Association Between Cardiovascular and Intraocular Pressure Changes in a 14-day 6° Head Down Tilt (HDT) Bed Rest Study: Possible Implications in Retinal Anatomy

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BACKGROUND

• History of visual impairment among astronauts with microgravity exposure.
• Numerous signs comprise the Visual Impairment/Intracranial Pressure (VIIP) syndrome. (below)

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From Mader et al. Ophthalmology 2011;118(10):2058-69

• Lack of data and analog studies have hindered development of preventive countermeasures.
• Current theory on VIIP etiology involves interaction of increased intracranial pressure (ICP), intracranial pressure (ICP), and genetic susceptibility.

PURPOSE

• Characterize HDT BR as possible VIIP syndrome model.
• Investigate association between ocular/cardiovascular parameters.

METHOD

• 14 day 6° HDT bed rest (+14 days pre-bed rest & +7 days post-bed rest).

Nomenclature:
- BR-13 - BR-1 Pre-bed rest phase
- BR1 - BR14 In-bed rest phase
- BR+0 - BR+3 Post-bed rest phase
- 16 subjects: normotensive, non-smoker, normal weight/EMI
  - Male: 12
  - Female: 4
• Statistical modeling performed using mixed effects linear regression model with random intercepts for subject and is labeled with a letter notating each different test subject. A 95% confidence interval (CI) is estimated using Cirrus HD-OCT.

RESULTS

• Mean IOP at BR3 increased over baseline values from BR-3 (p < 0.01).
• Mean IOP at BR10 remained higher than baseline values from BR-3 (p < 0.01).
• Mean IOP approached baseline values by BR+2 and was no longer elevated at a statistically significant level (p < 0.47).
• Although mean IOP increased during the 6 HDT in-bed phase, it remained within the normal limits for subject safety.
• Analysis of RNFL Thickness with Cirrus HD-OCT showed no statistically significant changes (p < 0.48).
• Central subfield (macula) thickness decreased from an average of 260.31 μm at BR-10 to an average of 258.44 μm at BR+2 with statistical significance (p < 0.01).

Fig. 1. IOP changes during pre-in/post-bed rest. Each circle represents IOP from either eye (left/right) and is labeled with a letter notating each different test subject. A 95% confidence interval (CI) is estimated at each point with the all-subject mean at the center. Average mean trend is indicated by the line connecting data points. IOP was measured for all subjects using Goldmann applanation (pre-post), iCARE (in-bed, 11 subjects), and Tonopen (in-bed, 5 subjects). Tonopen was used for 5 subjects in-bed rest.

Fig. 2. A Somer’s d non-parametric measure of association was used to assess the correlation between changes in intraocular pressure (IOP) and cardiovascular (CV) variables. No statistically significant p values were seen when comparing all of the CV variables (Plasma Volume/PV, Stroke Volume/SV, Heart Rate/HR, Systolic Blood Pressure/SBP, Diastolic Blood Pressure/DBP) to IOP.

CONCLUSIONS

• Mean IOP significantly increased while at 6° HDT and returned towards pre-bed rest values upon leaving bed rest.
• While mean IOP increased during bed rest, it remained within the normal limits for subject safety.
• Diuretic shift and cardiovascular deconditioning occurs during in-bed rest, as expected.
• There was no demonstrable correlation between the largest change in IOP (pre/post) and cardiovascular measure changes (pre/post).
• Additional mixed effects linear regression modeling may reveal some subclinical physiological changes that might assist in describing the VIIP syndrome pathophysiology.

ACKNOWLEDGEMENTS

NASA Flight Analogs Research Unit (FARU) personnel, NASA Flight Analogs Project funding 516724.03.04.01

DISCLOSURE

Taibbi, G None; Cromwell, RL None; Zanello, SB None; Yarbough, PO None; Vizzeri, G None; Brewer, J None
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