Long-term Effects of Simulated Spaceflight Exposure to the Basilar Artery

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Background

Brain function is reliant on adequate blood perfusion supplied by the cardiovascular system, (e.g. the basilar artery). The brain and cardiovascular systems have been shown to adapt to spaceflight exposure, where astronauts are subjected to environmental factors such as deep-space radiation and microgravity. These environmental factors may cause crew adaptations and increased risk of developing adverse medical conditions, such as spaceflight associated neuro-ocular syndrome (SANS). SANS results from structural adaptations to the cerebrovascular system and may lead to astronaut vision loss.

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, specifically with the basilar artery, predisposing astronauts to increased risk of developing cardiovascular disease and SANS.

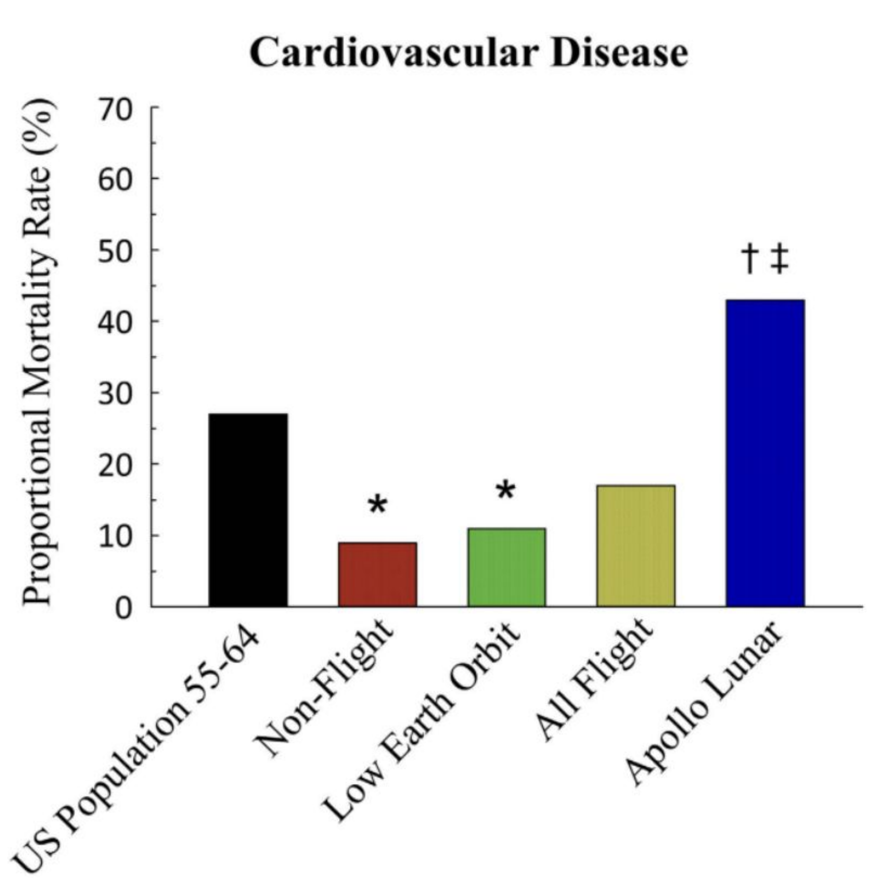

Figure 1. The proportional mortality rate due to cardiovascular disease of astronauts. (See reference 1).

Methods

Biospecimen samples were collected and processed from the following groups:

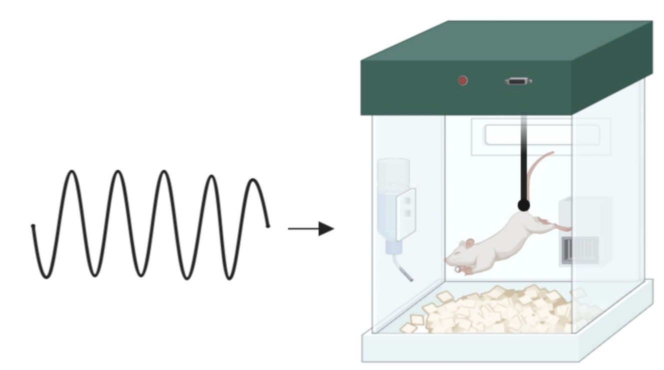

Figure 6. Simulated radiation and hind limb unloading.

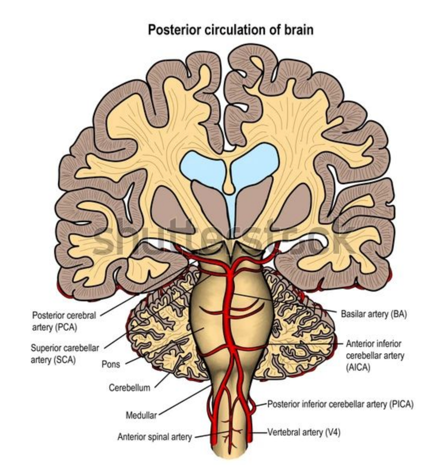

Figure 7. The basilar artery (in red) supplies blood to the brain.

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

Ongoing experiment efforts include cryostat sectioning of basilar arteries for histological sections. These will be further processed, probed and visualized for specific protein markers through immunofluorescence.

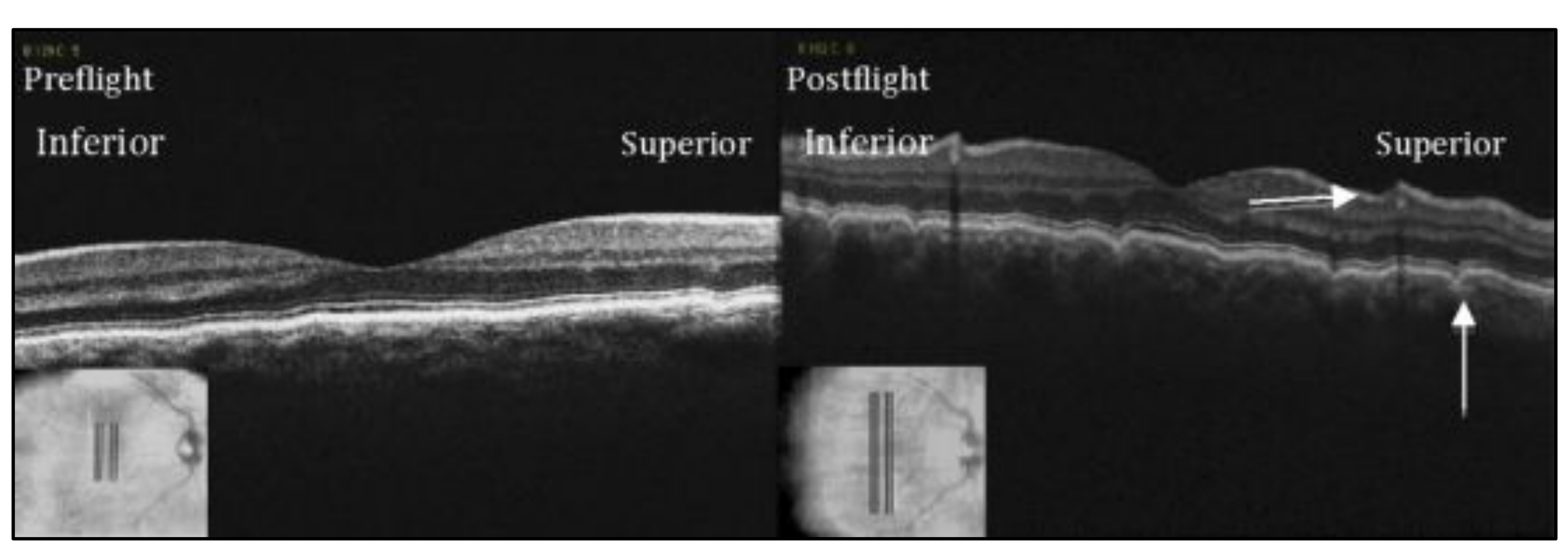

Figure 2. Cross section of the retina of an astronaut preflight and postflight, displaying structural changes. (See reference 2).

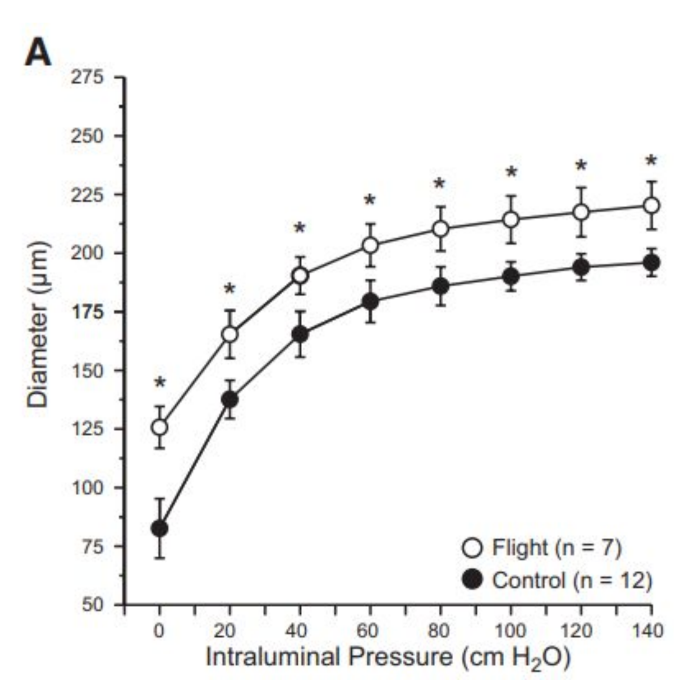

Figure 3. Vascular function responses to spaceflight exposure. (See reference 4). Spaceflight leads to increased vascular functional sensitivity to pressure changes.

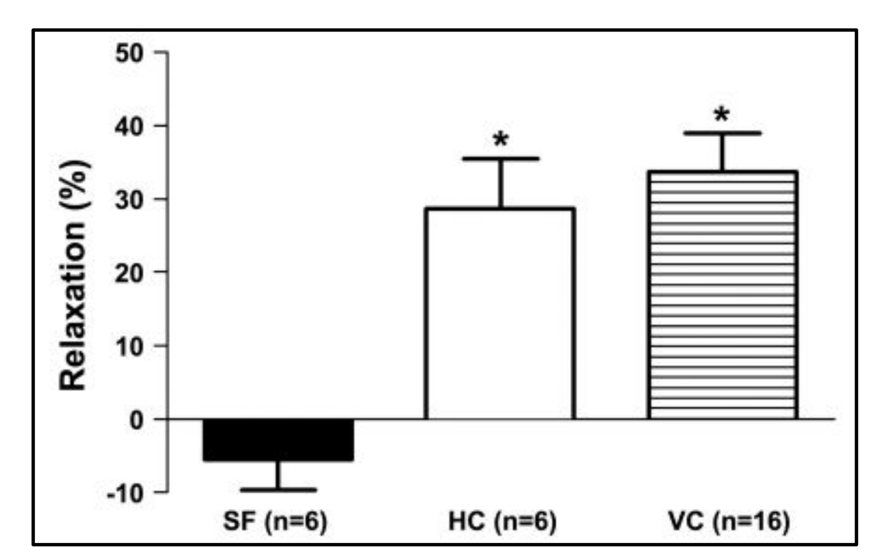

Figure 4. Endothelium-dependent vasodilation of the basilar artery is impaired in spaceflight conditions compared to controls. (See reference 3).

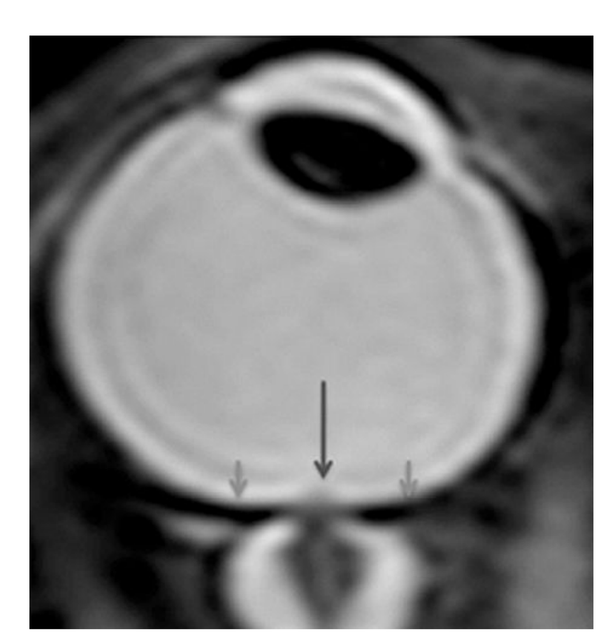

Figure 5. Postflight magnetic resonance imaging of an eye of an astronaut with optic nerve swelling and flattening of the posterior region, consistent with SANS. (See reference 2).

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 study 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 and SANS.

References

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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). We thank the conference organizers for the opportunity to present our work.