TEMPORAL CHANGES IN LEFT VENTRICULAR MECHANICS:
IMPACT OF BED REST AND EXERCISE

Jessica M. Scott,1 Timothy Matz,2 Timothy Caine,2 David S. Martin,3 Meghan Downs,4
Lori Ploutz-Snyder1

1 Universities Space Research Association, Houston, TX, Houston, TX; 2 MET Tech, Houston, TX; 3 Wyle Integrated Science and Engineering Group, Houston, TX; 4 University of Houston, Houston, TX

Abstract

BACKGROUND Current techniques used to assess cardiac function following spaceflight or head-down tilt bed rest (HDTBR) involve invasive and time-consuming procedures such as Swan-Ganz catheterization or cardiac magnetic resonance imaging. An alternative approach, echocardiography, can monitor cardiac morphology and function via sequential measurements of left ventricular (LV) mass and ejection fraction (EF). However, LV mass and EF are insensitive indicators of early (subclinical) cardiac deconditioning, and a decrease in LV mass and EF become evident only once significant deconditioning has already occurred. The use of more sensitive and specific echocardiographic techniques such as speckle tracking imaging may address the current limitations of conventional cardiac imaging techniques to provide insights into the magnitude and time course of cardiac deconditioning.

METHODS Speckle-tracking assessment of longitudinal, radial, and circumferential strain and twist was used to evaluate the impact of 70 days of HDTBR (n=7) and HDTBR + exercise (n=11) on temporal changes in LV mechanics. Echocardiograms were performed pre-BR2), during (BR31, 70), and following (BR4hr) HDTBR. Multi-level modeling was used to evaluate the effect of HDTBR condition (Control, Exercise) on cardiac variables. RESULTS Compared to BR-2, longitudinal (BR-2: -19.0 ± 1.8%; BR31: -15.9 ± 2.4%; BR70: -14.9 ± 2.4%; BR+4hr: -16.0 ± 2.1%) and radial (BR-2: -15.0 ± 1.9%; BR31: -12.3 ± 2.4%; BR70: 1.3 ± 2.2%; BR+4hr: 13.5 ± 2.5%) strains were significantly impaired during and following bed rest (p<0.05), while twist (BR-2: 18.0 ± 4.0°; BR31: 18.1 ± 3.6°; BR70: 17.0 ± 3.6°; BR+4hr: 18.1 ± 4.3°) was significantly decreased at BR70 (p<0.05). In contrast, exercise preserved LV mechanics for longitudinal strain (BR-2: -19.1 ± 1.5%; BR31: -19.0 ± 1.8%; BR70: -19.1 ± 2.7%; BR+4hr: -17.8 ± 2.1°), radial strain (BR-2: 13.8 ± 2.4°; BR31: 14.1 ± 2.0°; BR70: 14.5 ± 1.6°; BR+4hr: 14.4 ± 2.4°), and twist (BR-2: 17.3 ± 3.6°; BR31: 18.0 ± 3.6°; BR70: 18.2 ± 5.9°; BR+4hr: 18.3 ± 3.2°). CONCLUSIONS Speckle-tracking echocardiography provides important new insights into temporal changes in LV mechanics during disuse and exercise training.

Statistical Analysis

• Multi-level modeling was used to evaluate the effect of HDTBR condition (Control, Exercise) on cardiac variables.
• All data were analyzed using SPSS (LEAD Technologies, Inc., US) and Excel 2007 (Microsoft Corp, Redmond, WA, USA).

Discussion

• Given that exercise preserved LV mechanics during disuse, serial evaluation of subclinical markers of cardiac dysfunction with speckle tracking echocardiography could provide critically important information for the design and optimization of in-flight exercise countermeasure programs.
• Future analysis will include indices of diastolic function, which could provide insight into the mechanisms underlying impaired aerobic capacity following disuse. Indeed, loss of early diastolic longitudinal relaxation and delayed untwisting have previously been shown to contribute to exercise limitations.5

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REFERENCES: