

ECG-derived Sympathetic and Parasympathetic Nervous System Dynamics: A Congestive Heart Failure Study

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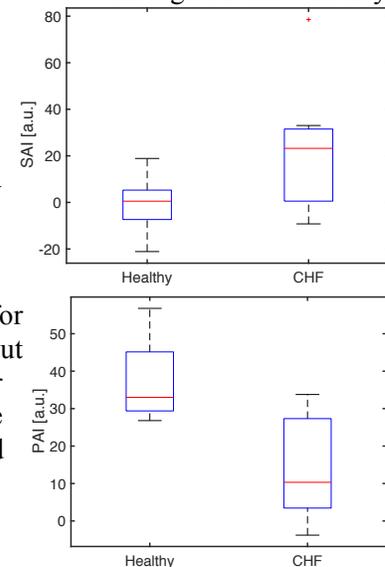
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Introduction: The effective estimation of sympathetic and parasympathetic peripheral outflow from non-invasive physiological measurements has been a long-lasting challenge in cardiovascular research. Spectral analysis of heart rate variability (HRV), in fact, does not fully reflect separate influences of the two peripheral branches on heartbeat because of their simultaneous action in the LF band (0.04-0.15Hz). To overcome this limitation, we recently proposed a methodological framework defining the Sympathetic Activity Index (SAI) and the Parasympathetic Activity Index (PAI), which have been proven effective in healthy subjects [1]. In this study, we aim to validate the SAI and PAI indices in the pathological case of Congestive Heart Failure (CHF).

Methods: We estimated SAI and PAI indices from HRV series recorded from Physionet recordings, i.e., 10 CHF patients (from BIDMC-CHF Database) and 10 healthy subjects (from MIT-BIH Normal Sinus Rhythm Database). A set of disentangling coefficients associated with *Laguerre* functions has been taken from a previous autonomic blockade study [1]. Group comparison is performed through Mann-Whitney non-parametric tests.

Results: Results show a characteristic increase of the sympathetic dynamics in CHF with respect to the healthy (SAI - healthy: 0.53 ± 6.32 ; CHF: 23.22 ± 9.05 ; $p=0.0211$). Results also highlight a significantly reduced vagal activity in CHF with respect to the healthy (PAI - healthy: 33.01 ± 4.48 ; CHF: 10.33 ± 8.50 ; $p=0.0017$).

Conclusions: We demonstrate the reliability of the proposed measures for a non-invasive autonomic assessment in the healthy and in CHF without the need of a model calibration at the level of the individual. Higher sympathetic activity in CHF than in the healthy has been revealed by the SAI index despite the significant reduction of spectral power associated with HRV series during CHF.



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[1] Valenza G, Citi L, Saul JP, Barbieri R. "Measures of Sympathetic and Parasympathetic Autonomic Outflow from Heartbeat Dynamics", *Journal of Applied Physiology*, 2018.