EFFECTS OF SPACEFLIGHT ON VENOUS AND ARTERIAL COMPLIANCE

S.H. Platts[1], L.C. Ribeiro[2], S.S. Laurie[2], S.M.C. Lee[2], D.S. Martin[2], R. Ploutz-Snyder[3], M.B. Stenger[2]
[1]NASA Johnson Space Center, Houston, TX; [2]Wyle Science, Technology & Engineering Group, Houston, TX;
[3]Universities Space Research Association, Houston, TX, and

BACKGROUND

The visual impairment and intracranial pressure (VIIP) syndrome is a spaceflight-associated medical condition consisting of a constellation of symptoms affecting >70% of American astronauts who have flown International Space Station (ISS) missions. VIIP is defined primarily by visual acuity deficits and anatomical changes to eye structures and is hypothesized to be related to elevated intracranial pressure secondary to spaceflight-induced cephalad fluid shifts, although other space flight factors (e.g., diet, environmental factors) may contribute. Loss of visual acuity could be a significant threat to crew health and performance during and after an exploration mission and may have implications for years postflight.

PURPOSE

Our primary objective is to determine if space flight alters vascular compliance and whether such an adaptation is related to the incidence of VIIP. This objective will be met by completing three separate but related projects.

METHODS

Although the headward fluid shift associated with space flight has been hypothesized to be one of the primary contributors to VIIP, VIIP symptoms have not been replicated in bed rest, a well-accepted space flight analog. Thus, in one project we sought to determine whether the combination of two additional factors suggested to contribute to VIIP in ISS astronauts that have not been studied previously in bed rest, older age and high sodium intake, might result in VIIP symptoms. Eleven men (25-35 yrs, n=7; 45-55 yrs, n=4) participated in a 14-day 6° head-down bed rest during which NASA standard bed rest conditions were maintained except that sodium intake was higher (~40%) than consumed in previous bed rest studies. Hemodynamic (stroke volume and blood pressure), ocular (tonometry and ocular ultrasound), venous (supratrochlear, jugular, and vertebral) and arterial (middle cerebral, common, internal and external carotid, and vertebral) parameters were acquired across a range of tilt angles (20°, 10°, 0°, -10°, -20°) before and immediately after bed rest. Additionally, internal jugular venous pressure was measured (compression sonography) in a subset of subjects. Optical coherence tomography measures were obtained in subjects seated upright before and within 30 min following bed rest.

The objective of the second project is to identify parameters that may increase an astronaut's susceptibility to developing VIIP by using data mining techniques to evaluate astronaut data obtained from the Lifetime Surveillance of Astronaut Health (LSAH) archives. Medical history, family history, space flight history and related exposures, and history of high-performance jet aircraft experience are being examined for their potential relationship to VIIP-related ocular outcomes.

The third project will characterize the baseline condition of astronauts before they participate in a space flight mission. We will study 8 astronauts who have never flown in space by performing a comprehensive evaluation of the vasculature of the head, neck, and eyes. Hemodynamic (stroke volume and blood pressure), ocular (tonometry and ocular ultrasound), and venous and arterial parameters will be acquired while seated upright and across a range of tilt angles (+10°, 0°, -10°, -15°). Optical coherence tomography measures also will be obtained.

RESULTS/DISCUSSION

Bed rest did not produce VIIP symptoms in any of the subjects, regardless of age, even with a higher sodium intake than previous studies. Additionally, while jugular vein pressure and diameter increased with decreasing tilt angle before and after bed rest, bed rest did not appear to have an effect on this relationship. Further, while some measures of ocular structure appear to be different between older and younger subjects before bed rest, these did not change during the course of bed rest in either group. These preliminary results suggests that the addition of a high salt diet to standard bed rest conditions was not sufficient to produce VIIP symptoms similar to those observed in astronauts.

The retrospective analysis of astronaut data received from LSAH is ongoing, and the recruitment of astronauts who have never flown in space will commence shortly.