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 compared to lower body as the result of HDTBR
Specific aim 2: define changes in arterial morphology and mechanics during HDTBR due to changing load and pressure profile

RESULTS

Morphological Analysis
- Measured: arterial wall thickness (IMT), systolic diameter (SD), diastolic diameter (DD), systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse pressure (PP = SBP-DBP)

Figure 1. Carotid IMT margins were significantly thicker than the brachial and tibial IMT (p < 0.001). The tibial IMT decreased relative to the brachial response from BR-5 to BR+3 (p = 0.05). The tibial IMT was thinned on BR0 (p = 0.001) and did not recover by BR+3 (p = 0.02). Error bars represent 95% confidence intervals.

Figure 2. Strain margins are not significantly different between days of bed rest within vessels. Error bars represent 95% confidence intervals.

Figure 3. The tibial artery trended towards increased DC (p = 0.01) from BR-5 to BR+3. Error bars represent 95% confidence intervals.

Functional Analysis
- Arterial deformation
- Stress-to-strain ratio
- Pressure-strain elastic modulus (PSE)

Discussion
- Carotid, brachial, and 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 volume. Resulting implications for longer duration spaceflight are unclear.
- Arterial health may be affected by microgravity, as shown by increased thoracic aorta stiffness in other ground based simulations (Aubert).

Limitations:
- Small n value
- Imprecise boundary determination methods
- Formulas sensitive to small measurement differences
- Single, non-blinded analysis

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References
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