Quality of life response to resistive airflow training in patients with chronic obstructive pulmonary disease

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This study was conducted to determine the quality of life response to resistive airflow training in patients with chronic obstructive disease. Sixty male patients were diagnosed clinically according to GOLD 2016 have moderate (GOLD 2) COPD with age ranged from 45-50 years enrolled in the study for twelve weeks. They were chosen from outpatient clinic of El-Sahel Teaching Hospital and were assigned into two groups equal in numbers. Both groups received traditional chest physical therapy (relaxed positions, diaphragmatic breathing, pursed lip breathing and postural drainage), while in program of the study group resistive airflow training using expand-a-lung was added. The 6MWT (walking distance and SPO2), and HRQL were assessed for both groups before and after 12 weeks of training. There was significant increase in results of 6MWT (walking distance 91.21%↑ and SPO2 4.34%↑), and significant decrease in the HRQL 75%↓ for the study group when compared with the control group . Resistive airflow training with expand-a-lung is an effective rehabilitative method for COPD patients in combination with traditional chest physical therapy improves HRQL, walking distances, peripheral oxygen saturation.

Keywords: Expand –a-lung/ Resistive airflow training/ Quality of life / COPD.

INTRODUCTION

Chronic pulmonary disease (COPD) were being the most common and major cause of lung-related disability that needed pulmonary rehabilitation and care for patients with chronic lung disease based on a growing body of scientific evidence (Anderson et al., 2017). In COPD there was weakness of inspiratory muscles and decrease in chest compliance as Hyperinflation has detrimental effects on the function of diaphragm that increase the work of breathing. First of all, the diaphragm is displaced into a flattened position which results in the decrease of the zone of apposition between the diaphragm and the abdominal wall. Secondly, the muscle fibers of the flattened diaphragm are shorter and are less capable of generating inspiratory pressures that leads to functional weakness of the inspiratory muscles. (Papandrinopoulou et al.,2012).

Resistive airflow training using Expand-a-lung provides resistance to airflow while breathing in and out against its restriction. It is a ventilatory muscle exercises and as such, can help strengthen the muscles that help breathing, help relieve/improve upon the symptom of shortness of breath. Many people with limited lung function such as those with COPD will be able to
strenthen and enhance their respiratory function by resistant airflow training using expand-a-lung as its resistance help to strengthen respiratory muscles and increase lung capacity and breathing efficiency (Wallack 2013).

So the objective of the current study was to determine the quality of life response to resistant airflow training using expand-a-lung.

**MATERIALS AND METHODS**

This randomized and control study was conducted to determine the quality of life response to resistant airflow training in patients with chronic obstructive pulmonary disease. Sixty male patients were diagnosed clinically according to GOLD 2016 have moderate (GOLD 2) COPD. Their age ranged from 45 to 55 years. They were selected according to their entrance from chest outpatient clinic El Sahel Teaching Hospital. They participated in the study for twelve weeks. The study started from September 2016 to November 2017. Patients with any other diseases that interfered with the physical therapy program or any other problems that could affect the results of the study were be excluded as neurological disorders, muscle disease, respiratory failure, and right ventricular hypertrophy. The patients were assigned randomly into Study group (A): That received resistant airflow training with expand-a-lung device in addition to traditional chest physical therapy program (relaxed positions, diaphragmatic breathing, pursed lip breathing and postural drainage) for 90 min, with frequency of 3 sessions per week for 12 weeks. Control group (B): participated in traditional chest physical therapy program only for 60 min, with frequency of 3 sessions per week for 12 weeks. Control group (B): participated in traditional chest physical therapy program only for 60 min, with frequency of 3 sessions per week for 12 weeks. The study was approved by ethical committee of Faculty of Physical Therapy, Cairo University, Approval number; P.T.REC/012/001347.

Age, weight, height, and body mass index values were recorded as physical characteristics of the patients. Peripheral oxygen saturation was recorded, by pulse oximetry, and walking distance for each patient. Also the scores of health related quality of life questionnaire were recorded before and after training (12 weeks).

The two groups received traditional chest physical therapy program (as mentioned before) in addition to respiratory training with expand-a-lung device for the study group (A) as following: The patient Breathe in and out while adjusting the resistance valve to select the desired level of breathing resistance according to performance gains and manufacturer guidelines. Once have set the desired level of resistance, the patient did the following three steps exercise without taking the mouthpiece out of his mouth. Inhaled through the mouthpiece slowly, as deep as he can, hold breath for a couple of seconds, exhale through the mouthpiece slowly until he is almost out of breath, removed the unit from his mouth and breathe normal until he catched his breath. Then repeat the above exercise 10 times to complete one set. Do 2 to 4 set per session; duration of session was 90 min, with frequency of 3 sessions per week for 12 weeks. Intensity: 30% from10 Repetition Max of the patient (Gosselink et al., 2011).

**Statistical analysis**

The data was collected from patients and classified into pre and post training values. Data was statistically described in terms of mean ± standard deviation (±S.D). Paired (t) test was used to compare the results pre and post training in the same group. Unpaired (t) test was used to compare the result pre and post in the two groups. All statistical analyses were significant at 0.05 of probability (p≤ 0.05).

**RESULTS**

**Baseline Characteristics Of The Subjects**

As revealed from table (1), there were no significant differences (P>0.05) between study and control groups readings to age, weight, height, BMI, and mean values of FEV1 and FEV1/FVC.

**Walking distance results**

That there was significant increase in walking distance values between the pre-training and post training within group A and group B, which has an associated probability value of 0.001(P<0.05). While the percentage of improvement was 91.21%↑ in group A and 62.4%↑ in group B as shown in Table (2) and demonstrated in figure(1).

**Peripheral Oxygen Saturation**

That there was significant increase in peripheral oxygen saturation values between the pre-training and post training within group A and group B, which has an associated probability value of 0.001(P<0.05). While the percentage of improvement was 4.34%↑ in group A and 1.276%↑ in group B as shown in Table (3) and demonstrated in figure(2).
Ahmed et al., Quality of life response to RMT in COPD.

Table (1): physical characteristics of patients enrolled in the study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group (A) Mean ±SD</th>
<th>Control group (B) Mean ±SD</th>
<th>MD</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>50.73±2.99</td>
<td>50.66±3.77</td>
<td>-0.07</td>
<td>0.06</td>
<td>0.94*</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>62.63±5.54</td>
<td>62.4±5.64</td>
<td>-0.23</td>
<td>0.13</td>
<td>0.98*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.06±5.98</td>
<td>164.64±6.6</td>
<td>-1.46</td>
<td>0.77</td>
<td>0.44*</td>
</tr>
<tr>
<td>BMI (Kg/cm²)</td>
<td>22.71±1.48</td>
<td>23.05±2.05</td>
<td>0.35</td>
<td>0.66</td>
<td>0.51*</td>
</tr>
<tr>
<td>FEV₁L</td>
<td>1.46±0.44</td>
<td>1.53±0.31</td>
<td>0.07</td>
<td>0.53</td>
<td>0.59*</td>
</tr>
<tr>
<td>FEV₁/FVC%</td>
<td>59.18±2.96</td>
<td>62.57±2.41</td>
<td>3.39</td>
<td>1.43</td>
<td>0.16*</td>
</tr>
</tbody>
</table>

SD: Standard Deviation  *: Non significant (P>0.05)  MD: Mean difference  cm: centimeter  P-value: Probability value  Kg: kilogram  BMI: Body Mass Index  Kg/cm²: Kilogram per centimeter square  FEV₁: Forced Expiratory Volume in one second  L: Liter  FEV₁/FVC: Ratio of forced expiratory volume in one second to forced vital capacity

Table (2): Comparison between mean values of pre- and post-training walking distances within each group and between groups.

<table>
<thead>
<tr>
<th>Walking distance</th>
<th>Group A</th>
<th>Group B</th>
<th>Post-treatment between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
<td>Pre-treatment</td>
</tr>
<tr>
<td>Mean ±SE</td>
<td>266.3±3.3</td>
<td>508.9±4.8</td>
<td>266±3.2</td>
</tr>
<tr>
<td>t-value</td>
<td>237.7</td>
<td>73.81</td>
<td>0.0001</td>
</tr>
<tr>
<td>P-value</td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>% of change</td>
<td>91.21%↑</td>
<td>62.4%↑</td>
<td>----</td>
</tr>
</tbody>
</table>

P-value: probability level  SD: Standard Deviation  NS: Non significant  S: Significant

Table (3): Comparison between mean values of pre- and post-training peripheral Oxygen Saturation within each group and between groups.

<table>
<thead>
<tr>
<th>Peripheral Oxygen Saturation</th>
<th>Group A</th>
<th>Group B</th>
<th>Post-treatment between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
<td>Pre-treatment</td>
</tr>
<tr>
<td>Mean ±SE</td>
<td>94.4±0.40</td>
<td>98.5±0.65</td>
<td>94±0.3</td>
</tr>
<tr>
<td>t-value</td>
<td>73.6</td>
<td>11.95</td>
<td>0.0001</td>
</tr>
<tr>
<td>P-value</td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>% of change</td>
<td>4.34%↑</td>
<td>1.276%↑</td>
<td>----</td>
</tr>
</tbody>
</table>

P-value: probability level  SD: Standard Deviation  NS: Non significant  S: Significant

Table (4): Comparison between mean values of pre- and post-training Health Related Quality Of Life score within each group and between groups.

<table>
<thead>
<tr>
<th>Health Related Quality Of Life Score</th>
<th>Group A</th>
<th>Group B</th>
<th>Post-treatment between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
<td>Pre-treatment</td>
</tr>
<tr>
<td>Mean ±SE</td>
<td>12±0.86</td>
<td>3±0.71</td>
<td>11±0.87</td>
</tr>
<tr>
<td>t-value</td>
<td>51.82</td>
<td>16.22</td>
<td>23.95</td>
</tr>
<tr>
<td>P-value</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>% of change</td>
<td>75%↓</td>
<td>27%↓</td>
<td>----</td>
</tr>
<tr>
<td>Significance</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

P-value: probability level  SD: Standard Deviation  NS: Non significant  S: Significant
Figure (1): Show the mean values of walking distance of the pre-training and post-training data of study and control groups.

Figure (2): The mean values of peripheral oxygen saturation of the pre-training and post-training data of study and control groups.
Health Related Quality of Life Questionnaire (HRQL) results

That there was significant decrease in Health Related Quality Of Life Score values between the pre-training and post training within group A and group B. which has an associated probability value of 0.0001(P<0.05).While the percentage of improvement was 75%↓ in group A and 27%↓ in group B as shown in Table (4) and demonstrated in figure(3).

DISCUSSION

The aim of the study was to assess the quality of life response to resistive airflow training in patients with obstructive pulmonary disease.

Sixty male COPD patients from El Sahel Teaching Hospital were included in this study. They were assigned into two groups equal in numbers. The study group who received resistive airflow training with expand-a-lung device in addition to traditional chest physical therapy program and the control group who received traditional chest physical therapy only. The training program for patients in both groups was 3 days per week for twelve weeks. The walking distance, oxygen saturation, health related quality of life scores measured at the beginning of the study and after twelve weeks of the training program.

The analysis of the results of the current study showed that there was a significant increase in walking distance in the study group 91.21% compared to control group where was 62.4%. Also, there was significant increase in peripheral oxygen saturation in the study group 4.34% compared to control where was 1.27%.

For the HRQL score values, the results of present study after the study period revealed that there was a significant decrease in HRQL score in the study group 75% compared to control group where was 27%.

From the results we can see that the improvement reached in all parameters used due to using of expand-a-lung device as expand-a-lung increased the diaphragmatic excursion, strength, and endurance due to the resistance opposed the inspiration phase that increases the expansion of lungs and thorax which causes enhancement in ventilation and gas exchange, and these cumulative effect improves lung volumes. The end result is deeper, easier and better breathing. Also expand-a-lung expiration against resistance leads to contraction of abdominal muscles which tenses diaphragm, eases expectoration and reduces dyspnea. Expand –a-lung improves exercise capacity,
quality of life and psychological status of the patient due its positive feedback effect.

The improvement shown in the results reached through using postural drainage with percussion and vibration was due to the positive effects of postural drainage with percussion and vibration that were efficacious in bronchial hygiene due to using gravity to assist in removal of secretions from periphery of the lungs to the bifurcation of the right and left main stem bronchus, the increased the velocity of mucous transportation, the gas exchange and improvement in pulmonary function, increased the depth and pattern of ventilation, perfusion. These together with increased expiratory flow rates seen with vibrations, provide some evidence to support the concept that vibrations improve mucociliary transport. Percussion of the chest wall producing a shock wave that is transmitted through the thorax as to loosen mucus from the airways walls.

The result of this study was supported by a study done by Wallack 2013, of resistive airflow training using Expand-a-lung that provides resistance to airflow while breathing in and out against it's restriction. It is a respiratory muscle exercise strengthens the muscles of breathing, to relieve/improve upon the symptom of shortness of breath and increases lung capacity and breathing efficiency in COPD patients.

The result of the current study was supported by the results of Celga, 2014 who stated that the patients with chronic obstructive pulmonary disease used the expand –a-lung had significantly improved the auscultation findings greatly shown in the clinical symptoms cough, expectoration, dyspnea, subjective well-being and quality of life also showed positive influences. In his opinion, the following factors also contribute to the positive effects:

Increase of diaphragmatic excursion and strength due to resistance in inspiration

Expiration against resistance leads to contraction of the abdominal musculature, which tenses and arches the diaphragm, improves the length-tension ratio, reduces dyspnea and eases expectoration.

The results of this study are supported by the results obtained by (Paula et al., 2009) who under took a controlled trial of resistive breathing exercise by IMT (pressure threshold) in 35 lung resection patients. The IMT group (n = 25) training for 20 minute per day, Six times per week for one week pre-operative and 3 weeks post-operative. Exhibited significant improvement in inspiratory muscle strength (70.35%) and reduction of post-operative atelectasis in study group more than control group.

The results of our study are coincided with the results of trials with resistive airflow training using IMT. The finding reveals that IMT intervention improves exercise capacity and quality of life, particular in patients with inspiratory muscle weakness. Moreover, IMT results in improved cardiovascular response to exercise and to those obtained with standard aerobic training. (Ribeiro et al., 2015).

Moreover, our results are consistent with Casalia et al., 2011 who found that resistive breathing exercise using IMT improve inspiratory muscle strength and endurance and account for earlier recovery of pulmonary airflows in patients submitted to thoracic surgery.

In agreement with Weiner et al., 2011 who studied thirty two patients with chronic obstructive pulmonary disease were randomized into two groups: 17 patients received specific inspiratory muscle training 20 minutes per day, 3 times per week for 12 weeks and 15 patients were assigned to control group no received training there was significantly increased inspiratory muscle strength in the training group (65.5%) and their ventilatory function improved.

The results of this study are gathered with the results of (Alfredo et al., 2007) who examined effect of IMT on inspiratory muscle strength and post-operative pneumonia in 40 patients 15 minute daily, six times per week, training for 2 week pre-operative and 2 weeks post-operative, there was significant increase in inspiratory muscle strength (67.39%) and reduce incidence of post-operative pneumonia in training group more than control group.

The current study results came to the same conclusion of (Chatham, 2000) who showed increase in diaphragmatic strength in 30 subjects trained for a 5- weeks period which resulted in increased in inspiratory muscle efficiency, improved pulmonary mechanics or both, so their ventilatory functions and quality of life improved.

Results of a study done by (Hill et al., 2006) were sharing the same point with ours , as they stated that 6 months of inspiratory threshold loading training; added to general exercise conditioning, markedly improved inspiratory muscle strength and endurance as well as exercise tolerance, in patients with COPD and that the improvement in this group of patients was significantly greater than achieved with general exercise conditioning alone and their quality of life
improved as well as their ventilatory functions.

The current study results hold the same opinion with results obtained by (Enright et al., 2013) who showed that regimen of resistive airflow training using high-intensity IMT produced an increase in inspiratory muscle function, induces morphological changes in the diaphragm in people who are healthy as well as improvement in quality of life and ventilatory functions.

The results of this study shares the view of Stephanie et al., (2016) who studied using of high-intensity inspiratory muscle training resulted in significant increase in inspiratory muscle functions (IMF) and strength of the contracted diaphragm, improved lung volumes, increased physical capacity and improved psychological status in COPD patients.

In accordance with our results, (Romer et al., 2009) showed that inspiratory muscle training for 6 weeks COPD patients increased the strength of diaphragm and improved the lung functions and breathing pattern as well as improved walking distances.

Also, San Chez et al., (2011) came to the same conclusion of our results that focused on inspiratory muscle training improves strength of diaphragm as it leads to hypertrophy of diaphragmatic muscle, relieves dyspnea, increases the capacity to walk and improve health related quality of life (HRQL) in COPD patients.

The results of the current study came in support with several studies as Antonio et al., 2007; Fink, 2002; and Lamar et al., 2006 who reported that the IMT improves the strength and endurance of the diaphragm and also improves lung functions in patient undergoing pulmonary resection surgery. Positioning and postural drainage with percussion have played an important role in increasing lung volumes, perfusion, oxygenation and mobilization of secretions. Postural drainage has been shown to improve mobilization of secretions in patient who produce, and have difficulty clearing large quantities of sputum. The benefits of postural drainage appear technique-dependent, requiring sufficient drainage time (3-5 min) for each position drained.

In contrast Mc Gill and Brown (2011) reported that a non-significant change in quality of life with inspiratory muscle training program for 4 weeks and they stated that might be explained by the short duration of the study.

The results achieved by (Reid, 2008) were unclear and opposes our results as he showed that the benefits of resistive airflow training in adolescents and adults with cystic fibrosis for outcomes of inspiratory muscle function are supported by week evidence. Its impact on exercise capacity, dyspnea and quality of life is not clear.

Finally it can be concluded that resistive airflow training with expand-a-lung device in addition to traditional chest physical therapy program for 2 to 4 sets per day, with frequency of 3 sessions per week for 12 weeks in COPD patients, significantly improved HRQL, walking distances and peripheral oxygen saturation of these patients in addition to improvement of mechanics of breathing for study group. So training by expand-a-lung device should be recommended for COPD patient.

CONCLUSION
Resistive airflow training with expand-a-lung is an effective rehabilitative method for COPD patients in combination with traditional chest physical therapy modalities, that improves HRQL, walking distances, peripheral oxygen saturation that reflects the increased functional capacity of patients that enhances them to be independent in the society.

CONFLICT OF INTEREST
The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEDGEMENT
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AUTHOR CONTRIBUTIONS
NSA designed and performed the experiment and also wrote the manuscript. ZMS, NGE, NHT and MWE performed continuous guidance and suggestions during the performance of experiment, data analysis and reviewed the manuscript. All authors read and approved the final version.

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