

Role of Cerebrospinal Fluid in Spaceflight-Induced Visual Impairment and Ocular Changes

Monday 11:00-11:10 AM | SSC11-04 | Room: N226

PURPOSE

Ocular and vision changes known as visual impairment intracranial pressure (VIIP) syndrome have been reported in nearly two thirds of long-duration mission International Space Station (ISS) astronauts. These changes are currently attributed to cephalad vascular fluid shift induced by exposure to microgravity. This study assesses ocular shape and CSF volume changes related to spaceflight to determine the underlying cause for these changes.

METHOD AND MATERIALS

High resolution orbit and brain MRI scans before and shortly after spaceflights for 7 long-duration mission ISS astronauts and 9 short-duration mission Space Shuttle astronauts were analytically measured and compared. Post flight increases in globe flattening and nerve protrusion were tested for association with increases in intra-orbital CSF volume, ventricular CSF volume, and brain tissue interstitial fluid volume.

RESULTS

Compared to short-duration astronauts, long-duration astronauts had significantly greater post-flight increases in globe flattening indices ($p < 0.00001$) and optic nerve protrusion indices ($p < 0.00001$). Long-duration astronauts also had significantly greater post flight increases in orbital CSF volume ($p = 0.005$) and ventricular CSF volume ($p = 0.048$). There were no significant post flight changes of grey matter volume or white matter volume in either group. The large post spaceflight ocular changes observed in ISS crewmembers were associated with greater increases in intra-orbital and intracranial CSF volume but not with interstitial brain tissue fluid volume.

CONCLUSION

The strong positive relationships between globe deformations and CSF volumes increases without changes to brain volumes indicate CSF has a direct role in spaceflight induced ocular changes. Vascular fluid shift has a lesser role than CSF in microgravity duced visual impairments and ocular changes syndrome.

CLINICAL RELEVANCE/APPLICATION

This study elucidate the previously unexplored role of the CSF in the formation of space-induced visual impairments. Identifying the origin for the space-induced ocular changes is necessary for the development of countermeasure to protect the crew from the ill effects of long-duration exposure to microgravity.