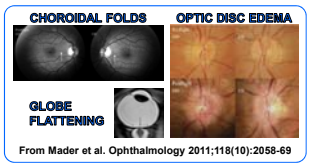
Ocular Outcomes Comparison Between 14- and 70-day Head-down Tilt Bed Rest

R.L. Cromwell,[1] G. Taibbi,[2] S. B. Zanello,[1] P.O. Yarbough,[1] R.J. Ploutz-Snyder,[1] and G. Vizzeri[2]

[1] Universities Space Research Association, Division of Space Life Sciences, Houston, TX *[2] Department of Ophthalmology and Visual Sciences, The University of Texas Medical Branch, Galveston, TX*

BACKGROUND

- Ophthalmological changes have been recently reported in some astronauts involved in long-duration space missions:



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

- Elevated intracranial pressure resulting from µG-induced cephalad fluid shifts may be responsible for most of these findings
- Head-down tilt bed rest (HDTBR) produces cephalad fluid shifts; used to simulate the effects of µG on the human body

PURPOSE

- To compare structural and functional ocular outcomes between 14- and 70-day HDTBR in healthy human subjects.
- Hypothesis: 70-day HDTBR induces ocular changes of greater magnitude as compared to 14-day HDTBR

METHODS

- Two integrated, multidisciplinary studies conducted at NASA Flight Analogs Research Unit (FARU): 14- and 70-day 6º HDTBR
- NASA standard HDTBR screening procedures (healthy adults)

NASA bed rest studies STANDARDIZED CONDITIONS

- ✓ Subject to rest in bed **at all times**
- ✓ Monitoring by a subject monitor and an in room camera **24 hrs 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

NASA Flight Analogs Research Unit (FARU)

70 days	HDTBR Duration	14 days
	OCULAR EXAMS:	
YES 2 office visits	Pre-BR	YES 2 office visits
YES Weekly (FARU)	During BR	YES Weekly (FARU)
YES 2 office visits	Post-BR	YES 1 office visit

METHODS

- Experimental protocols:

14-day HDTBR

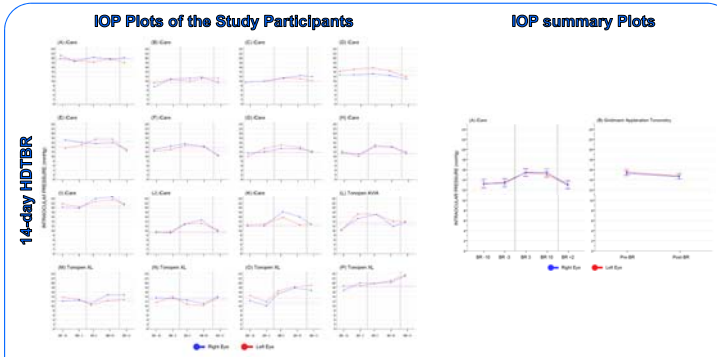
	Pre-HDTBR		HDTBR		Post-HDTBR
	-11	-5	3	10	+2
Visual Acuity (Distance & Near)	•	•	•	•	•
Modified Amsler Grid	•	•	•	•	•
Red Dot Test	•	•	•	•	•
Color Vision	•	•	•	•	•
Confrontational Visual Field	•	•	•	•	•
Cycloplegic Refraction	•	•	•	•	•
IOP (Handheld)	•	•	•	•	•
IOP (Goldmann)	•	•			•
SD-OCT	•				•
Color Fundus Photography	•				•

70-day HDTBR

Pre-HDTBR		HDTBR				Post-HDTBR	
-11	-5	3, 10, 17, 24, 31	38	45, 52, 59, 66		+2	+9
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•	•	•	•		•	•
•	•					•	•
•			•			•	•
•			•			•	•

- Pre/post-HDTBR differences in near visual acuity, spherical equivalent, IOP and SD-OCT average RNFL thickness were compared between the two studies

RESULTS



From Taibbi et al. Aviat Space Environ Med. 2014;85(10):983-92

	14-day HDTBR		70-day HDTBR	
	Pre-HDTBR	Post-HDTBR	Pre-HDTBR	Post-HDTBR
Intraocular Pressure (Goldmann), mmHg				
Right Eye	15.3	14.6	15.4	14.6
Left Eye	15.5	14.8	15.3	14.4

RESULTS

	14-day HDTBR	70-day HDTBR
n	16	6
Age	37.75 (8.78)	39.5 (7.8)
Gender (Male/Female)	12/4	5/1
Ethnicity:		
Caucasian/African-American	10/5	3/1
Others	1	2

HDTBR: Head-down Tilt Bed Rest

- 1 subject who completed the 14-day HDTBR study also completed the 70-day HDTBR study

	14-day HDTBR Pre/post Δ	70-day HDTBR Pre/post Δ	P*
Near Visual Acuity, logMAR	-0.05	-0.05	0.66
Spherical Equivalent, D	-0.27	-0.23	0.83
IOP (Goldmann), mmHg	-0.95	-0.20	0.35
Average RNFLT (Spectralis OCT), µm	1.16	1.33	0.81

HDTBR: Head-down Tilt Bed Rest; RNFLT, retinal nerve fiber later thickness
* Unpaired t-test

- In both studies:
  - ➢ subjects remained asymptomatic throughout the duration of HDTBR
  - ➢ distance and near visual acuity was 20/20 or better pre- and post-HDTBR in all subjects
  - ➢ modified Amsler grid, red dot test, color vision, confrontational visual field were within normal limits at all visits
  - ➢ no detectable changes on stereoscopic color fundus photography

CONCLUSIONS

- There were no significant pre/post-HDTBR differences between 14- and 70-day HDTBR for the structural and functional ophthalmological variables evaluated
- Further HDTBR studies with different duration and/or angle of tilt and/or environmental conditions (e.g., high CO_2 exposure during HDTBR) may help determine the validity of the HDTBR analog to investigate microgravity-induced ophthalmological changes

SUPPORT

NASA Flight Analogs Project, 516724.03.04.01

NIH/NCAT 1UL1RR029876-01

DISCLOSURE

Cromwell, RL None; **Taibbi, G** None; **Zanello, SB** None; **Yarbough, PO** None; **Ploutz-Snyder, RJ** None; **Vizzeri, G** None

ronita.l.cromwell@nasa.gov