

Validity of Venous Waveform Signal for Heart Rate Variability Monitoring

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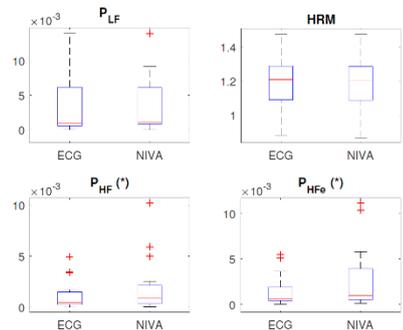
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Heart rate variability (HRV) at rest is widely accepted as a non-invasive measure of autonomic nervous system (ANS) regulation of the heart, and extensively used to assess autonomic function. HRV is typically derived from the ECG but, despite the advances in wearable technology, it still requires the use of contact electrodes which limits their spread and acceptance for daily or long-term monitoring among the non-patient population. Wrist-worn devices are readily accepted wearable devices. A novel technology (NIVAband) has been developed which captures venous waveforms via piezoelectric sensor on the skin over the venous plexus at the volar aspect of the wrist. In this study, we assessed the validity of Non-Invasive Venous waveform Analysis (NIVA) to determine pulse rate and pulse rate variability as a surrogate of HRV.

ECG from chest electrodes and NIVA signal from NIVAband were recorded simultaneously from 7 volunteers while seated in three different scenarios: paced breathing at low rate, fast rate, and spontaneous breathing. Pulses in the NIVA signal were detected by using a matched filter and a time-varying threshold. The power and frequency associated to main spectral components were derived from both beat (ECG) and pulse (NIVA) detections, in the low frequency (LF), high frequency (HF) and extended HF (HFe, up to half of the mean heart rate) bands.

Excellent reliability (>0.9) in the detections was achieved in all but 2 recordings. Mean heart rate (HRM) and LF power showed no significant differences between both devices. HF and HFe powers, however, were significantly different in the NIVA measurements: the HF component was higher using venous waveform analysis, similar as other peripheral signals such as photoplethysmography. Still, the frequency of these spectral components matched in most recordings with a discrepancy lower than 0.01Hz.



P_{LF} , HRM, P_{HF} and P_{HFe} . * denotes significant differences ($p < 0.01$)