NASA'S CURRENT EVIDENCE AND HYPOTHESIS FOR THE VISUAL IMPAIRMENT AND INTRACRANIAL PRESSURE RISK

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INTRODUCTION

While 40 years of human spaceflight exploration has reported visual decrement to a certain extent in a subgroup of astronauts, recent data suggests that there is indeed a subset of crewmembers that experience refraction changes (hyperoptic shift), cotton wool spot formation, choroidal fold development, papilledema, optic nerve sheath distention and/or posterior globe flattening with varying degrees of severity and permanence. Pre and postflight ocular measures have identified a potential risk of permanent visual changes as a result of microgravity exposure, which has been defined as the Visual Impairment and Intracranial Pressure risk (VIIP). The combination of symptoms are referred to as the VIIP syndrome. It is thought that the ocular structural and optic nerve changes are caused by events precipitated by the cephalad fluid shift crewmembers experience during long-duration spaceflight. Three important systems, ocular, cardiovascular, and central nervous, seem to be involved in the development of symptoms, but the etiology is still under speculation. It is believed that some crewmembers are more susceptible to these changes due to genetic/anatomical predisposition or lifestyle (fitness) related factors. Future research will focus on determining the etiology of the VIIP syndrome and development of mechanisms to mitigate the spaceflight risk.

VIIP SYNDROME: SPACEFLIGHT DATA

To date 15 confirmed cases have been identified from the NASA Longitudinal Spaceflight Astronaut Health database. Shown are examples from 3 specific cases:

ISS Crew Member	*Mission Duration*	*Refractive Change*	*Intraocular Pressure (mmHg)*	*Fundoscopic Exam Postflight*	*Disc Edema (Frisén)*	*OCT Postflight*	*Eye MRI Postflight* / *Globe Flattening*	*CSF Pressure Postflight (cmH_2O)*
CASE 1	6 months	Preflight: OD:-1.50 sph OS:-2.25-0.25x135 Postflight: OD:-1.25-0.25x005 OS:-2.50-0.25x160	Preflight: 15 OU Postflight: 10 OU	• Choroidal folds OD • Cotton wool spot OD	Edema: No disc edema	• Choroidal folds still visible inferior to the OD disc (R+>5yrs)	MRI not performed Globe Flattening: Not assessed	Not Measured
CASE 3	6 months	Preflight: OD:-0.5 sph OS:-.025 sph Postflight: OD:Plano OS:Plano	Preflight: 10 OU Postflight: 10 OU	• Bilateral disc edema OD>OS • Small hemorrhage OD	Edema: Grade 3 OD Grade 1 OS	• Severe NFL thickening OD>OS c/w disc edema	Optic nerve sheath distention OD Globe Flattening: None observed	Elevated • 21 at R+19 days
CASE 4	6 months	Preflight: OD:-0.75-0.50x100 OS:Plano-0.5x090 Postflight: OD:+0.75-0.5x105 OS:+0.75-0.75x090	Preflight: 15/13 Postflight: 11/10	• Disc edema OD • Choroidal folds OD	Edema: Grade 1 OD	• Mild NFL thickening OD>OS c/w disc edema • Choroidal folds OD	Optic nerve sheath distention and tortuous optic nerves OD>OS Globe Flattening: OD > OS	Elevated • 28.5 at R+57 days

(OD=right, OS=left, OU=both eyes, sph=sphere, OCT=optical coherence tomography, MRI=magnetic resonance imaging, CSF=cerebral spinal fluid, NFL=retinal nerve fiber layer, R+=return to Earth; [presented by number of days, for example, R+19 is 19 days after return to Earth]).

HYPOTHESIS: POTENTIAL INTERACTION OF VASCULAR, CNS & OCULAR SYSTEMS IN SPACEFLIGHT

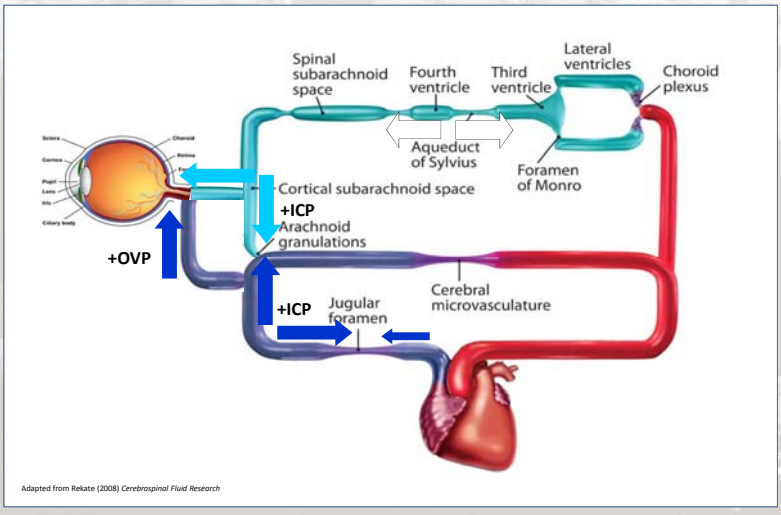
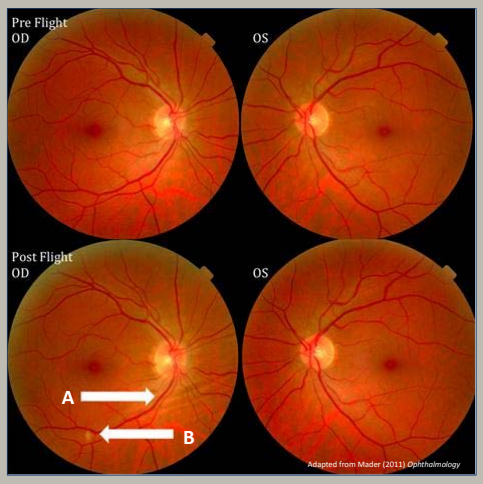
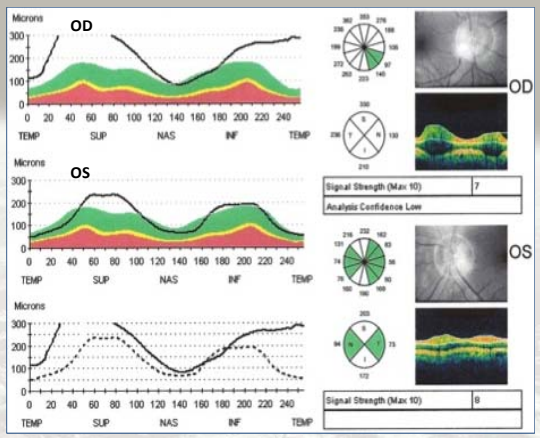


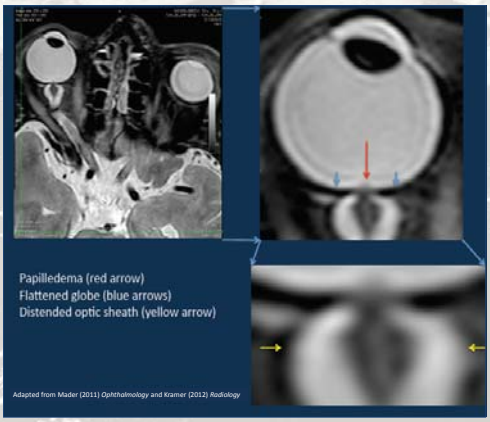
IMAGE GALLERY OF REPRESENTATIVE CASES



Fundoscopy image of Case 1 showing choroidal folds (A) and a cotton wool spot (B).



Optical Coherence Tomography (OCT) data from Case 3 showing retinal nerve fiber layer thickening of both eyes (OD and OS). (NASA image)



3T Magnetic Resonance Imaging (MRI) showing papilledema (grade 1), globe flattening, optic nerve sheath distention and optic nerve tortuosity in Case 4.

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