

Analysis of Cardiovascular Deconditioning Due to Long-term Bedrest as Observed on Seismocardiogram Morphology

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Purpose: During head down tilt bedrest (HDBR) the cardiovascular system is subject to fluid shifts. This fluid shift phenomenon is analogous to spaceflight microgravity. The purpose of this study is to investigate the effect of 60-day bedrest on the cardiac function using the morphology of seismocardiography (SCG).

Dataset: Three-lead electrocardiogram (ECG) and SCG recordings were collected simultaneously from 20 subjects in a 60-day HDBR study (MEDES, Toulouse, France). Signals were recorded in the supine position 12 days before HDBR (BDC12) and on day 52 of HDBR (HDBR52).

Method: SCG fiducial points of AO and AC corresponding with aortic valve closing and opening, respectively, were annotated. Using ECG, the following were determined: pre-ejection period (PEP, time interval between ECG Q and SCG AO); and left-ventricular ejection time (LVET, time interval between SCG AO and SCG AC). SCG morphology was analyzed using functional data analysis (FDA) where each SCG cycle was modeled as the linear combination of 23 spline base functions of order 4. The coefficients of the model were estimated over 20 cycles of SCG recordings of BDC12 and HDBR52. Wilcoxon Signed Rank test was performed to evaluate the differences between coefficients for BDC12 and HDBR52 (significant $p < 0.05$).

Results: AO and AC amplitudes showed significant decrease between BDC12 and HDBR52 ($p < 0.001$), while no significant changes in PEP, LVET and PEP/LVET were observed. FDA indicated that signal morphology 30 to 180 millisecond after ECG Q (Coefficient set 5) and 360 to 540 milliseconds after ECG Q (Coefficient set 15) were significantly changed by HDBR ($p < 0.03$, Figure 1).

Conclusion: HDBR SCG exhibited a decrease in cardiac peak amplitudes of AO and AC with HDBR. Further FDA analysis yielded SCG morphology changes in both AO and AC corresponding to decrease in mechanical strength of the heart possibly due fluid shifts from HDBR.

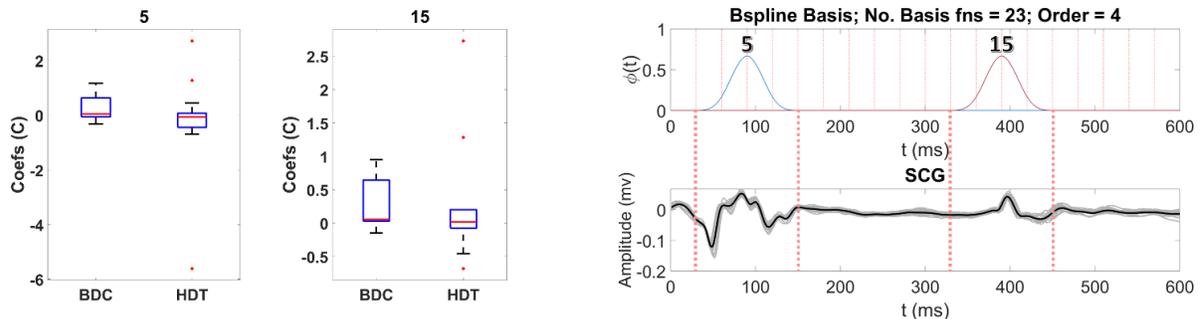


Figure 1: FDA spline basis function coefficient sets for all subjects compared between BDC and HDBR scenarios. Coefficient set 5 corresponds basis for AO while coefficient set 15 corresponds to basis for AC.