

## **PROSPECTIVE OBSERVATIONAL STUDY OF OCULAR HEALTH IN ISS CREWS – THE OCULAR HEALTH STUDY**

C. Otto<sup>1</sup>, Y. Barr<sup>2</sup>, S. Platts<sup>3</sup>, R. Ploutz-Snyder<sup>1</sup>, A. Sargsyan<sup>4</sup>, D. Alexander<sup>3</sup>, R. Riascos<sup>5</sup>, C. Gibson<sup>6</sup>, N. Patel<sup>7</sup>

<sup>1</sup>Universities Space Research Association, Houston, TX; <sup>2</sup>University of Texas Medical Branch; <sup>3</sup>NASA Johnson Space Center, Houston, TX; <sup>4</sup>Wyle Science, Technology & Engineering Group, Houston, TX; <sup>5</sup>The University of Texas Health Science Center at Houston, TX; <sup>6</sup>Coastal Eye Associates, Webster, TX; <sup>7</sup>The University of Houston, Houston, TX.

### **INTRODUCTION**

The Visual Impairment Intracranial Pressure (VIIP) syndrome is currently NASA's number one human space flight risk. The syndrome, which is related to microgravity exposure, manifests with changes in visual acuity (hyperopic shifts, scotomas), changes in eye structure (optic disc edema, choroidal folds, cotton wool spots, globe flattening, and dilated optic nerve sheaths), and in some cases with documented increased intracranial pressure (ICP) postflight. While the eye appears to be the main affected end organ of this syndrome, the ocular effects are thought to be related to underlying changes in the vascular system and the central nervous system. The leading hypotheses for the development of VIIP involve microgravity-induced head-ward fluid shifts along with a loss of gravity-assisted drainage of venous blood from the brain, leading to cephalic congestion, decreased CSF resorption and increased ICP. Since 70% of ISS crewmembers have manifested clinical signs or symptoms of the VIIP syndrome, it is assumed that the majority have some degree of ICP elevation in-flight compared to the ground. Prolonged elevations of ICP can cause long-term reduced visual acuity and loss of peripheral visual fields, and have been reported to cause mild cognitive impairment in the analog terrestrial population of Idiopathic Intracranial Hypertension (IIH). These potentially irreversible health consequences underscore the importance of identifying the factors that lead to this syndrome and mitigating them.

### **METHODS**

The Ocular Health study expands on the required in-flight medical testing required of long-duration crewmembers assigned to an International Space Station (ISS) mission, to include 13 sessions over a three-year period. Pre- and postflight evaluations include functional eye exams (visual testing), structural eye exams (fundoscopy, ocular ultrasound, optical coherence tomography, optical biometry and biomicroscopy), intraocular pressure (IOP, tonometry), cardiovascular compliance (via ultrasound with concurrent ECG and blood pressure), noninvasive intracranial pressure (via pulsatility index, measured by transcranial Doppler), and Magnetic Resonance Imaging (MRI) to assess brain anatomy. In-flight evaluations include visual testing, optical coherence tomography, fundoscopy, tonometry, cardiovascular compliance and transcranial Doppler.

### **RESULTS**

Preflight, in-flight and postflight data will be presented for five Ocular Health subjects. These data will include: visual acuity, refraction, fundoscopy, OCT, ocular ultrasound, vascular compliance, TCD, IOP and MRI. One-year postflight data will be presented for two of these subjects. Data indicates that vascular compliance, retro-orbital pressure and IOP affect retinal nerve fiber layer swelling.

### **DISCUSSION**

This prospective study aims to understand the etiology of the VIIP syndrome, establish preflight baseline characteristics, define the temporal sequence for the appearance of signs and symptoms, characterize the nature of in-flight changes, document the postflight time course for recovery to baseline, and determine the impact of prolonged changes on crew health. Data from this study will improve the understanding of VIIP incidence, signs, symptoms, susceptibilities, timeline for development and recovery, and aid in guiding the development of countermeasures and targeted treatments for preventing the VIIP syndrome and its complications.