Introduction

Hyperactivity of the sympathetic nervous system (SNS) may be paramount to the detrimental effects of stress on cardiovascular health. The Pre-Ejection Period (PEP) is the golden standard to measure SNS activity during naturalistic conditions. PEP measurement heavily relies on the accurate detection of ECG and ICG landmarks that are difficult to detect due to lapses in beat-to-beat signal quality for instance introduced by movement. Large scale epidemiological studies would benefit from a measure that relies on landmarks in ECG and ICG that are less sensitive to noise and do not show rater dependency. This study evaluates whether the more easily detected Initial Systolic Time interval (ISTI) can be used as a valid alternative for PEP.

Materials and methods

Ninety-one subjects participated in a 90 minute laboratory experiment in which a variety of often employed physical and mental stressors were presented and 31 further subjects participated in a structured 2 hour ambulatory recording in which they partook in natural activities that induced large variation in posture and physical activity (Table 1). The ICG and ECG signals were continuously recorded with the Biopac data acquisition system (lab study) and with the VU Ambulatory Monitoring System (ambulatory study). Four landmarks were automatically scored in the electrocardiogram (ECG) and impedance cardiogram (ICG) and rigorously checked by interactive inspection of two independent raters: QRS-onset, R-peak, B-point, and C-point (d2/dt-min) (Figure 1).

The statistical analyses were identical for the ambulatory and laboratory study. For both laboratory and ambulatory protocols a repeated measures ANOVA was used to test for the effect of condition on IBI and PEP to verify successful manipulation of autonomic tone within subjects. Pre-planned contrasts compared the pre-test resting baseline levels of the variables to the levels obtained in the experimental condition. Intraclass correlations correlation coefficients (ICCs) based on a random effects model (absolute agreement) were computed between PEP and ISTI scored by rater 1 and rater 2 separately for each of the conditions across all subjects (per-condition inter rater reliability) and for each of the subjects across all conditions (per-subject inter rater reliability). Finally, multilevel analysis was used to test the validity of using the ISTI as a replacement for PEP (Blackwell, de Leon, & Miller, 2006) allowing a random intercept and slope.

Results

Interrater Reliability

The C-point gained a higher per condition interrater reliability score than the B-point in both the laboratory (1.99 vs .92) and ambulatory (.85 vs .74) study. The lower per-condition interrater reliability for the B-point compared to C-point was confirmed in a lower per-subject interrater reliability (e.g. correlating PEP of rater 1 with PEP of rater 2 across all conditions for each subject).

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The relation of PEP to ISTI

Within and between-subject variation in the PEP was largely captured by the within and between-subject variation in the ISTI. MultiLevel results showed that ISTI explains 75.6 % of the variance in laboratory PEP and 81.2 % in the ambulatory PEP.

Table 1 and 2. Means(95%) and drive scores for all experimental conditions of the laboratory study (1127) and ambulatory study (89). * p < 0.001

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