The Egyptian Heart Journal 70 (2018) 283–285

Contents lists available at ScienceDirect

The Egyptian Heart Journal

journal homepage: www.elsevier.com/locate/ehj

Original Article

Effect of exercise training on heart rate recovery in patients post anterior myocardial infarction

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ARTICLE INFO

Article history:
Received 20 March 2018
Accepted 21 April 2018
Available online 31 May 2018

Keywords:
Heart rate recovery
Exercise training
Myocardial infarction

ABSTRACT

Background: Regular exercise training has been shown to reduce mortality, improve functional capacity; and control the risk factors in myocardial infarction (MI) patients. Heart rate recovery (HRR) is a strong independent mortality predictor in patients with previous MI.

Aim: The main objective of this study was to investigate the impact of exercise training on heart rate recovery in patients post anterior myocardial infarction.

Methods: We recruited patients one month after having anterior MI who were referred to cardiac rehabilitation (CR) clinic in Ain Shams University hospital between October 2016 and July 2017. All the patients participated in exercise training sessions 3 times a week for 12 weeks. Symptom limited treadmill exercise test was done before and after exercise training program to calculate heart rate recovery in 1st minute (HRR1) and 2nd minute (HRR2).

Results: A total of 50 patients, including 44 (88%) males, completed the exercise training program. The mean age was 51 years. Statistically significant improvement in HRR1 and HRR2 was observed (p value <0.001) after completion of exercise based cardiac rehabilitation program. Significant improvement in resting heart rate was also observed (p value <0.001). Moreover, metabolic equivalent (METs) and HR reserve were improved significantly (p value <0.001). No statistically significant changes were observed in resting systolic and diastolic blood pressures and maximum HR (p value = 0.95, 0.76 and 0.31 respectively).

Conclusion: Exercise training improves HRR, resting HR, METs and HR reserve in post anterior MI patients.

1. Introduction

The heart rate is an important prognostic factor of cardiovascular disease (CVD); as the heart rate is a significant indicator of myocardial oxygen demand, individuals with a resting heart rate of more than 90 beats per minute (bpm) were found in several studies to have a threefold increased mortality risk compared to those with a rate lower than 60 bpm.[1]

Heart rate recovery (HRR) is defined as the difference between peak HR during exercise and exactly 1 min or 2 min into the recovery period after exercise. A HRR value less than 12 beats/min or less than 22 beats/min at 1 and 2 min into the recovery period respectively was found abnormal.[2]

The heart rate is regulated and determined predominantly by the autonomic nervous system function. The change in heart rate (HR) during exercise and recovery is controlled by the balance between sympathetic and parasympathetic activity. Reduced parasympathetic activity is thought to be responsible for attenuated HRR after exercise.[3] A decreased HRR in first minute after graded exercise is considered a powerful predictor of overall mortality in patients with and without heart disease, independent of workload, the presence or absence of myocardial perfusion defects, and changes in heart rate during exercise.[4]

Hence the aim of the present study was to evaluate the effect of exercise training based cardiac rehabilitation (CR) on heart rate recovery in patients post anterior myocardial infarction.

2. Material and methods

The study included 50 patients one month after having anterior MI who were referred to cardiac rehabilitation (CR) unit in Ain Shams University hospital between October 2016 and July 2017.

All patients were subjected to formal cardiac rehabilitation program including medical evaluation, risk factor modification,

Peer review under responsibility of Egyptian Society of Cardiology.
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https://doi.org/10.1016/j.ehj.2018.04.007
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psychosocial management, nutritional counseling, physical activity counseling and treadmill exercise training. Moderate intensity exercise training 3 times a week for 12 weeks was prescribed achieving target heart rate of 40–60% of HR reserve calculated from pre-exercise symptom limited stress test by modified Bruce protocol. Each session was 30 min in duration. The exercise sessions were initiated with 5 min of warm-up exercise such as walking and stretching, followed by treadmill walking supervised by a nurse and one of our study team. The procedures were explained to the participants and informed written consent was obtained. The Borg scale of rate of perceived exertion (RPE) was used to follow up the progression of exercise intensity where the patients were exercised at an RPE of 11–13 in the absence of symptoms. Patient monitoring included rating of perceived exertion (RPE), continuous ECG monitoring, recording of heart rate, blood pressure and symptoms pre and post activity.

In order not to affect the results of the study, patients on beta blockers or other rate-reducing drugs continued using the same doses during the study period. The participants were asked regarding previous diagnoses of DM, hypertension, smoking, dyslipidemia and family history of premature ischemic heart disease. All patients had full history and thorough physical examination, Echocardiography to evaluate left ventricular ejection fraction by 2D biplane Simpson's methods.

All participants performed symptom limited exercise treadmill test with modified Bruce protocol before and after implementing exercise training program. In order to calculate HRR, the maximum heart rate during the exercise test was recorded. At the end of the exercise test the patients were asked to sit down without having a cooldown period and their heart rate was recorded again after 1 and 2 min into the recovery phase. The difference between maximum heart rate and these 2 recovery period measurements was considered HRR1 and HRR2 respectively. Patients with decompensated heart failure, musculoskeletal disease interfering with the planned exercise training, advanced kidney disease, advanced liver disease, malignancy, patients with incomplete coronary revascularization and residual ischemic symptoms as well as those who refused to participate in the study were excluded from the sudy.

Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

Table 1
Demographic data, ejection fraction and risk factors.

Characteristic	Total (N = 50)
Female	6 (12%)
Male	44 (88%)
Age (years) [Range – Mean ± SD]	33–63 [51.50 ± 7.46]
Smoking	34 (68%)
HTN	19 (38%)
DM	8 (16%)
Dyslipidemia	6 (12%)
Family history of premature IHD	8 (16%)
EF%	
<50%	37 (74%)
≥50%	13 (26%)
Range [Mean ± SD]	33–72 [44.32 ± 10.53]

3. Theory

Since exercise training helps to improve autonomic nervous system function and increase parasympathetic activity, we designed this study to investigate the impact of exercise training on heart rate recovery in patients post anterior myocardial infarction.

4. Results

A total of 50 patients completed the exercise training program. The baseline Demographic data, ejection fraction and risk factors are shown in Table 1.

In addition, resting heart rate, maximum heart rate, heart rate reserve, heart rate recovery 1st minute (HRR1), heart rate recovery 2nd minute (HRR2), metabolic equivalent (METs), resting and peak exercise systolic and diastolic blood pressures of the study group before and after exercise training program are included in Table 2.

There was statistically significant increase in (HRR1) and (HRR2) after exercise training program (18 ± 8.47 vs. 24.70 ± 7.57, p-value <0.001) and (30.52 ± 8.62 vs. 38.86 ± 10.13, p-value <0.001) respectively. Also There was a statistically significant increase in HR reserve (58.08 ± 20.50 to 65 ± 16.38, p-value <0.001). Moreover, there was significant decrease in resting HR after the exercise training program (76.20 ± 14.21 to 68.16 ± 8.39, p-value <0.001). Regarding maximum HR, resting systolic and diastolic blood pressures there were no statistically significant changes (134 ± 19.83 to 131.84 ± 16.42, p-value 0.316), (113 ± 13.98 to 112.90 ± 13.67, p-value 0.955) and (70.30 ± 10.22 to 70.80 ± 8.83, p-value 0.765) respectively.

5. Discussion

The benefits of exercise-based CR on cardiovascular risk factors, exercise tolerance, cardiac morbidity and mortality have been widely established in CAD patients [5].Our study showed statistically significant increase in mean HR recovery in 1st min (HRR1) and 2nd minute (HRR2) after exercise training program (18 ± 8.47 vs. 24.70 ± 7.57, p-value <0.001) and (30.52 ± 8.62 vs. 38.86 ± 10.13, p-value <0.001) respectively.

These improvements in HR recovery was supported by Hai et al. who investigated the effect of change in HR recovery after exercise

Table 2
Resting heart rate, maximum heart rate, heart rate reserve, heart rate recovery 1st minute (HRR1), heart rate recovery 2nd minute (HRR2), metabolic equivalent (METs), resting and peak exercise systolic and diastolic blood pressures of the study group before and after exercise training program.

	Before CR	After CR	Mean Diff.	p-value
Resting Heart rate	76.20 ± 14.21	68.16 ± 8.39	−8.040	<0.001
Maximum Heart rate	134.22 ± 19.83	131.84 ± 16.42	−2.380	0.316
Heart rate reserve (maximum HR-Resting HR)	58.08 ± 20.50	65.68 ± 16.38	7.6	<0.001
Heart rate recovery in 1st min	18.00 ± 8.47	24.7 ± 7.57	6.70 (37%)	<0.001
Heart rate recovery in 2nd min	30.52 ± 8.62	38.86 ± 10.13	8.34 (27%)	<0.001
Metabolic equivalent	7.16 ± 1.13	7.92 ± 0.78	0.760	<0.001
Resting blood pressure				
Systolic	113.02 ± 13.98	112.90 ± 13.67	−0.120	0.955
Diastolic	70.30 ± 10.22	70.80 ± 8.83	0.500	0.765
Peak exercise blood pressure				
Systolic	135.30 ± 18.33	134.90 ± 16.80	−0.400	0.893
Diastolic	84.90 ± 11.54	78.40 ± 9.87	−6.500	0.003

training on clinical outcomes in MI patients.[6] The study included 386 consecutive patients with recent MI who were enrolled into CR program. All patients underwent symptom-limited treadmill testing at baseline and after exercise training and were prospectively followed up in the outpatient clinic. Treadmill testing revealed significant improvement in HRR after 8 weeks of exercise training (17.5 ± 10.0 to 19 ± 12.3, p-value = 0.011).

Another study agreed with our results was done by Francesco et al. who recorded the effect of exercise based CR on HR recovery 1st min in elderly patients after MI.[7] This was a prospective observational study including 268 older patients after MI (217 men, 51 women), subdivided in two groups. Group A (N = 104) enrolled in an exercise training program and Group B (N = 164) discharged with generic instructions to continue physical activity. At baseline and at 3 months follow up, all group A and group B patients underwent an exercise testing. After completion of the exercise training program, an improvement in HR recovery was observed in group A (13.5 ± 3.7 to 18.7 ± 3.5, p-value <0.001). No changes in HRR were observed in group B patients.

The positive effect of exercise training on autonomic nervous system in supported also by Ribeiro et al.[8]. He conducted prospective randomized clinical trial on 38 patients after their first MI in order to assess the effect of cardiac rehabilitation on the autonomic function. Patients were randomized into two groups: exercise training or control. The exercise group participated in an 8 weeks of exercise training, while the control group received standard medical care and follow up. The exercise training group showed a significant decline in the systolic BP, decreased resting HR and increase in HR recovery 1st min.

Additionally, our study showed significant decrease in resting HR after the exercise training program (76.20 ± 14.21 to 68.16 ± 8.39, p-value <0.001). These results were similar to Tsai et al.'s findings who investigated the effects of CR on HR recovery 1 min and resting HR after peak exercise of patients who received coronary artery bypass graft (CABG) surgery.[9] Thirty patients who received CABG surgery were randomly assigned to enter or not enter a CR program (study group n = 15; control group n = 15). There was a significantly lower resting HR in the study group (77.46 ± 9.49 vs. 92.31 ± 10.18p-value <0.001).

Exercise training was expected to result in significant decrease in maximum HR, resting systolic and diastolic blood pressures; however, in our study there were no statistically significant changes (134 ± 19.83 to 131.84 ± 16.42, p-value 0.316), (113 ± 13.98 to 112.90 ± 13.67, p-value 0.955) and (70.30 ± 10.22 to 70.80 ± 8.83, p-value 0.765) respectively, this may attributed to the small number of patient included in this study. The meta-analysis on endurance training involved 72 trials and 105 study groups. Training induced significant net reductions in resting and daytime ambulatory blood pressure of, respectively, 3.0/2.4 mmHg ($P < 0.001$) and 3.3/3.5 mmHg ($P < 0.01$). Systemic vascular resistance decreased by 7.1% ($P < 0.05$).Body weight decreased by 1.2 kg ($P < 0.001$). Endurance training decreases blood pressure through a reduction in systemic vascular resistance, and favorably affects concomitant cardiovascular risk factors. The Exercise is a cornerstone therapy for the prevention, treatment and control of hypertension.[10]

Since the HR reserve is defined as the difference between maximum and resting HR, there was a statistically significant increase in HR reserve after exercise training based CR (58.08 ± 20.50 to 65 ± 16.38, p-value <0.001).

Moreover, there was a statistically significant increase in METs after exercise training based CR (7.16 ± 1.13 to 7.92 ± 0.78, p-value <0.001), our results are similar to the significant improvement in exercise capacity found by Rebecca et al. who retrospectively reviewed data from 458 patients enrolled in cardiac rehabilitation and exercise programs after major cardiac event.[11] At baseline (6 weeks after the cardiac event and before rehabilitation), exercise capacity (−9%, p = 0.08) after cardiac rehabilitation and exercise training, had significant improvements in exercise capacity (+40%, p < 0.001).

6. Conclusion

The present study showed that 3 sessions of exercise training / week for 3 months is sufficient to obtain improvement in HR recovery, resting HR and HR reserve. Moreover, improving exercise capacity.

7. Limitations of the study

1. Small number of patients.
2. Shorter duration of follow up (longer follow up for cardiac events will give strength to the present research).

8. Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

None

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