70 DAYS OF 6 DEGREES-HEAD DOWN TILT BED REST AND ITS IMPACT ON OCULAR PARAMETERS

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

¹Universities Space Research Associates, 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

Ocular changes such as visual impairment and intracranial pressure (VIP) have been observed in astronauts returning from long-duration spaceflight. Changes may be attributed to the shift in body fluids due to microgravity. It remains to be determined whether 6° head-down bed rest is a good analog for VIP.

Visual Impairment and Intracranial Pressure (VIP) Syndrome: May include the following symptoms:
- Hyperopic shift
- Cotton wool spots
- Choroidal folds
- Optic nerve sheath distention
- Edema of the Optic disc (papillodema), globe flattening

Bed Rest Platform:
- 6° head down-tilt (HDT) bed rest

Nomenclature
- Pre-bedrest phase: BR -14 to BR -1 for control subjects, BR -21 to BR -1 for exercisers
- In-bedrest phase: BR1 to BR70
- Post-bedrest phase: BR+0 to BR+13

NASA Flight Analogs Research Unit (FARU) Standardized Conditions:
- During in-bed phase: subject reclined and monitored 24 hours/day
- Vitals, body weight, fluid intake/output measured daily
- Awake time: 6:00 am – 10:00 pm
- Standardized diet to maintain weight within 3% of initial weight

PURPOSE

Investigate the effects of 6° head-down bed rest on ocular structures and function.
- Determine if 6° head-down bed rest is a suitable ground-based analog for modeling and studying the VIP Syndrome.

METHODS

- 16 subjects (15M, 1F, age range 29-54 years): healthy, normotensive, non-smoker, normal weight
- Participated in 70 days of 6° HDT bed rest
- Control group and exercise group
- Measurements used in this study:
  - Best corrected visual acuity (BCVA)
  - Spherical equivalent
  - Intraocular pressure (IOP)
  - Retinal nerve fiber layer (RNFL) thickness by OCT
- Statistical methods:
  - Completely repeated measures experimental design
  - Data collected longitudinally at several time points before, during and after bedrest, and for subjects’ left and right eyes at each time point.
  - Repeated measures data submitted to a mixed-effects linear regression with a-priori contrasts comparing subjects’ closest pre-bedrest observation to each subsequent observation available per outcome.

RESULTS

For the following variables, “Pre/Post” was defined as the CLOSEST Pre and Post observations to bedrest. Other in-bed time points were also utilized.

- Subjects’ closest pre-bedrest observations were between 3 and 6 days pre-bedrest.
- Subjects’ first bedrest observation was usually day 3 of bedrest (BR3).
- Subjects’ mid-bedrest observation was usually day 30 of bedrest (BR30).
- Subjects’ last bedrest observation was usually day 65 of bedrest (BR65).
- Subjects’ closest post-bedrest observations were between 2-3 days post.

- 6° head down-tilt (HDT) bed rest

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- Subjects’ last bedrest observation was usually day 65 of bedrest (BR65).
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BCVA Far (# of letters correctly identified) vs. BCVA Near (# of letters correctly identified)

- BCVA Near (# of letters correctly identified)
- BCVA Far (# of letters correctly identified)

<table>
<thead>
<tr>
<th>Day</th>
<th>Pre-BR</th>
<th>Post-BR</th>
<th>Pre-BR</th>
<th>Post-BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>63.00</td>
<td>64.96</td>
<td>77.40</td>
<td>79.59</td>
</tr>
<tr>
<td>CI (+/- 95%)</td>
<td>(61.76, 64.23)</td>
<td>(63.73, 66.20)</td>
<td>(76.37, 78.43)</td>
<td>(78.56, 81.09)</td>
</tr>
<tr>
<td>p (vs. pre-BR)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Fig. 3. BCVA Far and Near changes during pre-/post-bedrest.
- Mean BCVA far and near significantly increased from pre-BR to post-BR (p < 0.001).
- BCVA FAR and NEAR are significantly different from all of the in-BR and post-BR time points.

DISCUSSION

Although statistically significant changes were found, none were clinically significant.
- Both far and near best corrected visual acuity (BCVA) improved from pre-BR to post-BR. We speculate that this may be due to the learning effect of using the visual chart weekly during the study.
- Spherical equivalent decreased significantly from pre-BR to post-BR with both the Retinomax and Reichert device, which indicates a slight shift to myopic biometrics, which might be due to adjustment to near-vision activities during bed rest confinement.
- Reichert device is non-handheld and only used pre- and post-BR.
- There was a significant increase in IOP from pre-BR to all in-BR and post-BR time points.
- This increase in IOP associated with the positional change may be reversible with more time in the post-bed rest phase.
- Average retinal nerve fiber layer (RNFL) thickness by Spectralis OCT increased significantly from pre-BR to post-BR.
- Possibly due to interstitial edema from fluid redistribution.

CONCLUSION

- Although no clinically significant changes have been observed, IOP increase, spherical equivalent decrease, and thickening of the retina due to fluid redistribution in bed rest justify further investigation of HDT bed rest as an analog to model and study the VIP syndrome.

ACKNOWLEDGEMENTS

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DISCLOSURE

Taibbi, G None; Cromwell, RL None; Zanello, SB None; Yarbough, PO None; Vizzi, G None