

Heart rate reserve – A useful tool for evaluation of chest pain in middle aged

***C.P. Ganashree, S M Nataraj, R. Rajalakshmi, Vijaya Y Vageesh**
Department of Physiology, JSS Medical College, Mysore - 570015,
Karnataka.

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Corresponding author

Ganashree C P

E-mail: ganaraghu@yahoo.com

Abstract

Background: Chronotropic incompetence (CI) is the inability of heart rate response to meet metabolic demand. It is an attenuated heart rate response to exercise and is a predictor of all- cause mortality in healthy populations.

Objectives: To study heart rate reserve and CI in middle aged with non specific chest pain to isotonic exercise.

Methods: This is a retrospective cross sectional study carried out in the department of Medicine, JSS hospital. Study group comprised of 43 patients (Males-30 and Females-13) in the age group 40-50 years with history of nonspecific chest pain but normotensive, nondiabetic and normal resting ECG. Standard Bruce protocol was followed. Two groups were made-Group A(6 patients with typical angina) and Group B(37 patients with non typical angina).

Chronotropic incompetence was concluded if derived value is less than 85% of the patient's heart rate reserve.

Results: Mean Heart rate reserve was significantly lowered in Group A when compared to Group B (60.4750 vs78.8978, p value<0.05).

Conclusions: Angina patients are more prone for CI compared to patients without angina.

Incorporation of heart rate reserve and CI into routine evaluation of patients with symptoms of coronary artery disease (CAD) is useful for detection of CAD cases.

Key words: Angina, Chronotropic incompetence, Heart rate reserve, Treadmill test

Introduction

Exercise testing is a simple and inexpensive diagnostic tool that is performed routinely in every cardiology department. It is primarily used to look for the presence of myocardial ischaemia, but provides further valuable information that is not widely appreciated. Examination of the heart rate during exercise is of powerful prognostic value. In 1975 Ellestad and Wan showed that the lack of an appropriate heart rate response to exercise, a feature they termed 'Chronotropic incompetence', was associated with a greater risk of adverse cardiac

events in the next five years than was ST segment depression(1). Many further studies have confirmed that chronotropic incompetence is an independent predictor of risk in patients with coronary artery disease; although inferior to myocardial perfusion scanning in the prediction of cardiac death, it does add incremental prognostic value to this test(2). Chronotropic incompetence is also predictive of adverse cardiac events and total mortality in apparently healthy individuals even after adjustment for factors such as age, ST segment shift, physical activity, and traditional coronary disease risk factors(3). Further confirmation of the prognostic value of the heart rate response to exercise has been demonstrated in a study of about 6000 healthy male Parisian civil servants who underwent exercise testing between 1967 and 1972(4). A low heart rate response to exercise proved to be a powerful predictor of both sudden death and total mortality though not of death from “non-sudden myocardial infarction”. This finding was particularly striking as the lack of heart rate response in these individuals was relative; subjects who achieved less than 85% of their predicted maximum peak heart rate were excluded from the study. Chronotropic incompetence (CI) is the inability to proportionally increase heart rate (HR) to meet the increase in metabolic demand (4). It can refer to the inadequacy of the sinus node or of the escape pacemaker in the case of heart block. It can also refer to the inadequacy of AV nodal regulation of the supraventricular pacemaker as in atrial fibrillation. The clinical manifestations of CI are protean and include the inability to achieve maximal HR, a delay in achieving maximal HR, inadequate submaximal or recovering HR or rate instability with exertion (5,6). It is not known whether chronotropic incompetence is independently predictive of all-cause mortality among patients referred for stress testing after accounting for myocardial perfusion defects. The purpose of this study was to examine the association of chronotropic incompetence with myocardial perfusion defects and to determine the ability of chronotropic incompetence to predict all-cause mortality in a low-risk cohort of patients referred for exercise treadmill test.

Materials and methods:

This is a retrospective cross sectional study conducted in Treadmill Unit, Department of Medicine, JSS Hospital, JSS Medical College, Mysore. Approval from the Ethical committee was obtained prior to the commencement of the study.

Subjects:

Study group included Forty three patients comprising 30 males and 13 females belonging to the age group of 40-50 years. They came with a history of non-specific chest pain. They were normotensive, nondiabetic and had normal Electrocardiogram (ECG) at rest. Simple random selection was made. Patients with evidence of recent myocardial infarction, angina pectoris of recent onset or with a pronounced change in the severity or frequency of angina were excluded from the study. Standard Bruce Protocol was followed. Subjects were divided into two groups-Group A (6 patients with typical angina) and Group B (37patients with non typical angina).

Clinical data

Before exercise testing, a structured interview and chart review yielded data on symptoms, medications, coronary risk factors, prior cardiac events and a number of cardiac and noncardiac diagnosis. Resting hypertension was defined as a resting systolic blood pressure ≥ 140 mm Hg, a resting diastolic blood pressure of ≥ 90

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mm Hg or treatment with antihypertensive medications(7). Assessment of diabetes was based on questioning and medication use.

Exercise Testing

Treadmill testing was carried out according to standard protocols, usually Bruce or modified Bruce(8,9). To facilitate estimation of exercise capacity, leaning on handrails during exercise was explicitly not allowed. During each stage of exercise, data on symptoms, rhythm, heart rate, blood pressure (by indirect arm-cuff sphygmomanometer), estimated work load in metabolic equivalents (METs) and ST segments were collected and entered on-line. Estimated functional capacity in METs was estimated from standard published tables(9). Based on protocol and total time completed in the final stage; a MET is a measure of oxygen consumption equal to 3.5 ml/kg/min, which represents basal, resting metabolic needs. When ST segments were interpretable, an ischemic response was considered present if there was ≥ 1 mm of horizontal or down sloping ST-segment depression of 80 ms after the J-point or if there was ≥ 1 mm of additional ST-segment elevation in leads without pathologic Q waves. If a patient had more than one treadmill exercise echocardiogram performed during the study period, only the first one was considered for analysis. Chronotropic incompetence was first assessed as failure to achieve 85% of the age-predicted heart rate. This method may be confounded by effects of age, physical fitness and resting heart rate, so chronotropic response was also assessed by calculating the ratio of heart rate reserve (HRR) used at peak exercise; this chronotropic index has been described in detail elsewhere(3,10). In an analogous fashion, the percent HRR used is:

$\%HRR \text{ used} = (HR_{\text{peak}} - HR_{\text{rest}}) / (220 - \text{age} - HR_{\text{rest}}) \times 100$. In a group of healthy, non-hospitalized adults, the ratio of percent HRR used during exercise was approximate. Thus, chronotropic incompetence can be defined as a percent HRR used ratio of < 0.85 ; this will be referred to as a low chronotropic index. The advantage of using this approach to assess chronotropic response is that it accounts for age, functional capacity and resting heart rate; it is not merely a reflection of physical fitness or exercise time. Statistical analysis was done using SPSS for windows version 16.

Statistical analyses

Data was represented as mean \pm standard deviation (SD). Analysis was done using SPSS (version 16) and independent *t* test. P value < 0.05 was considered as statistically significant.

Results

Mean Heart rate reserve was decreased in Group A when compared to Group B, which was statistically significant. These are depicted in table 1 and figure 1. Mean heart rate reserve in females was higher when compared to males, which was not statistically significant.

Discussion:

The important new findings of this study are that apparently healthy individuals with an attenuated HR response to exercise are more likely to have chronotropic incompetence. This relationship was independent of selected risk factors for CAD. To the best of our knowledge, this study will help to report that chronotropic incompetence to exercise in healthy persons is associated with an increased risk of CAD(3,6).

Many studies have reported that an abnormal HR response to exercise is associated with a significantly increased risk of cardiovascular mortality after adjusting for age, exercise

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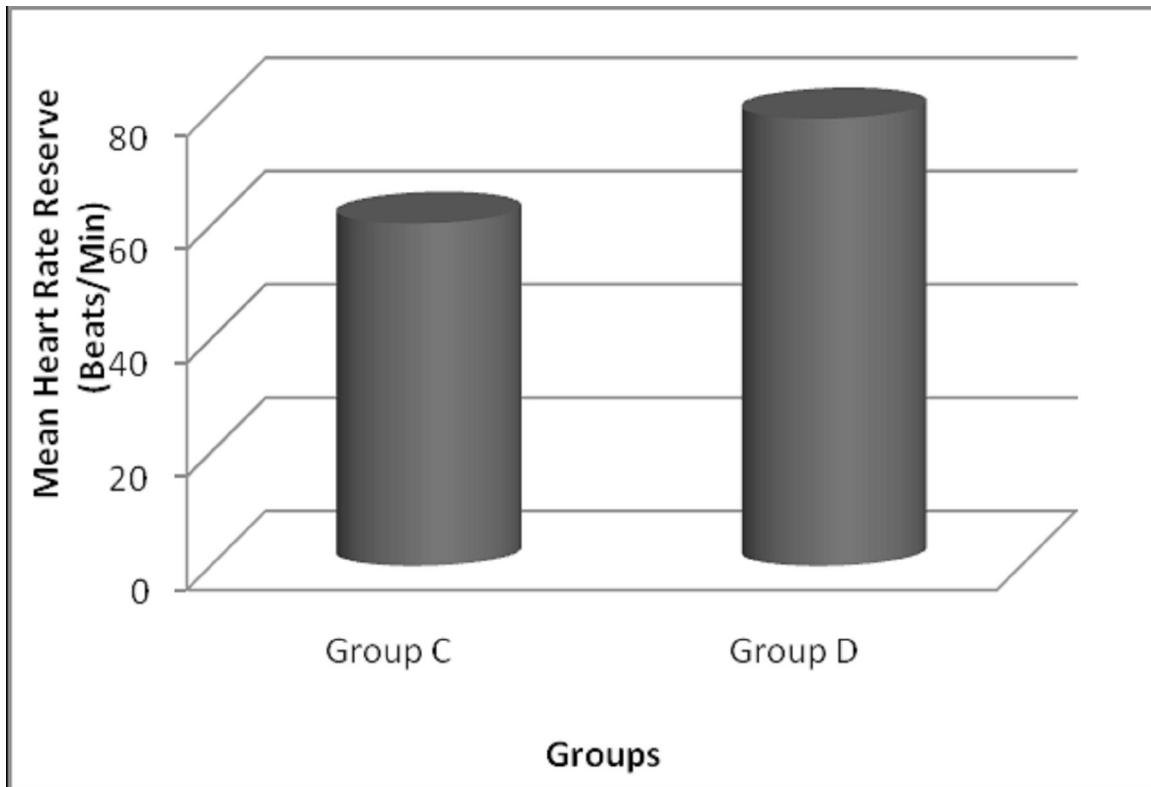
Group Statistics

Table 1: Heart rate reserve (in mean±SD) in patients with angina and without angina

Angina	No.of patients	Mean	Std. Deviation	T-test	P value
Positive	6	60.4750	19.26660	-2.859	.007 (HS)
	37	78.8978	13.87697		

P value<0.05 is significant, HS-Highly significant

Figure 1: Graph showing mean heart rate reserve in Group A and Group



***Group A has heart rate reserve < 85% of age predicted maximum heart rate.