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:
- Investigate how the spaceflight environment affects the cardiovascular mechanics will change with days of HDTBR

Specific aim 1:
- Define changes in arterial morphology and mechanics during HDTBR due to changing load and pressure profile

Specific aim 2:
- Investigate how the spaceflight environment affects the cardiovascular mechanics as a spaceflight analog

RESULTS

Morphological Analysis
- Intima Media Thickness (IMT)
- 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)

Day of Bed Rest
- 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 BR60 and BR+3 (p < 0.05).
- The tibial IMT was thinned on BR60 (p < 0.001) and did not recover by BR+3 (p = 0.02).

Functional Analysis
- Arterial deformation
- Stress-to-strain ratio
- Pressure-Strain Elastic Modulus (PSE)

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

- The tibial artery trended towards decreased stiffness (p = 0.06) from BR-5 to BR+3. Error bars represent 95% confidence intervals.

- Carotid, brachial, and tibial arteries reacted differently to HDTBR.

Discussion

• Carotid, brachial, and tibial arteries reacted differently to HDTBR.

• 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

Acknowledgements

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References

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