DEPARTMENT OF PHYSICS AND ASTRONOMY

COLLOQUIUM IN-PERSON ONLY EVENT

Effects of Microgravity on Vascular Integrity and Implications for Space Flight Associated Neuro-ocular Syndrome Development

Binu Tharakan

Associate Professor & Vice-chair of Research
Dept. of Surgery & Neuroscience Institute
Morehouse School of Medicine

Spaceflight and exposure to microgravity profoundly impacts human body, causing various physiological changes that affect visual, cognitive, cardiovascular, and skeletal system functions. Spaceflight-associated neuro-ocular syndrome (SANS) that affects near vision in nearly 70% of returning astronauts, describes a collection of neuro-ophthalmic findings after prolonged exposure to microgravity at the International Space Station (ISS). The inner blood-retinal barrier (BRB), that protects the retina of the eye, is a critical structure in maintaining retinal homeostasis, and its integrity and normal permeability are critical for overall ocular vascular hydrodynamics, overall retinal functions, and normal vision. The goal of our study was to understand the microvascular changes that take place in the retina, following exposure to microgravity at the ISS using mouse as a model organism. We performed the study in "spaceflight" mice that were housed aboard the ISS for 38.5 days, the corresponding habitat ground control (HGC) mice, and vivarium ground control (VGC) mice. Spaceflight mice were transported on the NASA Rodent Research-23 mission to the ISS and returned to Earth via SpaceX-21 Cargo Dragon 2. Our intravital microscopic imaging studies in live mice demonstrated evidence for BRB dysfunction/hyperpermeability in general, in spaceflight mice compared to control. Our gene expression analysis showed a decreasing trend in the BRB tight junction associated with proteins in the retina. Additional studies conducted in a simulated microgravity mouse model (hind-limb unloading model; HU) did not demonstrate a comparable change in BRB integrity. Human retinal microvascular endothelial cells, exposed to homocysteine (Hcy), a potential SANS susceptibility factor, demonstrated barrier dysfunction, and activation NLRP3 inflammasome signaling. In conclusion, our data suggest preliminary evidence for BRB dysfunction/vascular hyperpermeability in general, following exposure to microgravity, and involvement of Hcy and NLRP3 inflammasome pathway in BRB dysfunction, but further studies may be required to understand the significance of this study in the context of the development of SANS.

Funding: This work was supported by NASA Human Research Program grant 80NSSC19K0392 and NASA Space Biology grant 80NSSC19K025.

Thursday, January 15, at 2:55 PM

IN-PERSON EVENT ROOM 202

Local Contact: Dr. Tho Nguyen, ngtho@uga.edu