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List of Abbreviations

ACE .....Angiotensin Converting Enzyme

ACEIs .....Angiotensin Converting Enzyme Inhibitors

ADH.....Anti-Diuretic Hormone

AF.....Atrial fibrillation

ARBs.....Angiotensin Receptor Blockers

ARNI.....Angiotensin Receptor Neprilysin Inhibitor

AT.....Aerobic training

BB.....Beta blockers

BCL2 .....B-cell lymphoma 2

BMI.....Body mass index

BNP .....B-type Natriuretic Peptide

CAD .....Coronary Artery Disease

CHF .....Chronic Heart Failure

CK .....creatinine kinase

CPET .....Cardiopulmonary exercise testing

CPX .....Cardiopulmonary Exercise Test

CR .....Cardiac Rehabilitation

CRT .....Cardiac Resynchronization Therapy

DM.....Diabetes Mellitus

ECG .....Electrocardiogram

EF.....Ejection Fraction

ES.....Electric Stimulation

ESR .....Erythrocyte sedimentation rate

EVR .....Exercise Ventilatory Response

GFR .....Glomerular Filtration Rate

HBP .....High Blood Pressure

List of Abbreviations

HF .....Heart Failure

HFmrEF .....Heart Failure with Midrange Ejection Fraction

HFpEF .....Heart Failure with Preserved Ejection Fraction

HFrEF.....Heart Failure with Reduced Ejection Fraction

HRR.....Heart Rate Recovery

ICD .....Implantable cardiac defibrillators

IGF-1 .....Insulin Growth Factor 1

iNOS .....Inducible Nitric Oxide Synthetase

LDH .....Lactate Dehydrogenase

LV.....Left Ventricle

LVAD .....Left Ventricular Assist Device

LVH .....Left Ventricular Hypertrophy

METs .....Metabolic equivalent of tasks

MHC .....Myosin Heavy Chain

MLHFQ.....Minnesota Living with Heart Failure Questionnaire

MuRF.....Muscle Ring Finger Protein

NMES.....Neuromuscular Electric Stimulation

NPs .....Neuropeptides

NYHA.....New York Heart Association Functional Classification

PET.....Positron Emission Tomography

QOL .....Quality of Life

RAS .....Renin-Angiotensin Aldosterone System

RPE..... Ratings of Perceived Exertion scale

TOE .....Transoesophageal Echocardiography

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TTE .....Transthoracic Echocardiography

VCO_2.....Respiratory Carbon Dioxide Production

VE.....Minute Ventilation

VO_2.....Respiratory Oxygen Uptake

VT.....Ventilatory Threshold

WL .....Workload

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Abstract

Heart failure is a common and costly condition. Reduced endurance is the main limiting factor of exercise capacity in HF patients. CPX is considered the most objective method to assess exercise capacity in HF patients. Aim: To study the degree of improvement among chronic stable left ventricular heart failure patients with low and average functional capacity after functional capacity based rehabilitation program. Methods: Forty patients with CHF were randomized to either a control (received their medical treatment with no specific rehabilitation program) or a rehabilitation group. Symptom-limited cardiopulmonary exercise testing (CPX) was performed at baseline and at discharge from the program. Rehabilitation group was further divided according to their functional capacity measures obtained from CPX into group 1 and group 2. Minnesota Living with Heart Failure Questionnaire (MLHFQ) was obtained from all subjects. Group 1 received electric muscle stimulation of both lower limbs 5d/w for 5 weeks. Group2 received a conventional aerobic rehabilitation program 2 or 3 times/w for about 40 sessions. VO2p, VO2-VT, VE/VCO2, peak load, HRR and MLHFQ values were compared before and after the treatment period. Results: EMS produced significant improvement of functional capacity measures in addition to quality of life. It was comparable to the aerobic rehabilitation in group 2. Both rehabilitation protocols caused significant improvement when compared to the control group. Conclusion: Functional capacity and quality of life were improved after either EMS or aerobic rehabilitation protocol when applied to selected CHF patients when compared to control patients who didn't receive any rehabilitation program.

Keyword: CHF, electromymostimulation, aerobic training, VE/VCO2

INTRODUCTION

Heart failure is the pathophysiologic state in which the heart fails to pump blood at a rate commensurate with the requirements of the metabolizing tissues ***(Hunt et al., 2001a).*** The prevalence of heart failure increases dramatically with age, occurring in 1 to 2 percent of persons aged 45 to 54 years and up to 10 percent of individuals older than 75 years. The syndrome of chronic heart failure has become one of the most common cardiovascular disorders throughout the world, thus placing a heavy financial and social burden on public health funding ***(Hambrecht et al., 2000), (Pina et al., 2003) and (Colucci and Braunwald, 2005).***

The clinical manifestations of heart failure depend on the rate at which the syndrome develops. If the abnormality develops gradually, number of adaptive mechanisms, including cardiovascular remodeling and neurohormonal activation occurs which allows the patient to tolerate and adjust to the abnormality ***(Colucci and Braunwald, 2005).***

Chronic heart failure arose as a consequence of inadequate cardiac output and/or damming up of blood behind one or both ventricles ***(Moraes et al., 2000).*** Precipitating causes of heart failure may include arrhythmias, myocardial ischemia, systemic infections, pulmonary embolism, cardiac infection and inflammation, cardiac toxins and high output states ***(Givertz et al., 2005).***