

Optometry in Space: Vision Challenges in Zero Gravity

Prithvish Banik, 3rd year B.OPTM, VIDYASAGAR COLLEGE OF OPTOMETRY AND VISION SCIENCE

Abstract:

Extended spaceflight poses unique challenges to human vision. Astronauts frequently report visual disturbances, a phenomenon now recognized as Spaceflight-Associated Neuro-ocular Syndrome (SANS). In microgravity, fluid shifts toward the head cause increased intracranial pressure, potentially flattening the globe, distorting the retina, and altering visual acuity. This poster explores the physiological mechanisms behind these changes, highlights recent findings from ISS missions, and discusses implications for long-duration travel such as Mars missions. We also examine current countermeasures and the critical role of optometry in monitoring, diagnosing, and developing adaptive solutions to preserve ocular health.

Long-duration exposure to microgravity has revealed a constellation of neuro-ocular changes collectively termed Spaceflight-Associated Neuro-ocular Syndrome (SANS). Manifestations include optic disc edema, globe flattening, choroidal folds, cotton wool spots, and hyperopic shifts, with some changes persisting post-flight. The primary pathophysiological hypothesis involves cephalad fluid shifts induced by microgravity, leading to increased intracranial and orbital cerebrospinal fluid pressure, disrupting translaminar pressure gradients across the optic nerve head.

This poster reviews clinical findings from astronauts aboard the ISS, including optical coherence tomography (OCT) data, fundus imaging, and refraction changes. It also discusses current models of SANS development, such as compartmentalized CSF dynamics and vascular remodeling. Furthermore, we evaluate existing and emerging countermeasures— including negative pressure devices, lower body negative pressure (LBNP), pharmacologic agents, and artificial gravity simulations—and their potential roles in mitigating ocular risks during exploration-class missions.