NEURO-VESTIBULAR EXAMINATION DURING AND FOLLOWING SPACEFLIGHT (VESTIBULAR HEALTH)

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BACKGROUND

Adaptation to microgravity during spaceflight causes neurological disturbances that are either directly or indirectly mediated by the vestibular system. These disturbances can include space motion sickness, spatial disorientation, and cognitive impairment, as well as changes in head-eye coordination, vestibulo-ocular reflexes, and control of posture and locomotion. Otolith-mediated reflex gains appear to adapt rapidly during spaceflight and after landing. However, animal studies have shown that structural modifications of the vestibular sensory apparatus develop during long-duration spaceflight. To date, no studies have characterized the severity of vestibular syndromes experienced by astronauts as a function of the duration of spaceflight or whether the effects are caused by changes at the peripheral end organs, midbrain, cerebellum, or vestibular cortex.

OBJECTIVES

We will investigate temporal vestibular changes in crewmembers of short, 6-month, and one-year missions to identify trends in adaptation of vestibular health and performance in orbit and after landing. We will also determine whether the vestibular organs and/or the central vestibular system undergo structural changes during long-duration exposure to microgravity, which could cause vestibular disorders when transitioning to a different gravitational environment.

METHODS

Recordings of eye, head, and body movements, as well as subjective reports of perception of motion, will be used to determine the presence of abnormal eye movements, dysmetria, motion sickness symptoms, and illusions of motion during head or body movements. This includes characterization of temporal trends in central compensation for vestibular (otolith) asymmetry. Pre-flight data will be collected 90 days before launch. In-flight examinations will be performed early in the mission (Flight Days 1 and 30) and once every two or three months thereafter. Post-flight examinations will be performed on the following days after return (R) from the mission: R+0, R+4, R+9, and R+30. Ground-based control tests have been performed on healthy volunteers in the laboratory to estimate mean normative responses.

RESULTS

Data collection for this study is ongoing. Data processing techniques are being refined. Our eye tracking method for measuring three-dimensional eye movement takes advantage of modern computer vision software (OpenCV) and advances in the field of iris recognition to improve measurement of ocular-counterolling.

RELEVANCE

If the observed symptoms in crewmembers are more deleterious after the year-long missions than those documented after 6-month missions, then relevant countermeasures will be required to maintain the health and operational performance of astronauts during longer missions. Depending on the etiology of the vestibular syndrome revealed by these tests, countermeasures will be proposed based on vestibular rehabilitation therapies currently used in patients with vestibular disorders, such as habituation, gaze stabilization, and/or balance training exercises.

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