Bidirectional information transfer between blood pressure and heart rate and its relation to vascular properties in hypertensive patients

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Background: The impact of heart rate (HR) on blood pressure (BP) and the influence of blood pressure on heart rate are mediated by distinct mechanisms. Methods which allow the assessment of bidirectional interactions between HR and BP might be especially useful in patients with cardiovascular diseases [1]. Our previous results suggested that Transfer Entropy (TE) method is able to mirror various cardiovascular reactions during head-up tilt in patients with the history of syncope and healthy volunteers [2]. Therefore, we implemented methods based on the information transfer concept also in hypertensive individuals. Our pilot study showed that in patients with hypertension bidirectional HR – BP interaction was decreased compared to healthy volunteers. However, there was a strong relation between age and TE values.

The aim of the present study was twofold: first, to check if hypertension is related to alterations of interactions between HR and BP and second, to test if blood pressure values and vascular properties are associated with the above relation.

Methods: In 24 healthy individuals (CON; 14 men, age 43.4 ± 13.7 years) and 46 patients with hypertension (HTN, 28 men, age 52.1 ± 13.9) Symbolic Transfer Entropy (STE, [3]) was computed. 20-minutes recordings of ECG and beat-to-beat blood pressure (Finometer) in resting – supine conditions were used for the analyses. In all study participants body mass index (BMI), waist-hip ratio (WHR), office blood pressure measurements, 24-hour ambulatory blood pressure monitoring (ABPM) as well as the assessment of vascular properties (diameter and distensibility of carotid artery, intima-media thickness and carotid-femoral pulse wave velocity) were assessed.

Results: 1. In hypertensive subjects STE in both directions was significantly lower than in healthy individuals (RR → BP: 0.06±0.045 vs 0.09±0.041 and BP → RR: 0.05±0.03 vs 0.07±0.04; P=0.0036 and P=0.0066; respectively). However, the compared groups differed significantly with age. When both groups were selected to match each other according to age (14 CON vs 33 HTN, aged 36-65 years) STE differed only for the interaction directed RR → BP.

2. While in younger hypertensive patients (aged 25-44 years) solely transfer in RR → BP direction was decreased (0.06±0.02 vs 0.1±0.05; p=0.045), in middle-aged patients (45-64 years) both STE BP → RR and STE RR → BP values were lower in patients with hypertension compared to normotensive controls (0.04±0.02 vs 0.07±0.04 and 0.05±0.04 vs 0.09±0.06; P=0.006 and P=0.032; respectively).

3. In hypertensive patients STE for the direction BP → RR correlated with age (R = -0.3; P=0.041), carotid artery wall distensibility (R = 0.45; P=0.04) and carotid-femoral pulse wave
velocity (R= -0.49; P=0.01). Further, in HTN group STE RR→BP has not correlated with vascular parameters.

4. There was a significant correlation of STE BP→RR and standard deviation (SD) of day-time systolic BP as well as SD of day-time diastolic BP in ABPM (R= -0.44; P=0.002 and R= -0.32, P=0.02; respectively). Similarly, STE in RR→BP direction correlated with SD of day-time systolic BP and SD of HR (24-hour and night-time) in ABPM (R= -0.33; P=0.027 and R= 0.35, P=0.018 and R= 0.37, P=0.01; respectively).

Conclusion: In hypertensive patients bidirectional interaction between heart rate and blood pressure seems to be decreased, especially in middle-aged individuals. In HTN patients age and vascular properties are related to the information transfer directed BP → HR. Heart rate – blood pressure interaction is associated with blood pressure variability and heart rate variability and does not correlate with absolute values of blood pressure and heart rate.

References