Assessment of QT Interval Dynamics Induced by Heart Rate Changes through Bivariate Phase-Rectified Signal Averaging

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Aim: The aim of this study is to investigate the relationship between the RR and QT series through the bivariate phase-rectified signal averaging (BPRSA), assuming that spontaneous changes of RR (trigger signal) cause a response in QT (target signal). Moreover, the prognostic value of new deceleration-related indices in a chronic heart failure (CHF) population will be assessed.

Materials and methods: The 24-hour QT and RR series were extracted from 650 Holter recordings acquired in a CHF population. The PRSA and BPRSA techniques were applied to assess the QT/RR dependency. The original PRSA technique is designed for detecting and quantifying recurrent components in biological series, characterized by non-stationarities and noise. First, deceleration anchor points were identified as an RR increase, and segments of 2L+1=15 samples around them were extracted from both the trigger (RR) and the target signal (QT). Finally, all segments were aligned with respect to the anchor and averaged, and four new indices were defined as differences between consecutive samples of the BPRSA series ($x_{BPRSA}(i)$): $\Delta_{1,0} = x_{BPRSA}(1) - x_{BPRSA}(0)$ and $\Delta_{0,-1} = x_{BPRSA}(0) - x_{BPRSA}(-1)$, where $i = 0$ is the position of the aligned anchor points. For comparison, deceleration capacity (DC) and its bivariate analogous (BDC) were also assessed. Prognostic value of deceleration-based computed indices in predicting cardiac death was determined with univariate Cox proportional hazards analysis.

Results: Patients suffering from pump failure death (PFD) had significant lower DC and QT increase after heart rate deceleration. As shown in Table 1, the proposed BPRSA indices were associated to pump failure mortality in the studied population.

	Sudden Cardiac Death		Pump Failure Death	
	Hazard Ratio	**p-value**	**Hazard Ratio**	**p-value**
DC≤4.3	1.38 (0.77,2.48)	0.279	**3,036** **(1.82,5.06)**	**<0.001**
BDC≤-0.01	**1.843** **(1.06,3.20)**	**0.03**	0.809 (0.43,1.53)	0.513
$\Delta_{1,0}$≤ -0.424	0.785 (0.41,1.52)	0.153	**2,619** **(1.57,4.37)**	**<0,001**
$\Delta_{0,-1}$≥ 0.807	0.896 (0.47,1.70)	0.736	**2,177** **(1.29,3.66)**	**0.003**

Table 1: Association of BPRSA indices with sudden cardiac and pump failure death in patients with CHF.

Conclusion: A reduced QT increase in the beats immediately after heart rate deceleration is an indicator of higher mortality risk. The BPRSA technique has the advantage of characterizing QT/RR dynamics from ambulatory recordings in a computationally simple way.