Ocular Outcomes Comparison Between 14- and 70-day Head-down Tilt Bed Rest

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INTRODUCTION: Ophthalmological changes, including optic disc edema with optic nerve sheath
distension, posterior globe flattening with hyperopic shift, choroidal folds and cotton wool spots have
been detected in some astronauts involved in long-duration spaceflights.1 It is hypothesized that elevated
intracranial pressure resulting from microgravity-induced cephalad fluid shifts may be responsible for
most of these findings. Head-down tilt bed rest (HTDBR) is a ground-based microgravity analog which
also produces cephalad fluid shifts. It is conceivable that prolonged HTDBR exposure may induce ocular
changes similar to those experienced in microgravity. Therefore, the purpose of the present study was to
compare structural and functional ocular outcomes between 14- and 70-day HTDBR in healthy human
subjects. It is hypothesized that 70-d HTDBR induced ocular changes of greater magnitude as compared
to 14-d HTDBR.

METHODS: Two HTDBR studies were conducted at the NASA Flight Analogs Research Unit, located
at The University of Texas Medical Branch at Galveston, TX. Identical NASA standard screening
procedures and BR conditions (e.g., strict sleep-wake cycle, standardized diet, continuous video
monitoring) were implemented in both studies. Participants spent 14 and/or 70 consecutive days in a 6°
HDT position and did not engage in exercise. Subjects received weekly ocular examinations before,
during, and after HTDBR. Ocular testing included: distance and near best-corrected visual acuity
(BCVA), cycloplegic refraction, intraocular pressure (IOP) measurement, color vision, red dot test,
modified Amsler grid test, confrontational visual field, color fundus photography and Spectral-domain
OCT scans of the macula and the optic disc. Pre/post HTDBR differences between the two studies will be
evaluated for BCVA, spherical equivalent, IOP, retinal nerve fiber layer (RNFL) thickness and macular
OCT parameters.

RESULTS: 16 (12 males and 4 females) and 6 (5 males and 1 female) subjects participated in the 14 and
70-day HTDBR studies, respectively. One subject participated in both studies. The demographic and
ophthalmological characteristics of the 14-day HTDBR study have been presented elsewhere.2 In the 70-
day study, subjects age averaged 39.5 ± 7.8 years; pre- and post-HTDBR Goldmann IOP were, on
average, 15.4 and 14.6 mmHg in the right eye, and 15.3 and 14.4 mmHg in the left eye, respectively; pre-
and post-HTDBR Spectralis OCT (Heidelberg Engineering, GmbH, Heidelberg, Germany) average
RNFL thickness were 103.8 and 106 µm in the right eye, and 103 and 104.3 µm in the left eye,
respectively. In both studies, color vision, red dot test, modified Amsler grid test and confrontational
visual field were within normal limits at all time points; no changes were detected on stereoscopic color
optic disc photography. For the above outcomes, preliminary results of the pre/post HTDBR differences
between the two studies will be presented at the 2015 Human Research Program Investigators’
Workshop.

CONCLUSIONS: Although 14-day HTDBR did not seem to induce clinically relevant ocular changes,2
a systematic evaluation and comparison with the 70-day HTDBR study results will elucidate whether the
magnitude of ocular structural and functional changes is affected by the time spent in the recumbent
position. Further research will also address the effects of integrated resistance and aerobic training during
HTDBR on the ocular outcomes.

REFERENCES:
1. Mader TH et al. Optic disc edema, globe flattening, choroidal folds, and hyperopic shifts observed in
2. Taibbi G et al. Ocular outcomes evaluation in a 14-day head-down bed rest study. Aviat Space