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

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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 measures 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 evaluated to understand the impact of 70 days of HDTBR. METHODS: A total of 18 subjects completed 70 days of HDTBR; 11 were randomized to aerobic and resistance training, while 7 remained sedentary. Two-dimensional transthoracic short axis and apical four chamber views were acquired (Phillips iE33) pre (BR-2), during (BR31, 70), and following (BR+4h) HDTBR. Speckle tracking (Q-Lab, Philips) was used to assess longitudinal strain, radial strain, and twist.

Statistical Analysis

• Multi-level modeling was used to evaluate the effect of HDTBR condition (Control, Exercise) on cardiac variables.

• Controls: Compared to BR-2, longitudinal strain (BR-2: -19.0 ± 1.8%; BR 31: -19.0 ± 2.4%; BR70: -19.1 ± 2.7%; BR+4h: -17.8 ± 2.1%), radial strain (BR-2: -13.9 ± 2.4; BR31: 14.7 ± 2.4; BR70: 14.4 ± 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: 18.5 ± 2°). CONCLUSIONS Speckle-tracking echocardiography provides important new insight into temporal changes in LV mechanics during disuse and exercise training.

Introduction

• 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 measures 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.

• Importantly, given that strain, strain rate, and torsion measurements are sensitive indicators of cardiac function in populations of interest,4 it is plausible that these indices may provide early detection of disease-induced myocardial dysfunction.

Results

• Controls: Compared to BR-2, longitudinal strain (BR-2: -19.0 ± 1.8%; BR31: -19.0 ± 2.4%; BR70: -14.9 ± 2.4%; BR+4hr: -14.8 ± 2.5%). CONCLUSIONS Speckle-tracking echocardiography provides important new insight into temporal changes in LV mechanics during disuse and exercise training.

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: