Aerobic Exercise Plus Inspiratory Muscle Training Efficacy on BODE Index in Chronic Obstructive Pulmonary Disease (COPD) Patients

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Abstract

Background: Inspiratory muscle training (IMT) has been applied during pulmonary rehabilitation in patients with chronic obstructive pulmonary disease (COPD). However, it remains unclear if the addition of IMT to a general exercise training program leads to additional clinically relevant improvements in patients with COPD.

Aim of the Study: The aim of this study was to investigate whether the addition of inspiratory muscle trainer (IMT) to a general exercise training program for 2 months improved 6 min walking distance, pulmonary functions, health-related quality of life, in patients with COPD or not.

Design: This study was conducted from January 2013 to November 2013 in Giza chest hospital.

Patients: This study conducted on forty patients with moderate COPD men aged 45 to 55 years for 2 months.

Intervention: The 40 men were randomly assigned to two groups; Group (1) (n=20) and Group (2) (n=20). Both groups followed an exercise training program for 2 months. Group (1) received an additional inspiratory muscle training (IMT) program for the same period.

Main Outcomes Measures: Weight, body mass index (BMI), pulmonary function tests including FEV1, FVC, and FEV1/FVC, and Six minutes’ walk test, mMRC and BODE index.

Results: After 2 months, men in Group (1) (IMT and exercise training) showed a highly significant improvement in pulmonary functions (FEV1 with p<0.0001, FVC with p<0.001), 6MWD with p<0.001, and BODE index with p<0.001). In Group (2) (exercise training) also demonstrated significant statistically differences in the mean values in pulmonary functions (FEV1 with p<0.001, FVC with p<0.001), 6MWD with p<0.001, and BODE index with p<0.001). The improvement in Group (1) was more than in Group (2) in all variables.

Conclusions: The present study found that short-term aerobic training program plus IMT had the capacity to break out the vicious circle of dyspnea, physical inactivity and exercise intolerance—the hallmark features of COPD patients and improve some components of BODE index.

Key Words: COPD – Inspiratory muscle training – Aerobic exercise.

Introduction

CHRONIC obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality worldwide [1]. COPD is characterized by persistent expiratory flow limitation which is usually progressive [2]. Dyspnea is the most prominent exercise-limiting symptom of the disease, which leads to chronic avoidance of physical activities [3]. COPD affects 4% to 6% of the population. It is a major cause of morbidity throughout the world, and the fourth leading cause of death within the United States [4]. Chronic bronchitis and emphysema are the disease entities that may be present in varying combinations in individuals with COPD, with dyspnea and exercise intolerance being the most prevalent presenting complaints [8]. The mechanisms for dyspnea and exercise intolerance are multifactorial and include increased resistance to airflow (especially during expiration), impaired gas exchange resulting in hypoxemia and hypercapnia [6], dynamic hyperinflation [7], and skeletal muscle dysfunction [8].

While each of these contributing factors interacts with each other, individuals with COPD demonstrate an early onset of lactic acidosis during exercise and an inability to meet the associated ventilatory demand. Therefore, interventions that improve ventilation, such as inspiratory muscle training (IMT), may have the potential to reduce dyspnea and improve exercise tolerance [9]. Consequently, low-physical activity levels contribute to
skeletal muscle deconditioning and exercise capacity reduction, which impact negatively on health-related quality of life [10]. Inspiratory muscle dysfunction is another extra pulmonary manifestation, which is often present in patients with COPD [11]. It contributes to hypoxemia, hypercapnia, dyspnea and decreased exercise tolerance [12].

A multidimensional prognostic index that takes into account several indicators of COPD prognosis is the BODE index (body mass index [BMI], obstructive ventilatory defect severity, dyspnea severity, and exercise capacity). The components are derived from measures of the body mass index (weight in kg/height in m²), FEV₁ percent predicted, and the modified Medical Research Council dyspnea score. A BODE score greater than 7 is associated with a 30 percent 2-year mortality; whereas a score of 5 to 6 is associated with 15 percent 2-year mortality. If the BODE score is less than 5, the 2-year mortality is less than 10 percent [13].

The diagnosis of COPD should be suspected in all patients who report any combination of the following: Chronic cough, chronic sputum production, dyspnea at rest or with exertion, or a history of inhalational exposure to tobacco smoke, occupational dust, or occupational chemicals. Dyspnea with exertion may be underappreciated by individuals who unknowingly restrict their activity level. COPD is typically slowly progressive, persistent, and exacerbated by respiratory infection [14].

Chronic obstructive pulmonary diseases is confirmed when a patient, who has symptoms that are compatible with COPD, is found to have airflow obstruction (FEV₁/FVC ratio less than 0.70 and an FEV₁ less than 80 percent of predicted) and there is no alternative explanation for the symptoms and airflow obstruction (e.g., bronchiectasis, vocal cord paralysis, tracheal stenosis) [15].

Pulmonary rehabilitation including exercise training, education, nutritional intervention and psychosocial support is a standard care for patients with COPD to counteract extra pulmonary disease manifestations [16]. Inspiratory muscle training (IMT) has also been applied frequently and is extensively studied in recent years in patients with COPD. From meta-analyses of randomized controlled trials (RCTs) in patients with COPD, it can be concluded that IMT as a stand-alone therapy improves inspiratory muscle function (strength and endurance), decreases symptoms of dyspnea and improves exercise capacity [17].

The value of IMT as an add-on to a general exercise training program is, however, still under debate. While IMT always results in significant improvements in inspiratory muscle function, its additional effects on more clinically relevant outcomes (e.g., functional exercise capacity and quality of life) are insufficiently supported by scientific evidence so far [18]. From subgroup analyses in the most recent meta-analysis, it was concluded that significant additional effects of IMT on more clinically relevant outcomes are more likely to be found in patients with inspiratory muscle weakness [19]. It was recently shown that adjunctive IMT led to significantly greater functional improvements in a well-designed RCT in patients with chronic heart failure selected for inspiratory muscle weakness [20].

The outcome of this study will therefore have a direct impact on clinical practice, as the results will clarify whether adjunctive IMT leads to superior clinically relevant improvements for patients with COPD. Functional outcomes of relevance to patients (exercise capacity, quality of life, participation in daily physical activity and symptoms) were therefore chosen as the main outcomes.

The aim of this study was to evaluate the beneficial effects of generalized aerobic exercise in addition to inspiratory muscle training for treatment of COPD using several validated methods to measure outcomes as BODE index and pulmonary function tests, 6MWT, and MRC dyspnea score.

**Subjects and Methods**

This study was performed in Giza chest hospital, from January 2013 to November 2013. In this study, forty COPD male patients were included, and randomly divided into 2 groups; Group (1) (n=20) and Group (2) (n=20). Both groups followed an exercise training program on walking treadmill. Group (1) received an additional inspiratory muscle training (IMT) program.

**Inclusion criteria:**
- Male aged 40-60 years.
- Current or ex-smokers with a smoking history of ≥10 pack years.
- An established history and clinically stable moderate COPD and receive their routine drugs.

**Exclusion criteria:**
- Any subject with hepatic or renal impairment was excluded.
- Current diagnosis of asthma or respiratory disorders other than COPD.
- Chest radiograph indicating diagnosis other than COPD.
had a lung-volume reduction surgery and/or a lung transplant.

- Receiving long-term oral corticosteroid therapy.
- Severe uncontrolled diseases likely to interfere with the study.
- Diagnosed psychiatric or cognitive disorders.
- Orthopedic problems having an impact on our study.
- Previous inclusion in rehabilitation program (<1 year).

Patients were informed about the study protocol prior to the start of the rehabilitation program. Informed consent would be obtained at that time. Both groups followed an exercise training program for 2 months. Group (1) received an additional IMT program described to the patients as ‘resistance training’ at high intensity.

1- Complete medical history taking:
Each subject in the study was submitted to the following:

A- history taking included dyspnea scoring according to mMRC (modified medical research council) for assessing the severity of breathlessness [2].

Table (1): MMRC dyspnea questionnaire for assessing the severity of breathlessness.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>I get breathless only with strenuous exercise</td>
<td>0</td>
</tr>
<tr>
<td>I get short of breath when hurrying on the level or walking up a slight hill.</td>
<td>1</td>
</tr>
<tr>
<td>I walk slower than people of same age do on the level because of breathlessness or I have to stop for breath when walking on my own pace on the level</td>
<td>2</td>
</tr>
<tr>
<td>I stop for breath after walking about 100 m or after a few minutes on the level</td>
<td>3</td>
</tr>
<tr>
<td>I am too breathless to leave the house, or I am breathless when dressing or undressing.</td>
<td>4</td>
</tr>
</tbody>
</table>

MMRC = Modified Medical Research Council [2].

B- Complete clinical examination including (weight, height, and BMI).

The body mass index (BMI): It is defined as the individual body mass divided by the square of his height-with the value universally being given in units of kg/m² [21].

2- Chest X-ray (posterior-anterior view).

3- Pulmonary function study: Including FEV₁, FVC, and FEV₁/FVC post bronchodilator according to the European Respiratory Society guidelines for pulmonary function testing (VmaxAutobox, Sensor Medics, Bilthoven, The Netherlands) [2].

4- Assessment of COPD: 2 methods to evaluate the severity of COPD were used; first there is the GOID classification and the BODE INDEX (which compose of four items B for body mass index, O for level of obstruction using FEV₁, D for dyspnea score, and E for exercise tolerance).

A- GoLD Classification of COPD:

Table (2): Classification of severity of COPD according to GOID classification (GOID, 2011) [2].

<table>
<thead>
<tr>
<th>GOID</th>
<th>Severity</th>
<th>FEV₁ (% predicted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mild</td>
<td>FEV₁ ≥ 80%</td>
<td></td>
</tr>
<tr>
<td>2 Moderate</td>
<td>50% ≤ FEV₁ &lt; 80%</td>
<td></td>
</tr>
<tr>
<td>3 Severe</td>
<td>30% ≤ FEV₁ &lt; 50%</td>
<td></td>
</tr>
<tr>
<td>4 Very severe</td>
<td>FEV₁ &lt; 30%</td>
<td></td>
</tr>
</tbody>
</table>

B- BODE index: For assessment of COPD severity.

Table (3): Variables and point values used in BODE index.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Points on BODE index</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV₁ (percent of predicted)</td>
<td>0</td>
</tr>
<tr>
<td>Distance walked in 6 minutes (m)</td>
<td>1</td>
</tr>
<tr>
<td>MMRC dyspnea scale</td>
<td>2</td>
</tr>
<tr>
<td>Body-mass index</td>
<td>3</td>
</tr>
</tbody>
</table>

N.B.: All the previous measurements were done for all patients before and at the end of the study.

5- Treadmill six minutes’ walk test:
Use of a treadmill to determine the 6 MWD allows constant monitoring during the exercise. Standardized instructions and encouragement similar to those for the corridor walk were given, according to ATS guidelines [22]. Patients were instructed to walk “as far as possible” during the time—that is, as fast as possible. They were told that they could slow down or even stop if necessary.

There was no warming up before test. The initial treadmill speed was zero, and the test began when treadmill activated and the patient started walking. The patient controlled the treadmill speed during the test and could stop to rest at any time, as in the hallway test. Before, during, or after treadmill walk test, the walk testing was discontinued if the patient had thoracic pain, intolerable dyspnea, cramps, dizziness, staggering, diaphoresis, pallor, or an SpO₂ <90% [22].
Training instrument:

- **Inspiratory muscle trainer:**

  The threshold trainer is a small plastic handheld device supplied by Respironics. It includes a mouthpiece and a calibrated spring loaded valve. The valve controls a constant inspiratory pressure training load and the patient must generate the inspiratory pressure in order for the inspiratory valve to be opened and allow inhalation of air. The amount of resistance can be adjusted by varying the compression of the spring-loaded valve. Adjustment from 7 cm H₂O to 41 cm H₂O is possible. Threshold inspiratory muscle trainer; Respironics, Cedar Grove, NJ 07009-1201 USA [23].

Intervention:

1- **Aerobic exercise program:**

Patients in both groups followed a 2-month exercise training program. An Outpatient hospital Based-Exercise program for a period of 8 weeks of aerobic training as graduated treadmill exercises was initiated upon the results of the exercise testing, so the exercise prescription was individually designed. Training frequency was three sessions per week, resulting in a total of 24 training sessions. Duration of the training session increased from 20-30 min at the start of the program to 30-40 min after 2 months. The overall training intensity was increased gradually during the course of the program. An adequate training intensity for endurance conditioning usually targeted 70-85% of the individually determined maximal heart rate. The maximal heart rate can be estimated from the formula (220 minutes age) [24]. The exercise session was subdivided into: Warm up: 5-10 minutes of both light muscular stretching and inspiratory muscle training to avoid muscle strains and injuries. Stimulus phase: 10-30 min. Of treadmill exercise using Electrical treadmill with different speeds and inclination grades. Cool down phase: This relaxation period after the stimulus phase ensures the body not experiences any muscular problems. It includes 5-10 min. Of continued exercise with a speed 1 km/h with zero inclination.

**Progression of exercise includes:**

- First week of training should be at 60-70% of the individually determined maximum heart rate to allow for the development of motor skills and musculoskeletal conditioning.
- As patient’ tolerance for exercise improved, the duration of walking increase gradually and the target is increased by 5-10% of the maximum heart rate.
- After 4 weeks of training, exercise intensity achieves a level of 80% of maximum heart rate, as it was increased gradually every 2 weeks.

2- **Inspiratory muscle training program:**

Patients in Group (1) received high-intensity IMT. The training load in this study was adjusted according to data from a previously performed pilot study about a home-based, high-intensity IMT program in patients with COPD. Total daily training time was 21 min, consisting of 6 cycles of 30 breaths (2 cycles, 3 times daily). There was approximately 3.5 min of resistive breathing during every cycle, each followed by 1 min of resting. Patients were trained 7 days/week, for 8 weeks using the Power breathe Kh1 device (POWERbreatheKh1, haB International ltd, Southam, UK).

**Statistical analysis:**

All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, Ill, USA) version 15 for Microsoft Windows. Data were statistically described in terms of means ± standard deviation (±SD), median, and range. Comparison between the both groups was done using Student t-test for independent samples. Within group comparison was done using paired t-test. p-values less than 0.05 was considered statistically significant.

**Results**

There was no significant difference between both groups before the start of the program (Table 4) regarding the demographic data (age and body mass index). There was a highly statistically significant difference in Spirometric measurements in group 1 (aerobic ex. plus IMT) before and after the intervention (Table 5). Also, there was a significant difference in Spirometric measurements in group 2 (aerobic ex. only) before and after the intervention (Table 6). There was a statistically significant improvement in 6MWD with an increase of 72 meters in group 1 (aerobic ex. plus IMT) and an increase of 54 meters in Group 2 (aerobic ex. only) as shown in (Tables 5, 6) respectively.

**Table (4): Demographic data of Group (1) before and after the study.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group (1) Before</th>
<th>Group (1) After</th>
<th>p value</th>
<th>Group (2) Before</th>
<th>Group (2) After</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>52.32±</td>
<td>51.2±</td>
<td>0.88</td>
<td>51.8±</td>
<td>50.7±</td>
<td>0.86</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.54±</td>
<td>26.4±</td>
<td>0.74</td>
<td>25.9±</td>
<td>26.4±</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Significance at p≤0.05.
BMI: Body mass index.
Table (5): Spirometric measurements in Group (1) (aerobic ex. plus IMT) before and after the intervention.

<table>
<thead>
<tr>
<th>Characteristics within group 1</th>
<th>Before (Mean±SD)</th>
<th>After (Mean±SD)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEV₁ (% of predicted)</strong></td>
<td>54.96±18.3</td>
<td>73.25±14.38</td>
<td>0.0001 *</td>
</tr>
<tr>
<td><strong>FVC</strong></td>
<td>69.22±22.81</td>
<td>83.6±18.32</td>
<td>0.001 *</td>
</tr>
<tr>
<td><strong>FEV₁/FVC</strong></td>
<td>51.42±10.99</td>
<td>48.15±17.14</td>
<td>0.022 *</td>
</tr>
<tr>
<td><strong>6 MWD (in meters)</strong></td>
<td>93.42±11.32</td>
<td>165.54±11.32</td>
<td>0.0001 *</td>
</tr>
</tbody>
</table>

* : Significance at p≤0.05.

FEV₁: Forced expiratory volume in 1 second.
FVC: Forced vital capacity.
6MWD: 6 minute walking distance.

Table (6): Spirometric measurements in Group (2) (aerobic ex. only) before and after the intervention.

<table>
<thead>
<tr>
<th>Characteristics within group 2</th>
<th>Before (Mean±SD)</th>
<th>After (Mean±SD)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEV₁ (% of predicted)</strong></td>
<td>56.7±20.3</td>
<td>66.65±17.4</td>
<td>0.001 *</td>
</tr>
<tr>
<td><strong>FVC</strong></td>
<td>71.56±19.75</td>
<td>79.2±11.8</td>
<td>0.0001 *</td>
</tr>
<tr>
<td><strong>FEV₁/FVC</strong></td>
<td>49.5±11.2</td>
<td>46.34±15.4</td>
<td>0.003 *</td>
</tr>
<tr>
<td><strong>6 MWD (in meters)</strong></td>
<td>79.35±13.18</td>
<td>133.4±9.6</td>
<td>0.0001 *</td>
</tr>
</tbody>
</table>

* : Significance at p≤0.05.

Table (7): BODE index in both groups, before and after the end of the program (aerobic ex. plus IMT).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Before Mean±SD</th>
<th>After Mean±SD</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BODE index in group 1</strong></td>
<td>7.2±1.4</td>
<td>4.9±1.33</td>
<td>0.0001 *</td>
</tr>
<tr>
<td><strong>BODE index in group 2</strong></td>
<td>6.9±1.6</td>
<td>5.35±1.05</td>
<td>0.0001 *</td>
</tr>
</tbody>
</table>

* : Significance at p<0.05 statistically significant.

BODE: The body mass index (B), degree of airflow obstruction (O), functional dyspnea (D), and exercise capacity (E).

Table (8): Change in BODE index in both groups after the end of the program.

<table>
<thead>
<tr>
<th>Improved*</th>
<th>Not improved</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BODE index in group 1; n (% within the group)</strong></td>
<td>19 (95%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td><strong>BODE index in group 2; n (% within the group)</strong></td>
<td>16 (80%)</td>
<td>4 (20%)</td>
</tr>
</tbody>
</table>

* Improvement: At least one unit change in the BODE index.

BODE: The body mass index (B), degree of airflow obstruction (O), functional dyspnea (D), and exercise capacity (E).

Table (9): Comparison of Spirometric measurements and BODE index both groups after the end of the program.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group 1 (Mean±SD)</th>
<th>Group 2 (Mean±SD)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEV₁ (% of predicted)</strong></td>
<td>73.25±14.38</td>
<td>66.65±17.4</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>FVC</strong></td>
<td>83.6±18.32</td>
<td>79.2±11.8</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>FEV₁/FVC</strong></td>
<td>48.15±17.14</td>
<td>46.34±15.4</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>6 MWD (in meters)</strong></td>
<td>165.54±11.32</td>
<td>133.4±9.6</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>BODE index</strong></td>
<td>4.9±1.33</td>
<td>5.35±1.05</td>
<td>0.64</td>
</tr>
</tbody>
</table>

* p-value <0.05 statistically significant.
Discussion

The quality of life for a person suffering from COPD diminishes as the disease progresses. Worldwide, the prevalence of moderate (FEV₁ <80% predicted) to very severe (FEV₁ <30% predicted) COPD is 10%. COPD is associated with substantial societal burden and mortality. Using disability-adjusted life years (DALys) as a measure of burden of disease, COPD is projected to increase from the 11th leading cause of DALys in 2002 to the seventh leading cause in 2030. Similarly, in 2002 COPD was the fifth leading cause of death and is projected to be the fourth leading cause of death in 2030 [24].

The aim of our study was to investigate the effects of inspiratory muscle training (IMT) as an adjunct to an exercise training program for patients with COPD using several validated measures in assessment and treatment of COPD. After the pulmonary rehabilitation program, several outcomes measures such as 6MWD, MRC dyspnea score, BODE index, and pulmonary muscle function tests were evaluated.

The present study showed many beneficial effects of adding IMT as an adjunct method to the pulmonary rehabilitation in COPD patients. This agree with Padula and yeaw [28] showed that inspiratory muscle training (IMT) is a technique that is designed to improve the performance of the respiratory muscles (RMs) that may be impaired in a variety of conditions. Interest in IM training has expanded over the past two decades, and IM training has been used in an increasingly wide range of clinical conditions.

Despite the lack of a clear explanation for how inspiratory muscle dysfunction contributes to the dyspnea and exercise intolerance experienced by those with COPD, there is a considerable amount of research that has investigated the efficacy of IMT for improving inspiratory muscle strength, inspiratory muscle endurance, dyspnea, and exercise tolerance. To date, 6 systematic reviews [26-31] have been completed. The first review with meta-analysis by Smith et al. [26] in 1991 concluded that no beneficial effects of IMT were seen in inspiratory muscle function or exercise tolerance, but this review was limited by the inclusion of studies that did not control for training intensity. A 2002 update by lotters et al. [27] reviewed articles investigating IMT alone or in combination with exercise, and demonstrated improvements in inspiratory muscle strength, inspiratory muscle endurance, and dyspnea.

In 2005 a third group of investigators performed further meta-analysis and review of IMT alone [29] and IMT in combination with aerobic exercise [31]. They examined outcomes for inspiratory muscle strength, endurance, dyspnea, exercise tolerance, and health-related quality of life (hRQI). This group then further updated these reviews in 2008 [29,30]. These updates affirmed previous results that IMT alone significantly improves inspiratory muscle strength, inspiratory muscle endurance, and dyspnea. They also concluded that IMT alone also improves hRQI and exercise tolerance [28]. Further, they demonstrated that IMT in combination with exercise compared to exercise alone may only have additional benefit with respect to improvements in maximal inspiratory pressure. The above studies were in agreement with our results.

Pulmonary rehabilitation is an important component in the management of COPD. It has been shown to improve exercise capacity and health-related quality of life, and to reduce breathlessness, anxiety or depression, and the frequency and length of hospitalizations related to COPD [2]. Exercise training, a key component of a pulmonary rehabilitation program, may include aerobic exercise such as cycling or walking as well as upper and lower extremity strength training [31]. Exercise training is the cornerstone of comprehensive rehabilitation programs in patients with COPD [32]. Although specific exercise modalities can be applied to reverse muscle dysfunction, exercise intolerance, and reduced health-related quality of life there is a substantial heterogeneity in the response to exercise training among patients with clinically stable COPD [33].

The present study implemented moderate to high intensity training program with gradually increasing of the intensity to maximize the training effects. As patient ‘tolerance for exercise improved, the duration of walking on 6MWD was improved in both groups from (93.4m to 165m) in Group (1) and from (79.35m to 133.4m) in Group (2). This in con-
sistent with Clark et al., [34] who demonstrated dramatic improvement in treadmill walking time and suggested that their program would be applicable in patients with COPD with a wide range of functional defects. The improvement in exercise capacity after aerobic training program may be due to: 1) reconditioning, this reinforces the participation of chronic reduction in conditioning as the main mechanism of the peripheral skeletal muscle dysfunction & exercise intolerance in COPD patients [38].

This finding correlated with a meta-analysis done by Clark et al., [34], in a controlled 12-wk study of outpatient pulmonary rehabilitation, the 6-min walk distance increased by 80m at 6wk (half-way in the program), 113m at the end of the program, and 96m 12 week after the program ended.

The present study used BODE index to evaluate the effect of IMT plus aerobic exercise on COPD. It demonstrated that 19 patients or (95%) in group 1 (IMT plus ex.) showed a statistically significant improved in BODE index after 8 weeks. On the other hand, 16 patients or 80% in Group (2) (aerobic ex.only) showed a statistically significant improved in BODE index after 8 weeks.

This finding supported by Cote and Celli [36], who showed that the BODE index could be used to evaluate the effect of pulmonary rehabilitation and defined one unit change in BODE index as being clinically significant because it implies a change in any of its component of a magnitude large enough to influence clinical outcomes. Likewise, one unit change in the 6MWD in the BODE score far exceeds than 50m. Considered to be clinically significant changes for this test [37]. Similarly, one unit change in the FEV1 component of the BODE index reflects the thresholds that have been accepted by the European Respiratory Society and Global Initiative for Chronic Obstructive lung Disease (GOID) as the basis for the physiological staging of COPD [2].

The present study also showed, that there was a statistically significant improvement of both FEV1 & FVC physiological parameters of both groups (IMT and aerobic training group) and (aerobic training group) (Table 9), after the end of the program. This finding supports the concept that COPD is associated with local & systemic manifestations and that aerobic training program may produce great improvements in skeletal muscle function (both respiratory & peripheral muscles). Gohar, [38] was fully consistent with this, he found that there was a significant improvement of both FVC and FEV1 parameters in COPD patients undergo lower limb exercise for 6 weeks.

Conclusions:

The clinical benefits of improved dyspnea, walking test distance and quality of life appeared to be due to clinical benefits of adding IMT to aerobic exercise.

- The present study found that short-term aerobic training program plus IMT had the capacity to break out the vicious circle of dyspnea, physical inactivity and exercise intolerance-the hallmark features of COPD patients and improve some components of BODE index.
- The present study indicated that IMT can be a useful part of pulmonary rehabilitation for COPD patients. Further studies are required to determine which patients are most likely to benefit from this training modality.
- We anticipate that the outcomes of this study will be of direct relevance to clinical practice. The results of this study should therefore be incorporated immediately into evidence-based treatment recommendations for clinical practice.

References

9. POIKEy M.I., KyROUSSIS D., hAMNEGARD C.h., et al.: Diaphragm strength in chronic obstructive pulmo-