Analysis of Arterial Mechanics During Head-Down-Tilt Bed Rest

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BACKGROUND

Cardiovascular Lab
- Investigate how the spaceflight environment affects the cardiovascular system to aid in the improvement of astronaut health, develop countermeasures, and potentially benefit other populations on Earth
- Models of spaceflight: head-down-tilt bed rest (HDTBR), parabolic flight, and hypovolemia
- Study objective: retrospective data analysis to understand HDTBR effects on arterial mechanics as a spaceflight analog

HYPOTHESIS AND SPECIFIC AIMS

• Hypothesis: responses of vessels will vary with physiological location and arterial mechanics will change with days of HDTBR
• Specific aim 1: describe relative difference in arterial structure and function in the upper versus lower extremities, specifically a fluid shift, similar to spaceflight similar to increased vascular age in a clinical setting
- Investigate how the spaceflight environment affects the cardiovascular mechanics will change with days of HDTBR
• Specific aim 2: define changes in arterial morphology and mechanics during HDTBR due to changing load and pressure profile
- Models of spaceflight: head-down-tilt bed rest (HDTBR), parabolic flight, and hypovolemia

RESULTS

Morphological Analysis

<table>
<thead>
<tr>
<th>Intima Media Thickness (IMT)</th>
<th>Carotid</th>
<th>Brachial</th>
<th>Tibial</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMT</td>
<td>0.050</td>
<td>0.040</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Arterial Deformation

<table>
<thead>
<tr>
<th>Arterial Deformation</th>
<th>Carotid</th>
<th>Brachial</th>
<th>Tibial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strain (%)</td>
<td>4.2</td>
<td>2.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Pressure-Strain Elastic Modulus (PSE)

<table>
<thead>
<tr>
<th>Pressure-Strain Elastic Modulus (PSE)</th>
<th>Carotid</th>
<th>Brachial</th>
<th>Tibial</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSE (kPa)</td>
<td>450</td>
<td>380</td>
<td>310</td>
</tr>
</tbody>
</table>

FUNCTIONAL ANALYSIS

• Arterial deformation
- Carotid, brachial, and anterior tibial arteries reacted differently to HDTBR. Previous studies have not analyzed the mechanical properties of the human brachial or anterior tibial arteries
- After slight variations during bed-rest, arterial mechanical properties and IMT returned to pre-bed rest values, with the exception of tibial stiffness and PSE, which continued to be reduced post-bed rest while the DC remained elevated.
- The tibial artery remodeling was probably due to decreased pressure and load in the limb, which is consistent with past findings of previous studies (Aubert). Limitations:
  - Small n value
  - Imprecise boundary determination methods
  - Formulas sensitive to small measurement differences
  - Single, non-blinded analysis

Acknowledgements

Thank you to the Minority University Research and Education Program for funding this project and the NASA Johnson Space Center Cardiovascular Lab for their guidance.

References

Aubert, A.C. Acta Cardiol, 2006. 61(2): 129-151.