

Comparison of Structural and Functional Ocular Outcomes Between 14- and 70-day Bed Rest

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Purpose: To compare structural and functional ocular outcomes in healthy human subjects undergoing 14- and/or 70-day head-down-tilt bed rest (HDTBR). We hypothesized the amount of HDTBR-induced ocular changes be affected by the HDTBR duration.

Methods: The studies were conducted at the NASA Flight Analogs Research Unit, The University of Texas Medical Branch at Galveston, Galveston, TX. Participants were selected using NASA standard screening procedures. Standardized NASA screening procedures and bed rest conditions (e.g., strict sleep-wake cycle, standardized diet, continuous video monitoring) were implemented in both studies. Participants maintained a 6° HDTBR position for 14 and/or 70 consecutive days and did not engage in exercise. Weekly ophthalmological examinations were conducted in the sitting (pre/post-bed rest only) and HDT positions. Ocular outcomes of interest included: near best-corrected visual acuity (BCVA); spherical equivalent, as determined by cycloplegic autorefraction; Goldmann applanation tonometry and iCare (Icare Finland Oy, Espoo, Finland) intraocular pressure (IOP) measurement; color vision; red dot test; modified Amsler grid test; confrontational visual field; stereoscopic color fundus photography; Spectralis OCT (Heidelberg Engineering, GmbH, Heidelberg, Germany) retinal nerve fiber layer thickness (RNFLT), peripapillary and macular retinal thicknesses. Mixed-effects linear models were used to compare pre- and post-HDTBR observations between 14- and 70-day HDTBR for our continuously scaled outcomes.

Results: 16 (12 males and 4 females) and 6 (5 males and 1 female) subjects completed the 14 and 70-day HDTBR studies, respectively. One subject participated in both HDTBR campaigns. Subjects' age averaged 37.8 ± 8.8 and 39.5 ± 7.8 years in the 14- and 70-day HDTBR study, respectively. For all outcomes analyzed, the magnitude of HDTBR-induced ocular changes was not significantly different between the two studies, except for the peripapillary retinal thickness in the superior (mean pre/post-difference of 14- vs 70-day HDTBR: $+4.69 \mu\text{m}$ vs $+11.50 \mu\text{m}$), nasal ($+4.63 \mu\text{m}$ vs $+11.46 \mu\text{m}$) and inferior ($+4.34 \mu\text{m}$ vs $+10.08 \mu\text{m}$) sectors. There was a $+1.42 \text{ mmHg}$ and a $+1.79 \text{ mmHg}$ increase from baseline in iCare IOP during 14- and 70-day HDTBR, respectively. In both campaigns, color vision, red dot test, modified Amsler grid test and confrontational visual field remained within normal limits at all time points; no qualitative changes from baseline were detected on stereoscopic color fundus photography.

Conclusions: 70-day HDTBR induced greater peripapillary retinal thickening than 14-day HDTBR, suggesting that time spent in the HDTBR position may affect the amount of optic disc swelling. Spectralis OCT detected RNFLT thickening post-bed rest, which was not accompanied by clinical signs of optic disc edema. There was a small IOP increase during bed rest, which subsided post-bed rest. Such changes may have resulted from cephalad fluids shift induced by HDTBR. This study suggests that the duration of HDTBR may be critical for replicating microgravity-related ophthalmological changes observed in astronauts on ≥ 6 -month spaceflights.