

Three dimensional ballistocardiography: an old technique revived from research in microgravity

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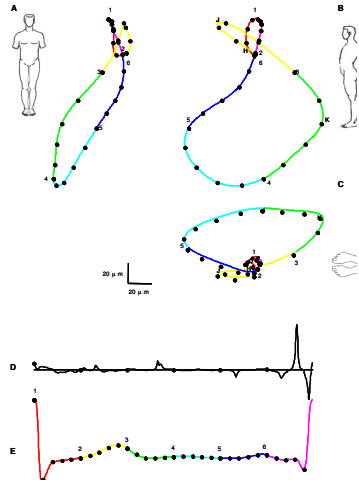
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Ballistocardiography (BCG) is a technique that had a large interest in cardiology between the fifties and eighties. Typically BCG consisted in the recording of mechanical acceleration (Acc), caused by cardiac activity, on a subject lying on a table. As Acc was recorded only in the 2-dimensions (2D) of the horizontal plane, the antero-posterior (Z-axis) component was often neglected. We analyzed a unique data set of 3-D BCG which was recorded in weightlessness on a crew member of the Spacelab-D2 mission (1993). We showed previously that the Z-axis Acc was of comparable magnitude as the 2 others [1], and was thus not negligible. This could be one of the reasons that 2D-BCG, lacking crucially important information, never reached routine use. More recently we demonstrated a new technique [2] for the analysis of the 3D curve described by the displacement vector (DV) of the centre of mass of blood in the arterial tree (see fig).

In the present paper we demonstrate further this technique. We show that DV presents unique features in the cardiac cycle that can be extracted through the analysis of its curvature torsion, and total displacement. Moreover, Fourier spectral analysis was applied to respiration, RRI and the beat-by-beat total displacement to show that DV share important variability with RRI and respiration which could be linked to stroke volume variability. These data suggest that the 3D-BCG, and our analysis of the displacement curve, could provide new physiological information on the mechanical heart function which was lacking in the former 2D-BCG.

[1] Prisk G.K., Verhaeghe, S. Padeken, D., Hamacher H., Paiva M., Three-Dimensional Ballistocardiography and respiratory motion in sustained microgravity, *Aviat. Space. Environ. Med.*, 2001; 72: 1067-1074.

[2] Migeotte P-F., Tank J., Pattyn N., Funtova I., Baevsky R.M., Neyt X., Prisk G.K., Three dimensional ballistocardiography: methodology and results from microgravity and dry immersion, *Submitted to IEEE-EMBC – Boston – August 30-September 3, 2011.*



Projections of the displacement on (A) frontal, (B) sagittal, and (C) transverse planes. (D) torsion curve (E) ECG. Displacements were inverted to represent the movement of moving elements in the body (mostly blood).