Preserving vision for astronauts

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JAXA astronaut Koichi Wakata sits in the chin rest during an Optical Coherence Tomography (OCT) session on ISS. Credit: NASA

Many astronauts who come back from space experience poorer vision after flight, some even years after, and researchers at the University of Alabama at Birmingham are working to see why.

Brian Samuels, M.D., assistant professor in the Department of Ophthalmology, and his fellow collaborators from the Georgia Institute of Technology and Emory University recently received a grant to study computational modeling as a method of determining why astronauts who are in space for extended periods of time are experiencing eye pathologies. Samuels is collaborating with scientists at the NASA Glenn Research Center, and others, to help identify the cause of these pathologies, and determine whether there is a way to intervene and prevent these types of vision complications in the future.

"We know that, if astronauts are in space for extended amounts of time, they have a higher propensity for developing pathologies similar to increased intracranial pressure," Samuels said. "We are trying to incorporate all of the existing clinical and research data into functional computational models of the eye itself, the central nervous system and the cardiovascular system to determine how they are interacting."

He says these computational models should answer some of the questions as to "why this is happening to our astronauts."

The length of time astronauts stayed in space changed in the mid-2000s when the International Space Station started being used. Space shuttle missions typically lasted two weeks, but now the ISS missions may last six months or longer. Astronauts were no longer going up to space and quickly coming back down to Earth.

It was around this time the scientific community noticed that longer durations in space, in microgravity, caused a larger propensity for changes in the eye.

Many astronauts who experience these vision issues are encountering a hyperopic shift in their vision, meaning they gradually become farsighted. Astronauts can develop folds in the retina, experience

swelling of the optic disk and also have distention of the optic nerve sheath behind the eye. Some astronauts who have returned from a mission are still experiencing vision issues five years later. Samuels and his colleagues believe there may be some permanent remodeling changes in the eye after extended periods of time in space.

"Given that one of NASA's primary goals is to send someone to Mars, this will be the longest amount of time humans have spent in space thus far," Samuels said. "If we are able to identify risk factors that might predispose someone to these types of issues in space, the computational models could become a screening tool for future astronauts."

Samuels says he also wants to find the direct cause behind these eye pathologies in an effort to develop tools to halt this process for astronauts in space.

"If an astronaut is six months from coming home and is already experiencing vision-related issues, we want to temporize any further damage that may occur," he said.

Samuels' role in this project is to interpret clinical and research data that informs the computational modeling and relay back to the other investigators whether the output data obtained from the models is realistic. As a clinician-scientist, he can take information that is gathered from research studies, clinical studies and computational modeling in the lab, and compare it to real-world scenarios in a clinic.

C. Ross Ethier, Ph.D., professor and interim chair of the Wallace H. Coulter Department of Biomedical Engineering at the Georgia Institute of Technology, is the project lead.

"Dr. Samuels helps ground us in clinical reality by relating effects in space to clinical conditions on Earth, detailing pathophysiologic

processes at the cellular level to clinical outcomes," Ethier said. "He is an incredible resource for our team and the broader space physiology community."

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