THE RELATIONSHIP BETWEEN HRT AND VALVES FUNCTION IN PATIENTS WITH CONGESTIVE HEART FAILURE

K. Szymanowska, A. Piątkowska, A. Nowicka, M. Kandziora, W. Biegalski, M. Michalski, M. Wierzchowiecki

2nd Department of Cardiology K. Marcinkowski University of Medical Sciences
Mickiewicza 2, 60-834 Poznań, Poland

Abstract: The assessment of heart rate turbulence (HRT) can be helpful in identifying high risk patients with congestive heart failure (CHF). Impaired HRT may be used as a predictive factor for CHF death. Mechanisms responsible for HRT are still not well recognized. Early acceleration and late deceleration phase of HRT after ventricular premature beat may be related to autonomic nervous system activation due to hemodynamic changes in the course of heart dysfunction. The aim of the study was to assess the relationship between parameters of HRT and valve function. 64 CHF patients (mean age 61 ± 12 years; 24 females and 40 males) in NYHA class I-IV, with sinus rhythm in ECG were enrolled into the study. Based on 24 hours ECG recordings the following HRT parameters were calculated: turbulence onset (TO) describing early acceleration phase, and turbulence slope (TS) describing late deceleration phase of HRT. 2D and Doppler echocardiography was performed in all patients. Degree of mitral insufficiency (MI) and aortic maximal gradient (max PG) were measured. MI of I st degree was found in 8 pts., II^0 - in 10 pts, III^0 - in 25 pts and IV^0 - in 21 pts. The maximal aortic gradient (Max PG of AV) ranged from 5,4 to 130 (mean 19,3) mmHg, in 10 pts max PG > 50 mmHg. Negative correlation between TS and the degree of MI (r = -0,33; p= 0,0075), also between TS and aortic max PG (r = -0,26; p= 0,03) was observed. There was no relationship between TO and MI or TO and maximal aortic gradient. Heart rate turbulence is related to the degree of mitral insufficiency and maximal aortic gradient. Hemodynamic disturbances depending on valve dysfunction in congestive heart failure patients may influence heart rate turbulence parameters, especially the turbulence slope.

Key Words: heart rate turbulence, congestive heart failure, valves function

INTRODUCTION

The phenomenon of heart rate turbulence is found in low risk cardiac patients. The absence of short term fluctuation in sinus cycle length after ventricular premature beat (VPB) predicts mortality and sudden cardiac death in patients with myocardial infarction, heart failure and some other diseases (1).

After a VPB in the normal state, heart rate accelerates immediately (2-3 beats) and then decelerates (maximum RR interval at about the 8^{th} to 10^{th} beat) before returning to baseline (before the 20^{th} beat).

The underlying mechanisms of the HRT are not well recognized. Only proper understanding of these mechanisms may offer an explanation why HRT is a potential risk stratifier in some cardiac diseases (2, 3). The value of HRT parameters assessment as a prognostic marker in CHF patients is confirmed (4, 5) but pathohysiological basis needs further investigations.

The purpose of the present study was to evaluate potential relationship between HRT parameters and valves function in CHF patients.

METHODS

Study group

Sixty four patients (24 women and 40 men, age from 38 to 82 years, mean age 61±12 years) with CHF were included to the study. Patient's characteristics are presented in the Table 1. They were diagnosed on the basis of clinical assessment (dyspnoe and exercise intolerance with signs of pulmonary congestion or peripheral edema) and left ventricular dysfunction in echocardiography. Patients with atrial fibrillation and permanent pacemakers were excluded from the study. Six of the 64 patients were in New York Heart Association (NYHA) functional class I, 32 in NYHA class

II, 17 in NYHA class III and 8 in NYHA class IV.

Table 1 Patients characteristics

Age (years) mean ± SD	61 ± 12
Age >60	32 (51%)
Hypertension	40 (63%)
Diabetes	16 (25%)
Coronary Artery Disease	38 (60%)
Myocardial Infarction	23 (37%)
Dilated Cardiomyopathy	15 (24%)
LBBB	12 (19%)
RBBB	6 (10%)
Mean EF ± SD	38±16%

Heart rate turbulence

Three-channel 24-hours Holter-recordings were analyzed by skilled operators using Pathfinder 700 system (Dal Mar Raynolds). After manual review and revision, computer files were generated containing the duration of RR intervals and morphology classifications of individual QRS complexes (normal, aberrant and premature aberrant). HRT analysis was performed on sequences of sinus RR intervals after VPB. The sinus rhythm immediately preceding and following the VPB was free from arrhythmia, artifacts and false classifications of QRS complexes.

HRT was assessed using two standard parameters: the turbulence onset (TO), which quantifies the initial shortening of RR intervals and the turbulence slope (TS), which quantifies the subsequent prolongation of RR intervals (6). TO is the difference between the mean of the first 2 sinus RR intervals following a VPB and the last 2 sinus RR intervals before the VPB divided by the mean of the last 2 sinus RR intervals before the VPB. These measurements were first performed for each single VPB and subsequently averaged to obtain the value characterizing the patient. TS was quantified by the steepest regression line between the RR interval count and duration.

Echocardiography

Two-dimensional and Doppler echocardiography were performed in all patients. Left-ventricular systolic function was assessed by ejection fraction (EF) measured with modified Simpson's rule. Diastolic dysfunction of left ventricle was recognized when signs of impaired relaxation, pseudonormal or restrictive mitral flow pattern were found. Degree of mitral insufficiency (MI) was estimated with Color Doppler and maximal aortic gradient (max PG) was measured using Continuous Wave Doppler.

RESULTS

First degree of MI was found in 8 pts, II° in 10, III° in 25 pts and IV° in 21 pts.

The maximal aortic gradient ranged from 5,4 to 130 (mean 19,3) mmHg, in 10 pts was >50 mmHg. Negative correlation between TS and the degree of MI (r= -0,33; p=0,0075) (Fig 1), also between TS and aortic max. PG (r= -0,26; p=0,03) (Fig 2) was observed. There was no relationship between TO and these echocardiographic parameters.

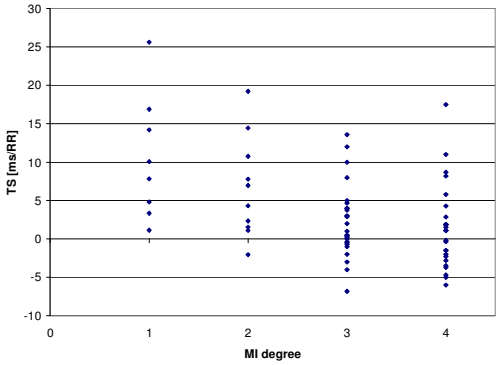

Fig. 1 Relation between turbulence slope (TS) and degree of mitral insufficiency (MI) in pts with CHF

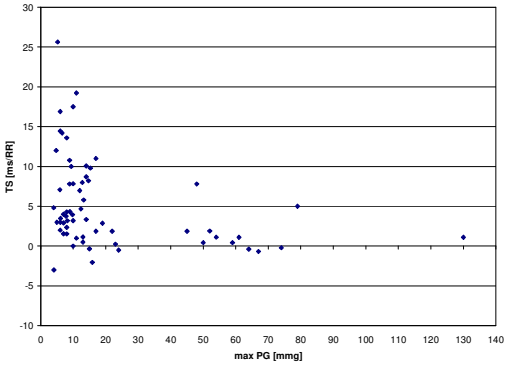

Fig 2. Relation between turbulence slope (TS) and maximal aortic gradient (max PG) in pts with CHF

DISCUSSION

This study has shown that HRT is related to valves function parameters in patients with chronic heart failure.

A physiologic model involving excitation in the heart, the hemodynamic situation in the aorta and baroreceptor feed-back was used to proved that the baroreflex is the mechanism underlying the HRT (1) Diastolic filling after VPB is incomplete leading to low ejection volume. The sudden drop in blood pressure (BP) activates the aortic and carotic baroreceptors, witch increase heart rate (HR). The following sudden BP elevation reduces HR through the baroreflex arc. The BP of the compensatory pause beat is higher then BP of a sinus beat.

We observe sequention: VPB - lower BP - HR increase - compensatory pause - higher BP - HR decrease. While in patients with abnormal left ventricular function, the late phase of HRT is mainly characterized by gradual return of HR and systolic BP back to pre-extrasystolic value, there is a significant overshoot of both RR intervals length and systolic BP above baseline values in patients with preserved left ventricular function.

The sympathetic activation and impaired baroreflex regulation in CHF patients seem to be the main mechanisms involved in HRT (4), but importance of haemodynamic factors was take also considered. The studies with autonomic blockade confirm, that in addition to parasympathetic activity, the sympathetic nervous system may play a role in modulating the interaction between baroreflex sensivity and post ventricular premature beat HR acceleration (7, 8). Both HRT parameters and low frequency HRV are significantly dependent on baroreflex activity and their correlation suggests autonomic mechanisms resulting in decreased vagal activity (9).

Various degree of mitral valve insufficiency is observed in pts with left ventricular enlargement in CHF. It leads to increase of the preload. The presence of the aortic stenosis with essential maximal aortic gradient leads to high end-systolic pressure in left ventricle. It is possible that HRT is influenced directly by changes in preload, afterload and relation between ejection and diastolic filling (10).

Conclusions

In patients with congestive heart failure sinus rate fluctuation after ventricular premature beat (HRT) is related to the degree of mitral insufficiency and maximal aortic gradient. Negative correlation observed between turbulence slope (TS) and these echocardiogaphic parameters may be explained by hemodynamic disturbances depending on valves function.

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