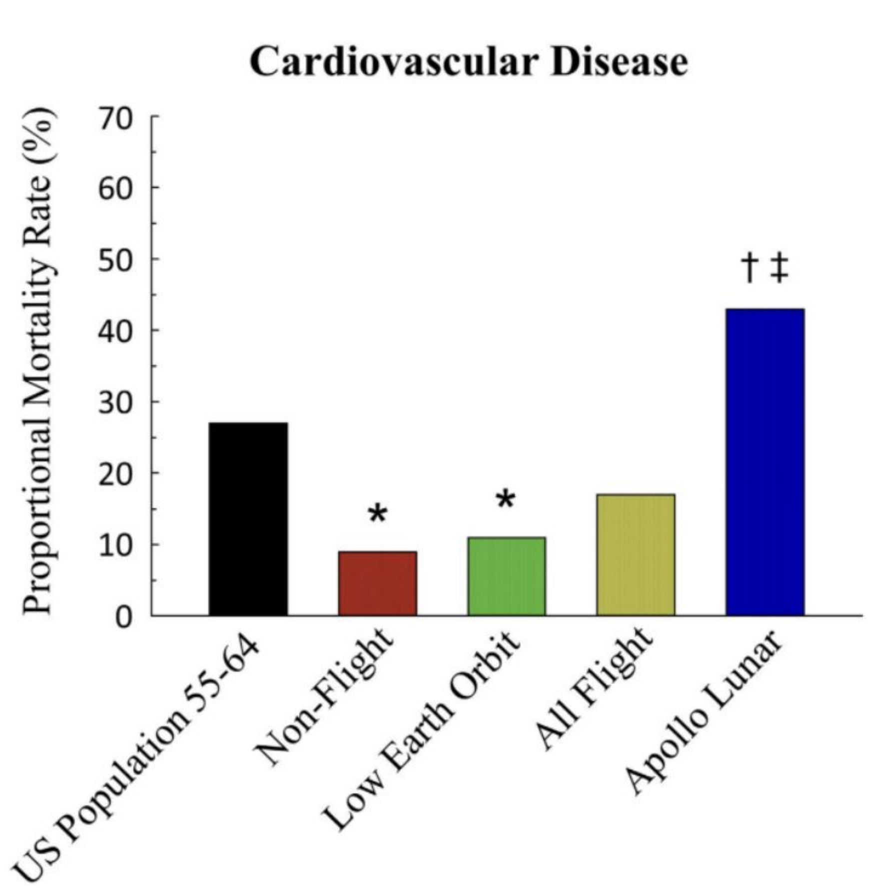


Figure 1. The proportional mortality rate due to Cardiovascular disease of astronauts. (See reference 1).

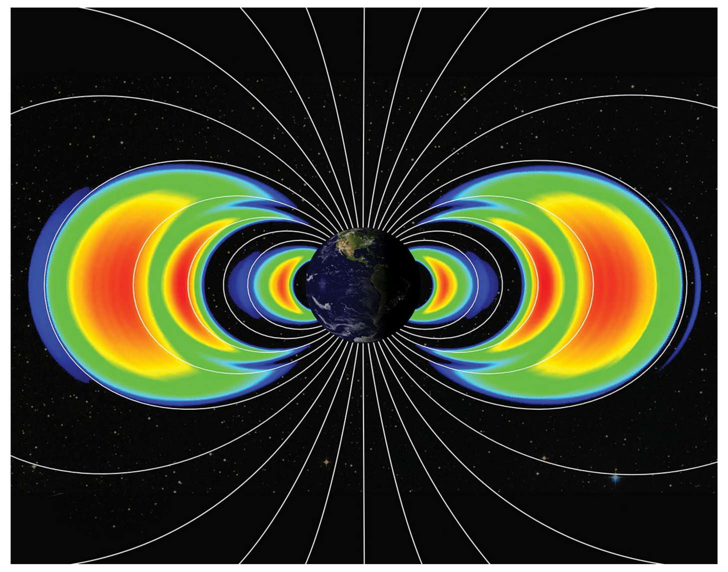


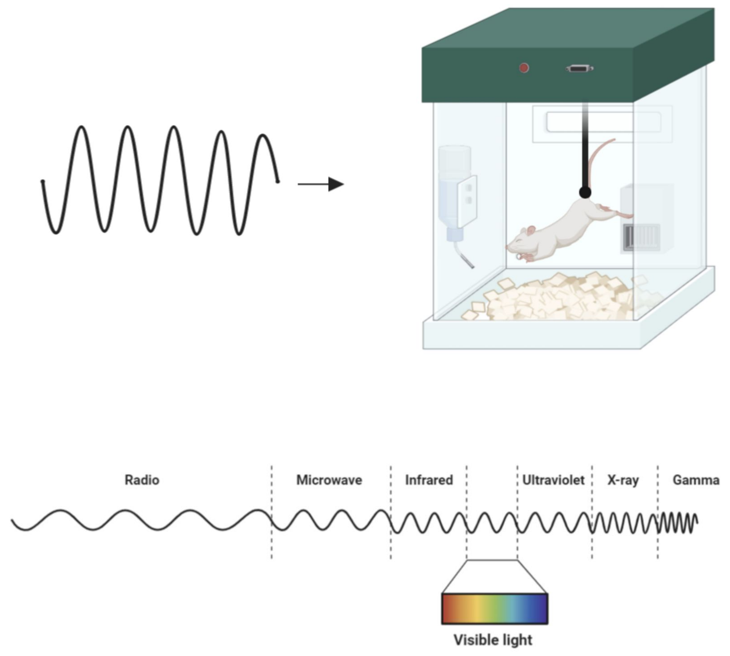
Figure 2. Van Allen Belts, *NASA's Goddard Space Flight Center/Johns Hopkins University, Applied Physics Laboratory*

Figure 3. Brookhaven National Laboratory

Methods

Biospecimen samples were collected and processed from the following groups:

Figure 4. Simulated radiation and hind limb unloading



Cohort 1. EXPERIMENTAL GROUPS	Rats/ Group
Sham Irradiation	18
Hind Limb Unloading Alone	18
Space Radiation Alone 0.75 Gy	18
Space Radiation Alone 1.5Gy	18
Hind Limb Unloading + Space Radiation, 0.75 Gy	18
Himb Limb Unloading + Space Radiation, 1.5 Gy	18
Total Animals	108

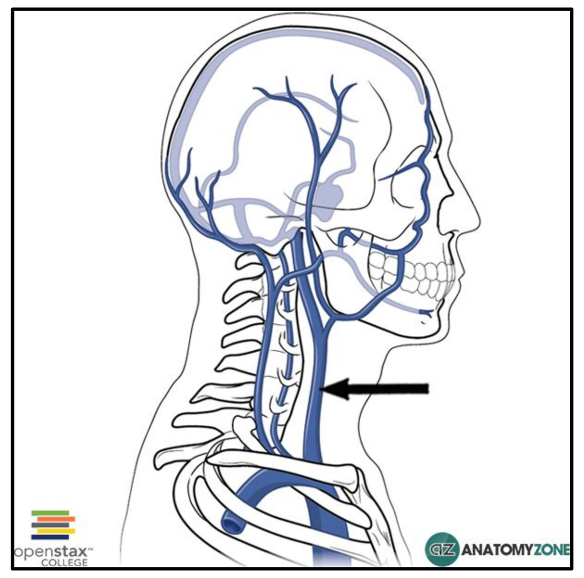


Figure 5. The internal jugular vein is responsible for draining deoxygenated blood from the brain, face, and neck, returning it to the heart for oxygenation.

Ongoing experiment efforts include cryostat sectioning of Internal Jugular Vein samples for histological sections. These will be further processed, probed and visualized for specific protein markers (e.g. immunofluorescence, see Fig. 6 and 7).

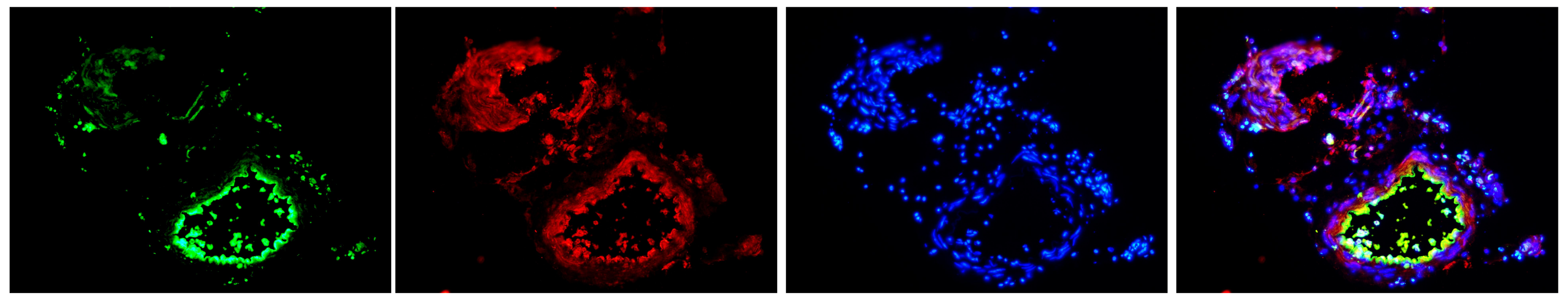


Figure 6. Green: eNOS, Red: SOD, Blue: DAPI

Methods

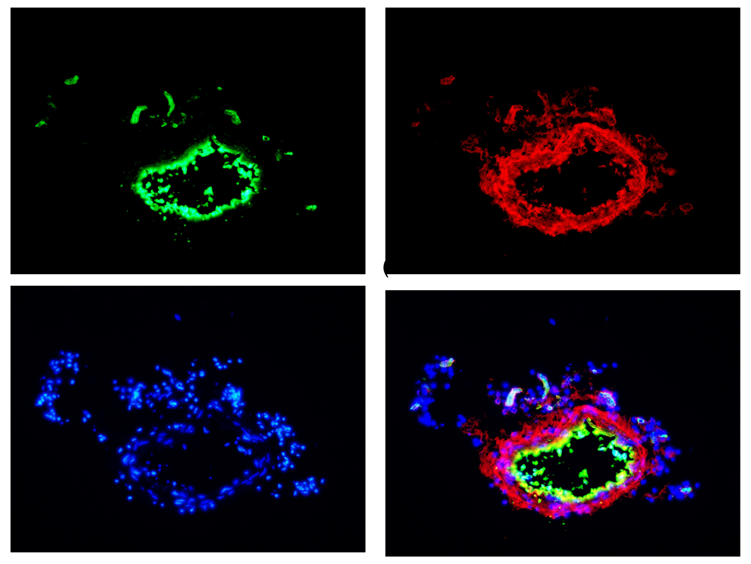


Figure 7. Green: CD31, Red: SM22-a, Blue: DAPI

Discussion

Our exploration of space now includes more people traveling and residing in space; thus, there is increasing rationale to understand the effects of spaceflight on human physiology.

As a model organism, we studied rats exposed to simulated spaceflight conditions (e.g. radiation and microgravity).

We will show how deep space radiation and/or microgravity exposure leads to specific biomedical adaptations with the cardiovascular system and identify crew risk to developing elevated risk of cardiovascular disease.

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.
2. Souza, Peter; Anatomy Zone: Internal Jugular Vein. Openstax College. 13 December 2020.

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.