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Research Article

Adjustment of Endurance Training by 6-Minute Walking Test for COPD Patients

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Abstract

Background: Exercise training can improve exercise tolerance and quality of life of COPD patients. However, the degree of benefit from exercise training is variable. Endurance training for COPD patients consistently leads to clinically significant improvement in submaximal exercise performance with variable effect on maximal exercise capacity.

Purpose: To adjust the endurance training program for COPD patients by 6-minute walking test (6MWT) interpretations.

Material and Methods: A parallel group study design was conducted in forty stable COPD patients (25 males and 15 females). All patients were randomly assigned into either waking group or bicycle group. All Patients had moderate airflow obstruction; forced expiratory volume in one second (FEV1) ≤ 70 - 50 ≥ %) were included. A walking group received endurance training on a treadmill while a bicycle group received endurance training on the bicycle. Dyspnea score, six-minute walking distance (6MWD), and quality of life were recorded.

Results: Both groups showed a statistically significant improvement of (6MWD), dyspnea score, and health-related quality of life (HRQL) measured by chronic respiratory questionnaire.

Conclusion: Walking training adjusted by the speed of 6MWT was visible and able to improve outcomes of pulmonary rehabilitation (PR) than bicycle training.

***Keywords:** Dyspnea; Walking Training; COPD*

Introduction

The world health organization (WHO) predicts that by 2020 COPD will rise from its current ranking as the 12th most prevalent disease worldwide to the 5th and from the 6th most common cause of death to the 3rd. Reasons for the dramatic increase in COPD include reduced mortality from other causes, such as cardiovascular diseases (CVD) in industrialized countries and infectious in developing countries, along with a marked increase in cigarette smoking and environmental pollution in developing countries [1].

Breathlessness, exercise intolerance and malnutrition are the most common symptoms in COPD and progress as the disease advances, resulting in a vicious cycle leading to further inactivity, social isolation, fear of dyspnea and depression contribute a large extent to morbidity [2,3].

Exercise training, widely regarded as the cornerstone of PR improves both exercise tolerance and HRQL in COPD patients [4-6]. Physiological changes contribute to these improvements include reduction of lactic acidosis, minute ventilation (MV) and heart rate (HR) for a given work rate, and enhanced activity of mitochondrial enzymes and capillary density in the trained muscles [7,8]. Skeletal muscle strength has also been reported to be significantly improved after exercise training in COPD. These observations give support to the hypothesis that inactivity is an important driver of the observed abnormalities in the skeletal muscles of these patients [7].

Other benefits include improved motivation and exercise technique, desensitization to dyspnea, and an optimized breathing pattern. A prospective, randomized, controlled trial showed that PR improves endurance tests, peak work rate, maximal oxygen consumption ($VO_2\,max$), and HRQL [8]. Exercise training programs should be customized to the individual functional ability taking cardiovascular, pulmonary, and skeletal muscle limitations into account [9]. From this point, the objective of this study conducted to determine the visibility of adjustment of walking training by 6MWT for COPD patients.

Materials and Methods

Study subjects

All Patients were diagnosed as moderate (FEV1 50 ≤ 70 ≥ % predicted) COPD, according to the American Thoracic Society guidelines (ATS) [10] were recruited from Al Abassya Chest Diseases Hospital. All Patients were in stable condition and with no hospital admissions or exacerbations for 4 weeks preceding the assessment were free from any clinical evidence of cardiovascular, musculoskeletal, or neuromuscular diseases or any other disease that might interfere with exercise.

The exclusion criteria were patients with clinically unstable conditions, acute exacerbation of COPD within the last 4 weeks, malignancies, clinically apparent heart failure (HF), renal, hepatic, diabetes mellitus (DM), and recent surgery. All patients received pulmonary maintenance medications if needed according to the physician prescription throughout the study also, they instructed to take their prescribed medications as usual. The Ethics Committee approved the study, and all patients gave their written informed consent before the study.

Study design

A parallel group study design in which forty stable COPD patients (25 males and 15 females) the patients were assigned randomly into two groups using a system of random number tables. The walking group (n = 20) and the bicycle group (n = 20).

Measurements

Pulmonary function test

All patients performed maximal expiratory flow maneuvers according to ATS [11] standards by spirometry (Vitalograph made in UK) in order to determine the forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and FEV_1/FVC. During all measurements, subjects were seated and a single experienced technician obtained recordings. All lung function measurements were expressed in liters and as a percentage of the predicted values for age, height, and sex. The 6-min walk test (6MWT) was conducted according to a standardized protocol [12]. The test conducted between 10 a.m. and 4 p.m. A 15-meter (m) flat, obstacle-free corridor, with chairs placed at either end was used. Patients were instructed to walk as far as possible cover the longest possible distance over six minute under the supervision, turning 180° every 15m in the allotted time of six min.

Dyspnea was measured by the Borg exertional dyspnea scale [13]. The measurement of dyspnea by 20 point Borg exertional dyspnea scale was conducted in this study at initial evaluation with 6MWT and immediately after finishing the PR program. Also it used for monitoring of exercise training during PR.

Health-related quality of life (HRQL) is assessed by Chronic Respiratory Questionnaire (CRQ) developed by Guyatt., *et al.* [14] includes four of dimensions: dyspnea, fatigue, emotional function, and mastery. In each area, scores are obtained by adding the scores for the items that make up each category and dividing it up by the number of items [14]. A sport Tester Watch (Polar; Kempele, Finland) were recorded HR during exercise training.

Intervention

The treatment program of both groups started by warming up for ten minutes in form of stretching and pulse raise exercises and it ended by cooling down exercises in form of stretching connected with breathing control for five minutes. For walking group, the endurance training was conducted on a treadmill. The speed of walking was given according to the speed of 6MWT for every patients. The duration of endurance training adjusted by modified Borg scale [13] between (4 - 6). The speed was gradually increased by 10% every week when achieve the desirable effects. For the bicycle group received endurance exercise training on cycle ergometer. The intensity of endurance exercise training also adjusted by dyspnea sensation between (4 - 6) on the modified Borg scale (0 - 10) during initial assessment of workload on cycle ergometer according to with the initial training intensity set at 60% based on previous studies [15] of the peak work capacity achieved in the incremental cycle test. The study duration for both groups was 6 week, three session/week. All patients were supervised and trained by a qualified same therapist.

Statistical Analysis

Measurements of 6MWT, dyspnea by Borg scale, and HRQL by CRQ were taken at pretreatment, after six weeks. Data were analyzed by computer using SPSS software for Windows (version 22; SPSS, Inc., Chicago, IL). Methods used were Mean (χ) to measure the central value of a group of data it equals the summation of variables over their number. Student's test: to measure the significant difference between means of both groups. Paired t test to measure significant difference between two readings (pre-treatment and after six weeks in the same studied group. Significant difference was considered if $p < 0.05$ high significant difference was considered if $p < 0.01$ or $p < 0.001$.

Results

The current study was comprised of forty COPD patients (25 males and 15 females).

Patient characteristics

Table 1 showed Patient characteristics of whole samples. As shown from this table, 25 males (62.55%) and 15 females (37.5%) In treatment group twelve patients (60%) were males and eight patients (40%) of them were females. There was no statistical significant difference between both groups at pretreatment. All variables indicated there were no statistical significant differences between both groups at pretreatment, table 1.

Variables	Walking group No = 20	Bicycle group No = 20	P- Value
Age (ys)	65 ± 7.1	64.5 ± 9.2	0.7
Men	12	13	
Women	8	7	
Height (cm)	167 ± 7.4	164.45 ± 9.2	0.24
Weight (kg)	74.2 ± 10.5	76.2 ± 9.6	1
BMI (kg/ m^2)	26.3 ± 2.7	25.5 ± 2.4	0.3
HR	74 ± 12	77 ± 8	0.6
FEV1, % pred	61 ± 15	62 ± 13	0.82
FEV1/FVC ratio	0.56 ± 0.1	0.61 ± .05	0.8

Table 1: *Showed patient characteristics of whole samples.*

The date presented as means χ and standard deviation SD±; p > 0.05 = No significant.

Abbreviations: ys: Years; cm: Centimeter; kg: Kilogram; BMI: Body Mass Index; kg/m²: Kilogram Per Meter Square; QOL: Quality of Life; CRQ: Chronic Respiratory Questionnaire

6-minute walking test

Table 2 showed no statistical significant difference between walking and bicycle groups at pretreatment. After six weeks, both groups showed a significant statistical improvement compared with pretreatment. The improvement in walking group ware statistically greater than in bicycle group < 0.001.

6MWT 6MWD (m)	Walking group No = 20		Bicycle group No = 20		P-Value
	Range	χ ± SD	Range	χ ± SD	
Pre.					
Males	370 - 564	420 ± 57	312 - 582	412 ± 46	> 0.05
females	302 - 408	372 ± 65	290 - 450	354 ± 54	> 0.05
Post					
Males	442 - 602	473.75 (± 49.4)	352 - 621	456 (± 79)	< .001
females	300 - 530	402 (± 63.3)	321 - 482	392	
Dyspnea Borg scale					
Pre.	5 - 9	5.3 ± 1	7 - 4	5.4 ± 0.8	> 0 .05
Post.	6 - 2	3.8 ± 0.6	5 - 3	5.4 ± 1.1	< 0.001
HRQL					
Pre.	52 - 123	78 ± 17	52 - 122	77.55 ± 17.3	> 0.05
Post.	102 - 141	125.65 ± 11.2	50 - 120	104.45 ± 17	< 0.001

Table 2: *Shows comparison between all values between both groups.*

The date presented as means χ and standard deviation SD ±

Abbreviations: 6MWT: Six Minute Walking Test; m: Meter; 6MWD: Six Minute Walking Distance; Pre.: Pretreatment; Post.: Post Treatment.

Significant level, p > 0.05 = No significant; p <0.001 = High significant; χ = mean.

Dyspnea

Statistical analysis of dyspnea in the walking group showed that a mean values of dyspnea scale was 5.3 (±1), at the pretreatment as showed in table 2 this changed into 3.8 (±0.9) after six weeks, p < 0.001. In bicycle group, the mean of dyspnea scale was statistically improved at the end of the study. There was not a statistically significant difference between both groups at the end of the study (P = 0.744).

Quality of life

From table 2 showed the comparison between the values between both groups. There was no statistical significant difference between the mean of the walking group 78 (± 17) and the bicycle group 77.55 (±17.3) receptivity at the pretreatment, P > 0.05. While the difference was highly statistical significant at post treatment the mean of QOL in the walking group was 125.65 (±11) and the mean of QOL in the bicycle group was 104.45 (±17), p < 0.001.

Discussion

The main findings of this study were that the speed of walking training determined by 6MWT is a useful tool to adjust exercise intensity during walking. In addition, the results showed a greater improvement was in walk group compared to the bicycle group. Although, walking is used extensively in activities of daily living, most exercise training in PR is based only on bicycle endurance training [16]. Up-to-date detailed recommendations for prescribing walking training can rarely be found in the literature [16]. A possible explanation to use cycle training is easier to adjust the exercise to intensity than walking on a treadmill. Furthermore, there was no guideline adjusting the intensity of walking training on a treadmill. The current study used means of speed determined by 6MWT and the duration of training limited by modified Borg scale. In previous studies a set the walking speed calculated as 80% of peak VO_2, which was achieved in a shuttle walking test [15,17]. The clinical relevance of the benefit of PR based on endurance exercise training is illustrated by the improved submaximal functional capacity, as measured by the 6MWD [18]. In the current study, the improvement of 6MWD was 17.8%. The findings of the present study were consistent with the results of these trials that show the percentage of improvement of dyspnea after six weeks of PR was 28.3%. The improvement in exertional dyspnea and exercise endurance after exercise training was explained primarily by reducing ventilatory requirements [19].

The results of current study showed that walking training on a treadmill able to improve HRQL in COPD patients. The current findings were supported by the previous study that were conducted to measure the usage of quantitative and qualitative research methods to evaluate QOL changes in patients with COPD after pulmonary rehabilitation [20].

Conclusion

Endurance exercise training has valuable effects of improving exercise capacity determined by 6MWD. Improving dyspnea score measured by Borg scale, and improving HRQL. Walk training resulted in a significantly greater increase in endurance walking capacity compared to cycle training in people with COPD. The adjustment of walking training by 6MWT interpretation has valuable effects of improving exercise capacity determined by 6MWD.

Limitations

The limitation of this study was the lack of a control group of no exercise training. Furthermore, the study did not extensively evaluate the physiological improvement after endurance training. The reasons was that, the aim of this study was to examine the intensity of walking training and its impact on overall improvements. Further studies needed to investigate the accurate walking speed and the optimal walking duration regarding to physiological changes.

Conflict of Interest Statement

The authors report no conflicts of interest in this work.

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