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

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Background

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

The spaceflight environment includes exposure to deep-space radiation, changes in crew life-style (e.g. changes in diet and activity), and changes in gravity. This different environment leads to increased risk for crew to develop adverse medical conditions.

This investigation assesses cardiovascular and gastrointestinal disease risk from the single and combined effects of space radiation and microgravity on rats.

Our hypothesis includes spaceflight environmental factor exposure leads to physiological structural and functional changes, predisposing astronauts to increased risk of developing medical conditions.

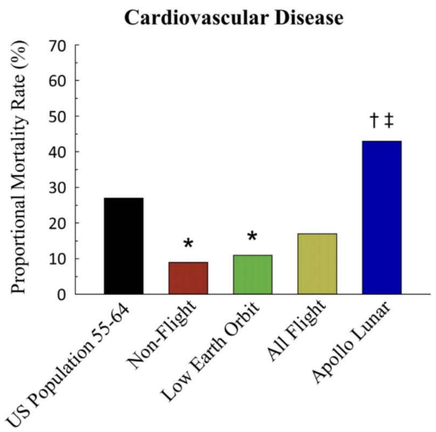


Figure 1. The proportional mortality rate due to Cardiovascular disease of astronauts. (See reference 1).

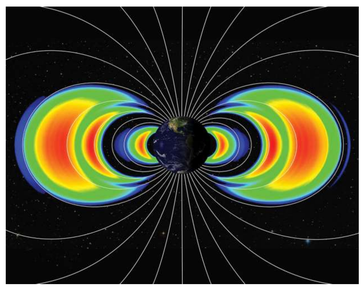


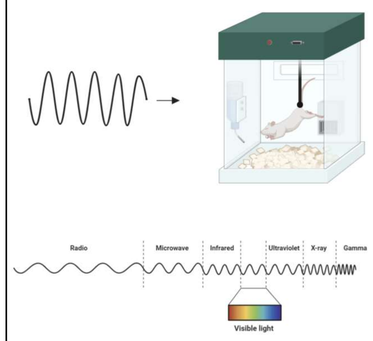
Figure 2. Van Allen Belts, *NASA's Goddard Space Flight Center/Johns Hopkins University, Applied Physics Laboratory*

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

Ongoing experiment efforts include cryostat sectioning of mesenteric arteries for histological sections. These will be further processed, probed and visualized for specific protein markers (e.g. immunofluorescence, see Fig. 5).

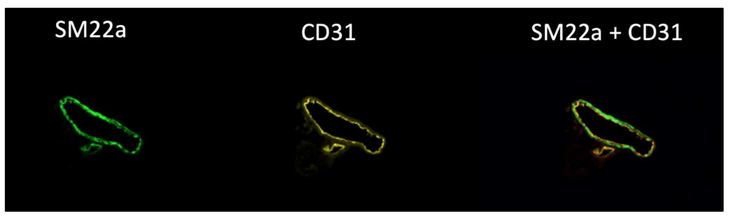


Figure 5. Representative Immunofluorescence staining of the mesenteric artery of endothelial (yellow) and smooth muscle (green) markers.

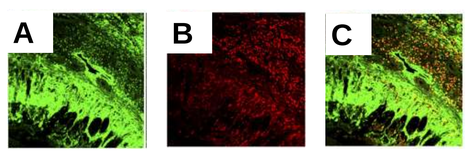


Figure 6.
Representative immunofluorescent staining of the colon for lymphatic (green) and immune (pro-inflammation protein) markers. (See reference 2)

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 are studying 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 to identify crew risk for developing elevated risk of medical conditions.

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. S. Anand Narayanan, Corinne E. Metzger, Susan A. Bloomfield, David C. Zawieja. Inflammation-Induced lymphatic architecture and bone turnover changes are ameliorated by irisin treatment in chronic inflammatory bowel disease. FASEB J. 2018 Sep;32(9):4848-4861.

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