MICROGRAVITY INDUCED VISUAL ALTERATIONS AND INTRACRANIAL PRESSURE

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BACKGROUND
Humans have been travelling in space for more than 40 years without clear evidence of visual impairment in astronauts. However very recently, it has been identified that some astronauts on the International Space Station (ISS) seem to be at risk for visual changes that may be due to transient or sustained elevations in intracranial pressure (ICP). Despite the enthusiasm for noninvasive measurements of ICP, none are currently very robust or reliable in individual subjects. Thus the only way to advance our understanding of this phenomenon with confidence is to make direct, continuous and invasive measurements of ICP during simulated and real microgravity.

PRIMARY OBJECTIVE
The primary objective is to make the first direct, invasive measurements of intracranial pressure, cerebral hemodynamics, and structure of the visual apparatus during changes in hydrostatic gradients induced by simulated (head-down tilt bed rest) microgravity. Furthermore, the effect of small additions of inspiratory CO₂ and leg press exercise will be assessed (in order to mimic conditions on the ISS) alongside careful attention to detect clinically relevant B waves.

METHODS
Subjects will be healthy adults who have been cured of a hematologic malignancy, and have had an Ommaya reservoir implanted, which is a small port placed under the scalp allowing quick and safe access to the cerebral spinal fluid for injection of medications, or in this case, for continuous pressure measurements (Figure). Alongside ICP, assessment of right atrial pressure will be measured directly by a small (4 Fr) peripherally inserted central catheter as the final common sight of venous outflow resistance, hemodynamics by beat-to-beat photoplethysmography and acetylene rebreathing, cerebral blood flow and oxygenation by transcranial Doppler and near infrared spectroscopy and the visual apparatus by Doppler ultrasound and standard visual acuity tests.

PROTOCOLS
Subsequent to baseline supine data collection, the hydrostatic indifference point (where rotation around that Gy axis in the Gz plane causes no change in hydrostatic pressure) will be identified in each subject. A full set of hemodynamic measurements will then be obtained in the sitting position, after 5 minutes of 2% CO₂ breathing and during leg press exercise using calibrated surgical tubing. The subjects will then be placed in a 6 degree head-down tilt position for 24 hrs whereby repeat measurements will be obtained after 5 minutes, 3 hrs, and 24 hrs.

Our first participant is scheduled for the 21st of November 2013 and testing will continue thereafter. Thus preliminary data will be available for the Human Research Program Investigators’ Workshop, February 2014.

SIGNIFICANCE
The proposed comprehensive examination of cardiocerebral hemodynamics, combined with creative strategies to alter hydrostatic gradients will have a major impact on the understanding of human pathophysiology during microgravity. Moreover, it will serve as the critical science base required to address a potential critical impediment and possibly individual susceptibility to safe, long-duration space flight.