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Efficacy of Controlled Chest Expansion Exercise on Autonomic Function in Heart Failure Patients

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Abstract : Autonomic dysfunction of the heart can increase the incidence of the cardio vascular mortality in heart failure patients, heart rate variability analysis consider an important method to assess cardiac autonomic dysfunction and also used to assess the left ventricular morphology and function. The purpose of this study was to investigate whether the diaphragmatic training could induce change on heart rate variability in with heart failure. Thirty patients, with heart failure, were assigned to two groups equal in number. Group (1) study group including 15 patients participated in a supervised diaphragmatic training program for 8 weeks with usual care. Group (2) control group including 15 patients undergo usual care. Main outcome parameters were HRV parameters. Evaluations were carried out pre and post experimentally using EGG. Results showed that the parasympathetically modulated HRV of the patients in the exercise group increased significantly compared with the HRV of patients in the control group. It had been concluded that diaphragmatic training could increase autonomic modulation of cardiac function in patients with heart failure. It is also suggested that analysis of HRV can be earned out to assess the effect of diaphragmatic training on cardiac autonomic dysfunction in patients with heart failure.

Keywords : Controlled chest expansion, Autonomic function, Heart Failure.

Introduction

The heart function is pumping blood to all the body. Heart failure mean that, the heart is not able to pump enough blood to meet needs of the body heart failure occur when the heart muscle become weaker than normal or when there is defect prevents normal circulation of the heart that prevents blood to be getting out into the normal circulation. [(1)].

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Heart failure still represent an important cause of the morbidity and mortality between the population.**[2]**.

Different studies approved that, the 6 years mortality rate approaches 65% in the female and approaches 80% in males the mortality and morbidity of the heart failure will continue to increase with aging. **[3]**.

The heart failure patients have dyspnea, inspiratory weakness restrictive pattern of lung function (stiff lung) due to pulmonary hypertension. Heart rate variability represent the normal response of the heart rat (rise and fall) to breathing , or hormones or blood pressure , emotions and autonomic activity changes**[4]**.

It is used as reflective and predicative method to assess general health and psychological illness. Heart rate variability impairment can be observed in many clinical scenarios, As myocardial infraction, autonomic neuropathy, congestive heart failure heart trans plantation and other cardiac non cardiac disease. Diminished HRV may be associated with Increased morbidity and mortality. Various life changes with pharmacologic therapies may improve HRV **[6]**.

Respiratory exercises can affect heart rate through physiological and anatomical mechanisms**[7]**. Respiratory restraining with diaphragmatic breathing consider a useful method for cardio respiratory control **[8]**. Has been approv3ed that slow controlled breathing at 6 cycle per minute can increase the sensitivity of baroreflex in normal subjects and heart failure patients .Slow breathing is used to decrease the sympathetic activity and reduce coronary events and heart attack.

Slow breathing can reduce respiratory muscle tension and increase feeling of relaxation and can lowers the blood pressure even in resistant hypertensive patients. Proper deep breathing exercise can influence subtle cardiac parameters as pulmonary arterial pressure, aortic pressure, ejection fraction, pre load and after load and tissue oxygenation.

Subjects:

Thirty patients their age more than 40 years old were recruited for the study from Critical Care Medicine Department of Heart Institute with the following:

Inclusion criteria:

1. All subjects were diagnosed as left side heart failure with ejection fraction of the left ventricle was ranged from 30% to 45% and their NYHA classes **II** and **III.**
2. Weakness of the inspiratory muscle with maximal pressure (Plmax < 70% of predicted. It will calculate as:
3. All subjects were medically and clinically stable with using standard cardiac medications all over the study (diuretics, angiotensin converting enzyme (ACE) inhibitors, and glycosides etc...

Exclusion criteria:

Subject who had met one of the following criteria were exclude from:

1. Patients with chronic lung disorders, anemia or sever hypoxia.
2. Patients with history of pulmonary edema or myocardial infarction six months before the study.
3. Patients with of uncontrolled diabetes mellitus or hypertension.
4. Patients with left ventricular ejection fraction less than 30 % or more than 45%. They were divided randomly into two equal groups:

The patients were randomly divided into two equal groups:

Group (1): (Study Group)

Diaphragmatic breathing exercise group:

- Fifteen subjects were participated in inspiratory muscle training with chest physical therapy.
- The patients were asked to practice diaphragmatic exercise in slow rate of 6 to 10 breath per minute for 18-20 minute.

Group (2): (Control group)

- Fifteen subjects had been represented the control group and they were given instruction to practice their normal activities and chest physical therapy.

Procedures:

I- Evaluating procedures:

Twenty - four hour ECG holter monitoring

The electrical activity of the cardiac muscle was recorded in both groups pre and post Exercise by holter monitoring in the following steps:

1. Subjects was introduced to holter monitoring unit.
2. Adequate skin preparation was done.
3. Adequate attaching and fixation of the pickup electrode and recording unit .
4. Patients was re-seen after holter removal by 24-hours.
5. The outcome result of the heart rate variability was processed by specialized physician:

a) Mean of R-R intervals.
b) Total power (TP).
c) High frequency power (HF power)
d) Low frequency power (LE power)
e) Low frequency (LE) in normalize units.
f) Low frequency/high frequency (LE/ HF ratio)

II–Treatment Procedures:

Group A (Inspiratory muscle training):

Each patient was asked to complete 12 weeks of diaphragmatic muscle training through the Iμt at selected load. [9].

Exercise prescription:

All patients were asked to take deep slow breathing at 6 : 10 breathing rate per minute for 18-20 minute.

*** Intensity:**

The selected work load was measured.

*** Graduation:**

All subjects train ten training session at least, then selected work load was increased by 5 cm H_2O every 3 session.

*** Duration:**

6-10 br / minute with 5 minute rest for 18-20 minute.

*** Frequency:**

For 3-5 times/week.

Results

In the control group the mean age, weight, height and BMI were 54.07 ± 2.96 yrs., 89.73 ± 4.23 kg., 1.65 ± 0.04 m and 32.84 ± 2.09 (Kg/m^2), respectively.

In the study group the mean age, weight, height and BMI were 54.87 ± 3.58 yrs., 91.67 ± 4.55 kg., 1.65 ± 0.04 m. and 33.83 ± 1.12, respectively.

There was not statistical significant difference between the two groups as regards age (t= -0.666; p= 0.511), weight (t= -1.205, p= 0.238), height (t= 0.605, p= 0.550) and BMI (t= -1.606, p= 0.120).

Table (1):Demographic features (general characteristics) of the two studied groups.

	Control group (n= 15)	**Study group (n= 15)**	**t value**	**P value**
Age (yrs.)	54.07 ± 2.96	54.87 ± 3.58	-0.666	0.511 (NS)
Weight (kg)	89.73 ± 4.23	91.67 ± 4.55	-1.205	0.238 (NS)
Height (m)	1.65 ± 0.04	1.65 ± 0.04	0.605	0.550 (NS)
BMI (Kg/m^2)	32.84 ± 2.09	33.83 ± 1.12	-1.606	0.120 (NS)

Data are expressed as mean ± SD. NS= p> 0.05= not significant.

Comparison between mean values of heart rate variability in the two studied groups measured pre- and post-treatment.

In the control group, there was no statistical significant difference in the mean value of heart rate variability measured at pre-treatment (13.21 ± 0.74) and its corresponding value at post-treatment (13.18 ± 0.87) with t test = 0.267 and p value = 0.794. While in the study group, there was a statistical significant increase in the mean value of heart rate variability measured at post-treatment (15.71 ± 1.06) when compared with its corresponding value measured at pre-treatment (13.32 ± 0.48) with t test = -9.735 and p value = 0.001.

The percentage of improvement in mean value of heart rate variability was higher in study group (17.94%) than in control group (0.002%).

Table (2): Comparison between mean values of heart rate variability in the two studied groups measured pre- and post-treatment.

	Control group (n= 20)	**Study group (n= 20)**
Pre-treatment	13.21 ± 0.74	13.32 ± 0.48
Post-treatment	13.18 ± 0.87	15.71 ± 1.06
Difference	0.03	- 2.39
Percentage of reduction	0.002 ↓	17.94 ↑
t value	0.267	-9.735
P value	0.794 (NS)	0.001**

Data are expressed as mean ± SD. NS= p> 0.05= not significant. **p< 0.01= highly significant

Comparison between pre-treatment mean values and mean difference values of heart rate variability in the two studied groups.

Pre-treatment, there was no statistical significant difference between the mean value of heart rate variability in the control group (13.21 ± 0.74) and its corresponding value in study group (13.32 ± 0.48) (t test = -0.499 and p value = 0.622).

At the other hand there was a statistical significant increase in the mean value of difference in heart rate variability in the study group (-2.39 ± 0.95) when compared with its corresponding value in control group (0.03 ± 0.43) (t test = 8.997 and p value = 0.001).

Table (3) : Comparison between pre-treatment mean values and mean difference values of heart rate variability in the two studied groups.

	Control group(n= 15)	Study group(n=15)	t value	P value
Pre-treatment	13.21 ± 0.74	13.32 ± 0.48	-0.499	0.622 (NS)
Post-treatment	13.18 ± 0.87	15.71 ± 1.06	---	---
Mean difference	0.03 ± 0.43	- 2.39 ± 0.95	8.997	0.001**

Data are expressed as mean ± SD. NS= p> 0.05= not significant. **p< 0.01= highly significant.

Discussion

HRV reflect a synergistic function between both branches of the Autonomic nervous system, HRV may also reflect autonomic modulation of the heart and put some insights about pathophysiological condition of the heart disease.

The improvement in the HRV which seen in the present study agreed with who studied the response of the sympathovagal control of HRV to cardiac rehabilitation in patients myocardial infraction, the study was applied of 30 patients after un complicated myocardial infraction , twenty two patients had completed 8 weeks of the rehabilitation while eight patients taken as untrained, positive improvement was detected in the HRV parameters after 8 weeks of training[(10)].

The improvement of HRV response seen in the training group in our study was agreed with who studied HRV response to exercise training in heart failure patients. HRV evaluation was done by noninvasive beat to beat monitoring of ECG and each exercise training session was lasted for 60 minute and consisted of (10) minute as warming up (20) minute as bicycle ergometer exercise and 20 minute as a resisted training and 10 minute as relaxation period and the exercise training lasted for 8 weeks it was concluded that after 8 weeks of training there were improvement in the HRV parameters.

Heart failure patients are limited in their function and activity because they always complain from respiratory muscle weakness, dyspnea, increase work of breathing, and decreased maximal inspiratory pressure so they have poor quality of life[(10)].

In agreement with the results of our study[(11)] who showed, an increase in diaphragmatic strength in 30 subjects trained for a 5-week period, which result in increased inspiratory muscle efficiency, improved pulmonary mechanics, or both. **Winkelmann et al.,** [(12)] approved that IMT may affect capacity of the exercise in subjects with CHF by increasing blood flow to the training limbs by attenuation of the metaboreflex of inspiratory muscle, and these findings are now supported by **Borghi-Silva et al.,** [(13)] who showed that unloading ventilation improves capacity and skeletal muscle perfusion in this patient population.

Within group examination in group 1 showed non- significant difference concerning RRM, while significant improvements were recorded at post test examination for the rest of HRV parameters. While within group examination in group 2 showed non-significant difference concerning RRM, HEP, LEPnu, LF/HF, while significant improvements were shown concerning TP, and LFP[(14)].

Concerning heart rate variability parameters results of the present study revealed that there were non- significant differences between groups pre- experimental means for RRM, TP, LFP, HEP, LFPnu, and LF/ HF. Post- experimental non- significant differences were recorded for RRM, and TP. While significant differences were detected for LFP, HFP, LFPnu, and LF/HF between both groups [(15)].

In the present study post test examination of HRV should improvements in comparison to pretest examination in group 1 for all measured power spectrum parameters, while in group 2 only TP and LFP were modulated. In addition, at baseline, the measured HRV parameters did not differ significantly between groups however, after interventions, the HRV of the patients in group 1 changed significantly compared with the HRV of patients in group 2. These results matched with the results reported in most studies that investigated the effects of exercises in heart rate variability in various cardiac conditions[16].

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