Long duration head-down tilt bed rest studies: safety considerations regarding vision health

RL Cromwell¹, SB Zanello¹, PO Yarbough¹, R. Ploutz-Snyder¹, G. Taibbi², G. Vizzieri²

¹Universities Space Research Association, 3600 Bay Area Blvd., Houston, Texas 77058
²Department of Ophthalmology and Visual Sciences, The University of Texas Medical Branch, 301 University Blvd., Galveston, Texas 77555

BACKGROUND
- Visual symptoms reported in astronauts returning from long duration missions in low Earth orbit are thought to be related to fluid shifts within the body due to microgravity exposure.
- Because of this possible relation to fluid shifts, and given the thought to be related to fluid shifts within the body due to microgravity exposure, this study was conducted to investigate evidence of changes in ocular structure and function in human bed rest subjects.

PURPOSE
- To conduct vision monitoring in bed rest (BR) subjects in order to evaluate the safety of HDT with respect to vision health.
- To investigate evidence of changes in ocular structure and function in human bed rest subjects.

METHODS
- An integrated, multidisciplinary 70-day -6° head-down tilt bed rest study
- Two experimental groups: exercisers and non-exercisers
- Vision tests: Pre-BR, 2 Baselines (Office; BR -10,-3); BR, weekly (FARU, or office); post-BR, 2 visits (Office; BR +2, +6)

NASA Flight Analogs Research Unit (FARU) Standardized Conditions
- Subject to rest in bed at all times during the in-bed phase
- Monitoring by a subject monitor and an in room camera 24 hours a day
- Daily measurement of vital signs, body weight, fluid intake and fluid output
- No napping permitted between 6:00 am and 10:00 pm
- Standardized diet

Ocular Measures
- Stereophotographs of the retina and the optic disc (-6° BR, pre and post BR)
- Cycloplegic refraction and Best Corrected Visual Acuity (BCVA, at all time points)
- Intraocular pressure (IOP): 4 measurements per eye. Goldmann (pre- and post-BR); iCare (-6° BR, at all time points; IOP measured with Tonopen in 3 subjects)
- SPECTRAL-DOMAIN OCT (pre-, mid, and post-BR)
- Cirrus HD-OCT (Carl Zeiss Meditec, Dublin, CA; vers. 5.0)
- Spectralis OCT (Heidelberg Engineering, GmbH, Germany)
- iVue portable OCT device (Optovue, Inc., Fremont, CA)

RESULTS
- Results correspond to 9 subjects who completed the C11 study as of August 15, 2012.
- A group of 4 subjects (group A) had OCT measures with Cirrus/Spectralis; a group of 5 subjects (group B) had OCT measures with iVUE.
- Findings for the following tests were all reported as normal in each testing session for every subject: modified Amsler grid, red dot test, confrontation visual fields, color vision and fundus photography.
- Near and far visual acuity increased during the course of the study (p<.001). Intracocular pressure slightly increased during the bed rest phase at BR38 (p=0.059) and to a less extent, at post-bed rest with respect to baseline (p=0.048) (Figure 1).
- While IOP subtly increased with respect to baseline, average RNFL thickness did not change significantly from baseline at the end of the bed rest phase (Figures 2 and 3)

Figure 1-Intraocular pressure in pre-, in- and post bed rest. Measures correspond to multiple time points in each bed rest phase, for which the mean was calculated.

Figure 2-OCT measures for average retinal nerve fiber layer (RNFL) for each individual in GROUP A (Cirrus) and GROUP B (iVUE).

GROUP A

GROUP B

CIRRUSS
SPECTRALIS
IVUE

Figure 3- Kendall’s Tau-b Association between IOP and average RNFL with various OCT instruments
- This analysis showed a significant positive association between IOP and average RNFL thickness measured by Cirrus (p=0.028) and nearly significant as measured by Spectralis (p=0.079). In contrast, there was no association between IOP and RNFL thickness as measured with the iVUE instrument (p=0.904).

CONCLUSIONS
- No vision-related clinical changes were found in this 70-day -6° head-down tilt bed rest study.
- The increase in visual acuity may likely indicate a learning effect.
- -6° head-down tilt BR produced a subtle increase in IOP.
- More research is needed to evaluate ocular changes and to better characterize patterns of IOP changes related to long-duration BR, in particular in the early days of bed rest, and the recovery period.
- These preliminary results suggest a positive association between IOP and average RNFL thickness, however, a larger sample size is necessary to confirm this finding.
- iVUE measurements introduced larger variability and suggest less technical precision with this instrument.
- Further research will assess the validity of HDT bed rest as a ground-based analog to study ocular changes related to microgravity.

SUPPORT
NASA Flight Analogs Project, 516724.03.04.01