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CASE REPORT

BENEFITS OF A COMBINED PROTOCOL OF PHYSICAL EXERCISE AND CPAP ON A PATIENT AFFECTED BY HEART FAILURE AND MITRAL INSUFFICIENCY: A CASE REPORT

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Objective: To describe the ideal/optimal application of continuous positive airway pressure (CPAP) and to evaluate its effect associated with physical exercise on functional capacity, respiratory muscle strength and quality of life in a patient with heart failure (HF) and moderate Mitral Insufficiency (MI). **Methods**: A 60 year old female patient, left ventricular ejection fraction (LVEF) of 33%, functional class III (NYHA), with respiratory muscle weakness (<70% predicted). Main complaints: calf pain and dyspnea with minimum exertion in daily activities, sporadic orthopnoea. Echocardiogram associated with CPAP was performed to determine ideal positive pressure. Cardiopulmonary exercise testing (CPET), six-minute walk test (6MWT), and assessment of respiratory muscle strength and of quality of life before and after two months of aerobic training were conducted. Testing was performed on a treadmill (HR between thresholds 1 and 2 of CPET) associated with CPAP (6 cm H_2O) for 40 minutes 3x/week. **Results**: Increased peak oxygen consumption (11%); distance covered in the 6MWT (168m); inspiratory (158%) and expiratory (47%) muscle strength; and improved quality of life with relevant decreased swelling in the legs, decreased pain symptoms and dyspnea. **Conclusion**: This study has allowed us to provide more information on the optimal positive pressure used for patients with chronic HF and MI participating in a cardiovascular rehabilitation program and its benefits after eight weeks of training by increasing functional capacity, respiratory muscle strength and improved quality of life.

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INTRODUCTON

According to the 3rd Brazilian Guidelines on Chronic Heart Failure (HF), the main cause of this syndrome is chronic ischemic heart disease associated with hypertension. However, little is reported about other etiologies such as valvar dysfunctions that can result from ischemic disease accentuating symptoms such as dyspnea and reduced exercise tolerance. Moreover, the functional capacity of patients with HF is not only limited due to cardiac factors, but also because of the combination of abnormal ventilatory responses[1,2] and peripheral muscle dysfunction that reduce the ability to participate in daily life tasks, thus undermining quality of life[3]. They can also present decreased strength and respiratory muscle strength, causing a redistribution of blood flow from locomotor muscles to respiratory muscles in order to optimize respiratory efficiency during physical activity[4].

Continuous positive airway pressure (CPAP) has been reported as a resource to improve the mechanics of heart failure by increasing intrathoracic pressure which decreases transmural pressure by increasing stroke volume and left ventricle output volume, thereby improving heart function and relieving symptoms[2]. The effect of CPAP on respiratory muscles in HF are not yet elucidated, however, it may decrease respiratory effort required during exercise and improve peripheral circulation, increasing exercise tolerance[3].Due to the scarcity of information on the effect of CPAP on respiratory muscles and on how the etiology associated with co-morbidities can influence treatment of patients with HF, the objective of this study was to describe the application of an optimal positive pressure and the benefits of an associated aerobic exercise program with CPAP on functional capacity, respiratory muscle strength and quality of life of a patient with HF and moderate mitral insufficiency (MI) inserted into a cardiac rehabilitation program.

CASE DESCRIPTION

A 60 year-old female patient with ischemic HF and moderate MI (regurgitation of 31.51 ml/cycle) due to the HF etiology, left ventricular ejection fraction of 33%, functional class III (*New York Heart Association*), with respiratory muscle weakness (<70% of predicted values)[5]. The patient had not been able to exercise for the last six months, and before that she had no adherence to the exercise program. In the evaluation, her main complaints were calf pain and shortness of breath during small efforts in activities of daily living, as well as sporadic orthopnea. The patient suffered a heart attack over 20 years ago (1994) and presented risk factors for HF such as family history, high blood pressure and was a former smoker. Continuous use of medications without changes in the last three months: Angiotensin converting enzyme inhibitors (ACE inhibitors) (Captopril 25mg), beta-blockers (carvedilol 37.5 mg), diuretics (spironolactone 25mg and furosemide 40mg) and statin (simvastatin 20mg). The patient received information on the study and signed the free and informed consent form. This case report was guided by the Case Report - CARE.

Pre- and post-intervention were: 1. Cardiopulmonary exercise testing (CPET). Evaluation of peak oxygen consumption (VO_2peak) was determined by a spirometry system (Metalyzser 3B, Córtex Biophisi) using the Micromed® treadmill test; ramp protocol to determine anaerobic threshold (L1) and respiratory compensation point (L2) for evaluation of cardiorespiratory capacity and exercise prescription; 2. Six-minute walk test (6MWT) according to the *American Thoracic Society*; 3. Quality of life assessment through the *Minnesota Living with Heart Failure (MLHFQ)*; 4. Evidence of respiratory muscle strength by manometer with prediction equation validated for the Brazilian population[5]. Respiratory muscle strength, with maximum inspiratory (IPmax) and expiratory pressure (EPmax) in cmH_2O was measured using a digital manometer (MVD 3000, Globalmed), coupled to a specific nozzle with 1mm diameter drain hole; and 5. Echocardiogram. During the initial echocardiogram, the optimum pressure was determined based on reduction of mitral valve regurgitation or the presence of minimal respiratory distress. An initial positive pressure of $4cmH_2O$ was maintained for five minutes, followed by an increase of $1cmH_2O$, increasing $1cmH_2O$ at each minute for another five minutes until reaching $8cmH_2O$. Despite there being no change of regurgitation, the patient reported greater comfort during a pressure of $6cmH_2O$. A c-series Tango CPAP with *ComfortGel Blue SizingGaugeResMed* nasal mask was used.

The supervised aerobic exercise program was performed three times weekly for eight weeks, with the heart rate (HR) intensity between the CPET thresholds of 1 and 2. Positive pressure of 6cmH_2O was used during the whole aerobic exercise on a treadmill which consisted of: a warm up – 3 minutes; main exercise - 35 minutes of aerobic exercise at the prescribed intensity; cooling down - three minutes; at the end, five minutes of stretching without CPAP. HR was checked every five minutes of exercise with a pulse frequency counter (Polar RS800 CX), peripheral oxygen saturation (SpO_2) using a wrist oximeter (Onix Nonin 2500®) and dyspnea using the modified BORG scale. The average of the eight weeks of training of these variables is represented in figure 1. Blood pressure was measured before and after each session by casual measurement following the recommendations of the VI Brazilian Guidelines on Hypertension. The data of this variable shown in Table 1 are the average of initial and final values of each session.

Clinical results

After training, VO_2peak increased by 11% and testing time by 1:40min. There was an increase of 168m in the 6MWT. In the respiratory muscle strength test there was improvement of 158% for IPmax and 47% for EPmax. Despite significant improvement, respiratory muscle strength was below the predicted values[5]. In evaluating the quality of life by MLHFQ, the patient showed improvement in the physical dimension, with a reduction of swelling in the legs, of lower limb muscle fatigue and of shortness of breath, making walking and climbing stairs more comfortable. The patient adhered to treatment and reported being comfortable using the CPAP nasal mask. At no time were there any adverse effects of therapy either from exercise or the use of CPAP.

Table 1. Pre- and post-evaluation of aerobic exercise intervention associated with CPAP for patients with HF.

Evaluations	Variables	PRE	POST	% improvement
CPET	VO_2	16.6	18.4	10.84
6MWT	Distance covered (m)	274	442	61.31
Echocardiogram	LVEF (%)	33.1	38.7	16.91
Manovacuometry	IPmax (cmH	12	31	158.33
	EPmax (cmH	36	53	47.22
Minnesota	Score	36	10	72.22
SBP	mmHg	93.08	92.75	-
DBP	mmHg	63.29	62.62	-

CPET - cardiopulmonary exercise testing; VO_2peak - peak oxygen consumption; 6MWT - six-minute walk test; LVEF - *left ventricular ejection fraction* (Simpson method); IPmax - maximum inspiratory pressure; EPmax - maximum expiratory pressure; SBP – systolic blood pressure; mmHg – millimeters of mercury; DBP – diastolic blood pressure.

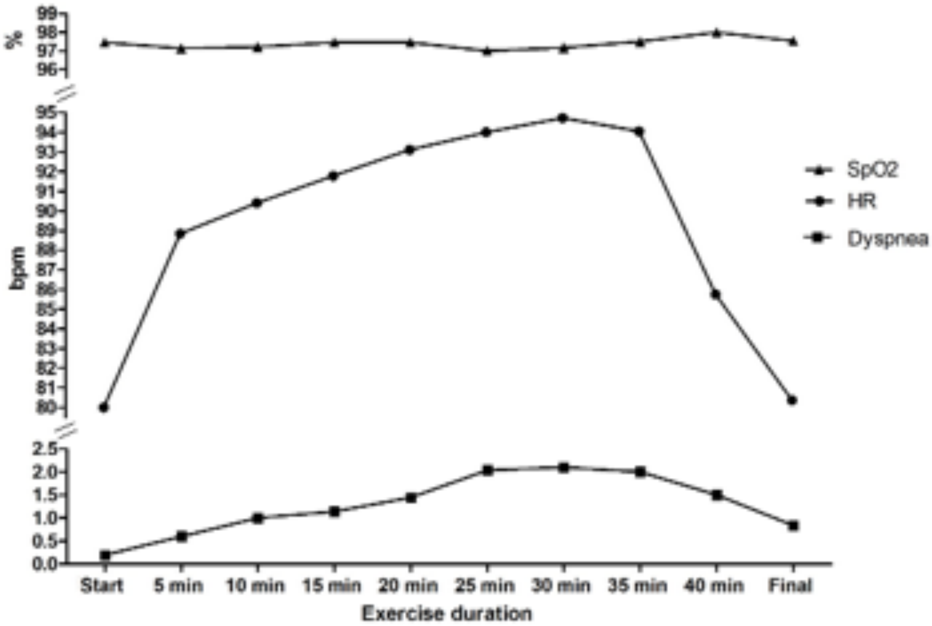

Figure 1. Variation of peripheral oxygen saturation - SpO_2, heart rate - HR and dyspnea during aerobic exercise with CPAP.

Case Discussion

Regarding VO2peak, there is no similar protocol published for comparing this variable. However, in the study of Freyssin et al.[6], continuous aerobic training carried out for eight weeks with 14 participants showed no improvement in VO_2peak in one of the groups studied. In this study, an 11% increase was observed in the same period of training. This result may be related to the gains in exercise tolerance that was due to improving the oxygen supply to peripheral muscles at the expense of redistributing blood flow[3], even with CPAP of 6 cmH_2O.

Positive pressure historically titrated to patients with acute HF is 10 cmH_2O. However, with the use of CPAP in chronic patients, these values have come under discussion both due to the need and the comfort of the patient to facilitate adherence to treatment[2,4]. In this study, we prioritized determining the optimal positive pressure during the course of echocardiography with two proposals: the pressure that brought more comfort to the patient or in an attempt to identify whether some level pressure would help in the reduction of mitral regurgitation. However, this did not happen in this case with titrated pressures.

In the initial 6MWT evaluation, the patient traveled a distance shorter than 350m, which is considered a predictor of mortality for patients with heart disease[7]. At the end, there was an increase of 38% in the 6MWT distance covered, indicating that the patient was out of the higher range of mortality risk for this benchmark. Our data are in agreement with Costa et al.[8] and Wittmer et al.[1] who suggest CPAP may improve exercise tolerance.

An original finding of this study was the increase in respiratory muscle strength after the use of CPAP associated with aerobic exercise. It was noted that this patient presented excessive respiratory muscles weakness, which can be frequently found in patients with HF. In literature, we have observed that there is research about respiratory muscle training through specific equipment compared to aerobic exercise. The latter alone can encourage increased IPmax as reported by Winkelmann et al.[9], which showed an increase of approximately 70% in HF patients with respiratory muscle weakness after eight weeks of training. For the patient in this study, there was an increase of 158% in the same period of training, suggesting that CPAP may have an effect on improving this parameter. Moreover, we emphasize that IPmax should be investigated by an independent prognosis predictor for patients with HF as it is correlated with the degree of dyspnea during daily activities[10].

Regarding quality of life, the physical dimension of the MLHFQ is of great importance for assessing the effect of an intervention, since it has high interrelation with dyspnea and fatigue of patients with HF. The observed improvement was reflected by the patient walking and climbing stairs easier. Added to this, there were positive changes in her emotional and social state. In a study by Costa et al.[8], a different training method also reported improvement in MLHFQ after intervention with CPAP.

Most studies evaluating the use of CPAP associated with exercise or investigating tolerance to exercise measurements, such as the 6MWT with different CPAP, use protocols which exclude patients with valvular heart disease, as this is considered a confounding factor in the results. Thus, studying a patient with HF and MI enriches the knowledge of professionals working daily in clinical practice and allows them to find a different reality from what is found in most studies that isolate many factors which may confound results, thereby not always accurately representing patients who are found in rehabilitation services.

CONCLUSION

The findings of this study resulted in more information on the optimal positive pressure used for patients with chronic HF participating in a cardiovascular rehabilitation program and its benefits at the end of eight weeks of training, such as increased functional capacity, respiratory muscle strength and improved quality of life; all of which can have important implications in cardiovascular rehabilitation programs and provide the basis for managing patients with HF and co-morbidities, and who often have trouble adhering to exercise due to an exacerbation of symptoms. This study can also provide the basis for a randomized clinical trial in which the hypotheses suggested here can be proven or refuted.

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