ABNORMAL HEART RATE RECOVERY AS A MARKER FOR AUTONOMIC NERVOUS SYSTEM DYSFUNCTION

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Abstract: *Introduction: Heart rate recovery (HRR) immediately after the exercise stress test is considered a reflection of the vagal reactivation and a marker for autonomic imbalance. Materials and methods: We performed a retrospective analysis on 31 patients with abnormal HRR studying the influence of the most important cardiovascular risk factors: smoking, diabetes, obesity and hypertension as determinants for autonomic imbalance. Results: There was no association between the major risk factors with the ΔHR1, which only seems to be correlated with the maximal load of the stress test. For sub-groups with lower cut-off values for HRR and aged above 75 we obtained several correlations with smoking status, diastolic blood pressure and obesity. Conclusions: Even though our study group is small, our findings still raise the question if we should be more strict when considering the HRR abnormality with a possible cut-off value of 8/9 for each of the minutes of recovery.*

INTRODUCTION

The important role of the nervous autonomic system on cardiovascular activity regulation has been well known since the beginning of the 20th century, and a shift towards a sympathetic predominance is associated with an overall increased cardiovascular risk (1-4) by elevated heart pressure, tachycardia and arrhythmias.

Heart rate recovery (HRR) immediately after stopping the exercise stress test is considered as a reflection of the balance between sympathetic and parasympathetic tone; the inability of the activation of the vagal tone represents a failure in descending the heart rate in the first minute at least 12 beats per minute from peak heart rate with an active recovery, and another 12 beats in the second minute.

Slow HRR has been associated with atherosclerosis and ischemic heart disease.(5,6,7) Also, HRR is a prognostic marker among heart failure patients (FEVG <40%) and hyperactivity of the sympathetic nervous system may be a pathogenesis factor.(8,9)

PURPOSE

The aim of this study was to evaluate HRR after ergometer exercise testing as a marker of impaired autonomic balance and the possible correlation between a slow HRR and cardiovascular risk factors (smoking, diabetes, age and hypertension).

MATERIALS AND METHODS

We have conducted a retrospective analysis of the patients referred for exercise stress test in our department between January 2015 – December 2015; from all the tests performed we only selected 31 patients who fulfilled the inclusion criteria: abnormal heart rate recovery defined as: heart rate (HR) minute 1 (ΔHR1) < peak heart rate -12; HR minute 2(ΔHR2) < ΔHR1-12; HR minute 3 (ΔHR3) < ΔHR2 minute-12.

We excluded the patients with left bundle branch, atrial fibrillation, the presence of a pacemaker or with other extracardiac conditions incompatible with accomplishing at least sub-maximal stress test (inferior member arteriopathy, sciatics, arthrosis of the knee or hip). Beta-blockers and calcium channel antagonists were discontinued at least 48 hours before the exercise test in all patients. All patients signed consent forms and answered a questionnaire about the presence of symptoms, treatment, risk factors for coronary artery disease, and cardiac history. Maximal predicted HR was calculated as 220 – age (years).

The reasons for terminating the test were: achievement of > 85% of age predicted maximum HR; systolic blood pressure > 250 mm Hg; typical angina; severe arrhythmias and more than 1 mm of horizontal or descending ST segment depression. In the recovery phase the patients spent 3 minutes performing a 0-30W workload effort (active recovery).

In our study we used as parameters some of the most important risk factors: smoking, diabetes, obesity and hypertension. Statistical analysis was performed using the software RStudio Version 1.0.44 performing a multivariate regression and a p value ≤ 0.05 was considered statistically significant.

RESULTS

A group of 31 patients met the inclusion criteria (18 men and 13 women) aged between 51 and 83 (67.7 +/- 9.21 mean age). 13 patients had an abnormal HRR minute 1, 22 an abnormal HRR minute 2, 20 minute 3; 12 of the individuals had an abnormal HRR for minute 1 and 2 and 5 for minutes 1,2 and 3. A summary of the characteristics of the variables in the study group is shown in table no. 1.

Surprisingly, there was no association found between the presence of the major risk factors with the ΔHR1 (table no. 2), which only seems to be correlated with the maximal load of the stress test (IMC p=0.6 r=-0.05; Diabetes p=0.4 r=-14; Hypertension p=0.7 r=-18; Smoking p=0.8 r=0.32) R=0.41

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p=0.01. When defining subgroups with:

- HR1<9 (ΔHR1') association found with the heart rate at rest (p=0.004, R=0.7)
- HR1<8 (ΔHR1") a negative correlation of DHR3 with age(p=0.01 R=-0.96) and with the number of ESV (p=0.05 R=-0.88); positive correlation between ΔHR2 and peak diastolic arterial pressure (p=0.03 R=0.93)

When taking into consideration only patients aged more than 75, ΔHR2 proves a negative correlation with the smoking status (p=0.001 R=-0.84).

Old age (>80) has a stronger negative correlation between ΔHR2 and smoking status (p=0.004 R= -0.93), with IMC (p=0.09 R=-0.92) and with maximal load (p=0.03 R=-0.82).

Table no. 1. Study group characteristics

Age	67 years (51-83)
Sex	18 males/13 female
IMC (kg/m^2)	28 (19-50)
Diabetics	11 patients
Hypertension	24 patients
Smoking	10 patients
LVEF (%)	60 (47-76)
FMT (%)	87 (64-100)
ΔHR1:Frecvmin1-Frecvmax	16(0-31)
ΔHR2:Frecvmin2-Frecvmin1	10 (-20-30)
ΔHR3:Frecvmin3-Frecvmin2	4.5 (-4-11)
HR at rest	74 (52-106)
HR peak exercise	135 (102-165)
TAS max	180 (129-197)
TAD max	101 (70-124)
Positive stress test	11

Table no. 2. Predictors of abnormal HRR in multivariate regression analysis

	P value ΔHR1	P value ΔHR2	P value ΔHR3
Age	0.9651	0.0813	0.742
IMC	0.6107	0.3489	0.481
Diabetic	0.4254	0.8273	0.882
Hypertension	0.7642	0.5102	0.325
Smoking	0.8675	0.3992	0.721
FMT	0.3583	0.1241	0.816
HRatrest	0.9499	0.7261	0.529
HRpeak	0.2459	0.7838	0.190
TASmax	0.1921	0.0578	0.248
TADma	0.1336	0.8070	0.806
Maxload	* 0.0140	0.0603	0.324

Figure no. 1. Comparison of HRR at minutes 1, 2 and 3

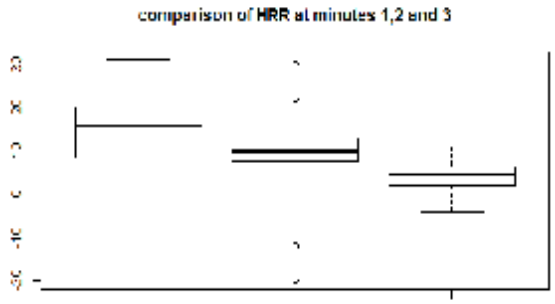
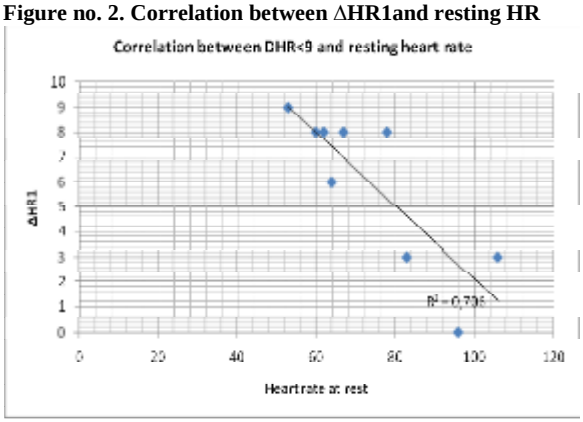


Figure no. 2. Correlation between ΔHR1and resting HR



DISCUSSIONS

Age is probably the most important determinant in our analysis, the older the patient the slower he will recover from the 3rd minute, our findings corresponding with the findings of previous studies available in literature.(10)

Smoking was already established to be correlated with an abnormal heart rate recovery in coronary artery disease (6) and dyslipidemic patients.(11) Our smoking patients over 75-80 years old have slower heart rate recovery from minute 2 and they are less capable to reach higher maximal loads.

The main limitation of our study is the small number of patients who were recruited in a single centre university hospital. Another concern and maybe a source of error is that there is no consensus worldwide for standardised cut-off values for abnormal heart rate recovery for each minute after stopping the test and neither for the duration to measure, some authors consider up to 5 minutes (12), others stop at 2. Others have proposed taking into consideration HRR at 30, 60 and 90 seconds as a predictor for responding to resynchronisation therapy.(13) Also there are no recommendations for using an active recovery (with a low workload exercise) or passive one (14) and which should be the cut-off values in each case. These differences make it very difficult to compare the studies.

CONCLUSIONS

Even though our study group is small, our findings still raise the question if we should be more strict when considering the HRR abnormality with a possible cut-off value of 8/9 for each of the minutes of recovery.

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