Oscillating Positive Expiratory Pressure Improves Peak Expiratory Flow and Exercise Capacity in Patients with Chronic Obstructive Pulmonary Disease

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Abstract

The purpose of the study was to assess the effect of oscillatory positive expiratory pressure (OPEP) device (flutter device) on exercise capacity and peak expiratory flow rate (PEFR) in patients with moderate COPD. Twenty men patients with moderate COPD based on spirometric measures for FEV₁, FEV₁/FVC with mean age 50.73 ± 2.9 were enrolled in that study for two months. They received flutter valve treatment as airway clearance. They underwent evaluation procedures at the beginning study that included weight, height and spirometric measures for FEV₁, FEV₁/FVC, PEFR and 6 minute walk test (6MWT). At the end of the study 6MWT and PEFR were retested. Results showed that there were significant increase of all the 6MWT measured parameters (Distance, SpO₂) as well as PEFR. It was concluded that the (OPEP) in the form of flutter device improved exercise capacity and peak expiratory flow in moderate COPD men patients who had chronic sputum production.

Key Words: Oscillatory positive expiratory pressure – Flutter – Exercise capacity – PEFR – COPD.

Introduction

CHRONIC obstructive pulmonary disease (COPD) is characterized by the chronic presence of symptoms such as cough and sputum production and, in more advanced cases, dyspnea (upon exertion or at rest), all caused by changes in pulmonary mechanics and gas exchange [1].

Exercise capacity has become an important outcome measure in COPD, as many patients complain of exercise intolerance and exertional dyspnea, and because it is a major determinant of an impaired health status. The improvement of exercise capacity is listed as one of the major goals for the management of COPD [2].

The Flutter VRP1 is an example of an oscillatory positive expiratory pressure (OPEP) device that assist in secretion clearance. When compared to conventional forms of airway clearance, such as autogenic drainage, active cycle of breathing, or chest physiotherapy, the Flutter was found to have good effects on oxygen saturation, pulmonary function, arterial blood gas values, symptoms scores, and hospital duration of stay [3].

Clinical and cardiorespiratory findings in patients with COPD were studied for effects of positive oscillatory expiratory pressure created in respiration through flutter on exercise adaptation. It was proved that breathing through flutter before exercise tolerance test raises tolerance to exercise in COPD patients, modifies a cardiorespiratory response in direction of its optimization [4].

The aim of this study was to assess the effect of OPEP as flutter device on PEFR and exercise capacity in patients with moderate COPD.

Subjects and Methods

Twenty men patients were diagnosed clinically to have moderate COPD The patients had moderate COPD based on spirometric measures of: (FEV₁/FVC <70%), (50% <FEV₁ <80% predicted) and with chronic symptoms “cough, sputum production” according to Global Initiative for Chronic Obstructive Lung Disease 2006 [5]. They participated in the study for two months. Their age ranged from 45-55 years. They were selected from chest department Eldemerdash Hospital, Ain-Shams University and its where the practical work took place.
A) **Evaluative procedures:** All patients underwent the following sequence:

- Weight and height scale to calculate body mass index (BMI) Kg/m\(^2\).
- Spirometer to measure forced expiratory volume in one second (FEV\(_1\)), forced expiratory volume in one second to forced vital capacity ratio (FEV\(_1\)/FVC) as to confirm the diagnosis of moderate COPD. PEFR was measured at baseline, after 1-month and after 2-months.
- Pulse oximetry (model: JAX 207; power: DC3.0V), that was applied during 6MWT, where the patients were monitored with a continuous pulse oximetry. Oxygen saturation was recorded and printed every 6 seconds at rest and during exercise, as determined by pulse oximetry \[6\].
- The 6-minute walk test (exercise capacity): The walk test was conducted in a temperature-controlled, measured and marked corridor (30 meter). The turnaround points were marked with a cone. A Starting line, which marks the beginning and end of each 30-m, was marked on the floor using brightly colored tape \[7\].

Every 30 seconds they were encouraged to continue walking as fast as possible, but not to run. During walk the examiner recorded the time, distance walked, duration of rests, and also monitored oxyhemoglobin saturation continuously by using a pulse oximeter. If the resting saturation was less than 90% on room air, patients were not considered eligible for room air 6-MWT. The 6-MWTs were symptom limited, so patients were allowed to stop if necessary, though they were instructed to resume walking as soon as possible. The test was stopped for safety purposes if the arterial oxygen saturation (SaO\(_2\)) dropped to <86% \[8\].

Reasons for immediately stopping a 6MWT include chest pain, intolerable dyspnea, leg cramps and pale appearance. If the test was stopped for any of these reasons, the patient should sit or lie supine as appropriate depending on the severity or the event and Oxygen should be administered as appropriate \[9\].

All patients performed the 6MWT at the beginning, after month and at the ending of the study. The distance (M) and oxyhaemoglobin saturation (%) were recorded. P.S.: The application of resting electrocardiogram (ECG) was preferred before the 6 minute walk test to avoid the incidence of silent myocardial infarction.

B) **Treatment procedure:** Included the application of Flutter Device Technique: Each patient in the study was trained by using flutter three times/week (15-20) minutes (gradual increase up to 20 minutes)/session for two months \[10\]. Disposable mouthpieces for each patient was used. Position of patient so that they were sitting with back straight, head extended slightly upward then holding the Flutter in one hand. The patient inhaled slowly beyond a normal breath, but did not fill lungs completely then held his breath for two to three seconds. Then he placed the Flutter in his mouth keeping cheeks as stiff as possible then exhaled through the Flutter Device. The degree of tilt of the Flutter Device was adjusted in order to maximize vibrations. Repeated the cycle (inspiration, hold and expiration) three times then Rest for 21 seconds. After the mucus was “loosened”, the patient performed one to two huffs, followed by coughing.

**Statistical analysis:**

At the end of the study, the raw collected data was statistically analyzed using the SPSS program 0.8 version. Inferential statistics was used to analyze the measured parameters. The demographic data such as age, weight, height and body mass index (BMI), were collected for all patients at entry of the study. The data related to 6 minutes walking test included walking distance, resting peripheral saturation (SpO\(_2\)-rest) and exercises peripheral saturation (SpO\(_2\)ex), as well as data of peak expiratory flow (PEFR) have been measured at baseline and after one month and two months.

**Results**

The results are shown in Tables (1,2) and Figs. (1-3).

**Table (1): Demographic data of patients included in the study.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>50.73±2.99</td>
</tr>
<tr>
<td>Weight (Kg.)</td>
<td>62.63±5.54</td>
</tr>
<tr>
<td>Height (cm.)</td>
<td>166.06±5.98</td>
</tr>
<tr>
<td>BMI (Kg/m(^2))</td>
<td>22.7±1.48</td>
</tr>
<tr>
<td>FEV(_1) (l)</td>
<td>1.46±0.44</td>
</tr>
<tr>
<td>FEV(_1)/FVC (%)</td>
<td>59.18±7.96</td>
</tr>
</tbody>
</table>
Table (2): Statistical analysis of related parameters.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>After 1 month</th>
<th>After 2 months</th>
<th>F-value</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking distance (cm)</td>
<td>296.46±80.55</td>
<td>369.66±92.53</td>
<td>447.8±97.07</td>
<td>29.97</td>
<td>0.001*</td>
</tr>
<tr>
<td>(\text{SpO}_2)rest (%)</td>
<td>95±1.23</td>
<td>95.93±1.43</td>
<td>97.33±1.09</td>
<td>45.03</td>
<td>0.001*</td>
</tr>
<tr>
<td>(\text{SpO}_2)ex (%)</td>
<td>91.36±2.31</td>
<td>91.6±3.71</td>
<td>95.06±1.41</td>
<td>33.39</td>
<td>0.0001*</td>
</tr>
<tr>
<td>PEFR (L/min.)</td>
<td>3.37±0.94</td>
<td>4.46±1.3</td>
<td>5.36±1.52</td>
<td>−8.5</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

\(\text{SpO}_2\)rest: Peripheral oxygen saturation at rest.
\(\text{SpO}_2\)ex: Peripheral oxygen saturation after exercise.

PEFR: Peak expiratory flow rates.

S*: Significant.

Discussion

This study demonstrated that two-months regimens of regular using Flutter improves 6MWT and PEFR in COPD patients with mucus hypersecretion.

The VRP1-Desitin device, also known as Flutter, is a small-sized pocket device designed to treat patients with chronic mucus retention and bronchial collapse. Although simple in design, the Flutter has demonstrated encouraging performance compared to traditional respiratory physiotherapy such as, for example, autogenic drainage. It is based on oscillations of pressure and air flow in the respiratory tract during expiration [10].

The Oscillating positive expiratory pressure (OPEP), Flutter is used to facilitate the opening of the airways and loosening of the remaining (or “trapped”) mucus in patients with COPD, that fact confirmed the results achieved by many studies that stated that, fluctuations of the air pressure, achieved by using the Flutter device, produce turbulences inside the airways, which enables the mucus to separate from the airway walls [11].

The result of the current study came in support with the results of [12] who stated that patients with chronic obstructive pulmonary disease used the flutter device three times a day for 5 minutes had significantly improved vital and forced vital capacity. The clinical symptoms cough, expectoration, dyspnoea, subjective well-being and performance capacity also showed positive influences. In his opinion, the following factors also contribute to the positive effects:

- Pressure-related bronchial expansion involving a separation of the bronchial mucus from the bronchial walls.
- Easing of expectoration due to intermittent respiratory flow acceleration (“stop-and-go” breathing).
- Expiration against resistance leads to contraction of the abdominal musculature, which tenses and arches the diaphragm, improves the length-to-tension ratio, reduces dyspnoea and eases expectoration [12].
The current study is also in agreement with the study conducted by [16] who determined the long-term efficacy of daily chest physiotherapy with the VRP1 in COPD and bronchial hypersecretion. After two months of physiotherapy, FVC, FEV₁ and distance walked in 12 minutes increased in the treated group, but were almost unchanged in the sham-treated (removing the ball) group.

The study was detailed [17,18] to find the efficacy of which mode of treatment was better in the two groups using three different evaluating tool such as Oxygen saturation level (SaO₂), PEFR and the Rate of perceived exertion. The analysis of variance between treatments of both the Groups using SaO₂ and PEFR had significant improvement for Positive expiratory pressure using Flutter technique than Autogenic drainage in improving the bronchial hygiene of patients with moderate chronic bronchitis. The results of this study showed that Flutter therapy resulted in a significant reduction in sputum viscoelasticity and thus improves mucus clearance.

The result of the current study came in support with the results of [19] who compared the short-term effects of Chest Physical Therapy (CPT) and the Flutter valve on pulmonary function and exercise tolerance in patients with cystic fibrosis. There was a significant improvement in FVC, FEV₁ FEF₂⁵-₇₅, 6-min walk distance, and resting arterial oxyhemoglobin saturation (SaO₂) between groups by the end of two weeks both groups, with no significant difference between groups.

The results showed by [3] which came coincided with results of the current study in such that flutter might also be effective in patients with COPD, specifically, by improving mucus clearance. However, the prior use of the Flutter, compared to the sham Flutter (removing of stainless steel ball), improved the subsequent bronchodilator response in these patients. Patients with a history of cough and sputum seemed to benefit most from the Flutter. After use of the Flutter and the bronchodilator, subjects were able to walk further, had a better oxygen saturation, and were slightly less dyspneic. The Flutter has been shown to improve pulmonary function (FEV₁ or FVC) in patients with obstructive lung disease. In the present study, 6-min walk distance increased significantly as pulmonary function improved.

Different studies showed the usefulness of the Flutter in increasing the volume of expectorated mucus and improving symptoms in patients with cystic fibrosis, as well as enhancing the bronchodilator response in patients with chronic obstructive pulmonary disease, and also restoring lung volumes in healthy subjects as well as studying the mechanical effect of using flutter in airway clearance that were reported by [20] that airway clearance is facilitated by the Flutter VRP 1 due to 4 potential basic effects generated by the device: (a) Its capacity to produce a positive expiratory pressure (PEP) in the airways (PEP effect is used to prevent airway closure, and its production depends, fundamentally, on the resistance of the device), (b) The occurrence of expiratory flow, which produces a maneuver of forced exhalation known as huff (In theory, huff performed with lower flow and with lower lung volume prevents excessive dynamic airway compression and promotes mobilization of the mucus located more in the periphery of the bronchial tree, whereas with high flows and high lung volumes the effect is more pronounced in the proximal airways), (c) The application of flow oscillations, and (d) The modification of bronchial mucus viscoelasticity by vibration, which facilitates its mobilization.

In contrast, [13] conducted a randomized crossover study to compare the short-term effects of improved secretion removal with three different techniques (postural drainage, FLUTTER, and Slow expiration with the glottis open during the entire exhalation, with the patient in infralateral decubitus position). With regard to oxygen saturation and pulmonary function during exacerbations of chronic bronchitis patients. All techniques were well tolerated, and oxygen saturation and pulmonary function did not change significantly during and after treatments.

On the contrary, a study conducted by [14] showed that there were no significant changes in transcutaneous oxygen hemoglobin saturation and in any lung function parameter (peak expiratory flow, FVC, FEV₁, maximal expiratory flow at 25% of FVC, thoracic gas volume, total lung capacity, residual volume/total lung capacity, airway resistance and specific airway conductance) occurred after a single session or after 2 weeks of physiotherapy with either method. They found no significant changes in oxygenation with the use of the PEP mask or the Flutter. This could be due to the relatively high baseline values of patients.

Moreover, [15] had suggested that Flutter device was a well accepted and tolerated airway clearance device and that the patient’s preference was more for Flutter device compared to active cycle of breathing techniques (ACBT) and postural drainage. Efficacy of ACBT with postural drainage within a week was superior to both ACBT alone and Flutter as measured by acute sputum produc-
tion. There was no change in oxygen saturation or FEV1 after week of all three modalities.

In contrast, it is concluded from the studied sample that the use of Flutter and the techniques of conventional physiotherapy (postural drainage, chest percussion and vibropression) are equally efficient in the clearance of secretions in patients with bronchiectasis. In addition, it was not observed significant SpO2 with any of the techniques [18].

The current study reflected that improvement of 6 minutes walking test included walking distance, resting peripheral saturation (SpO2-rest) and exercises peripheral saturation (SpO2-ex) and improvement of oxygen saturation (SaO2) after using Flutter after two months. Moreover, the improvement observed in PEFR with the use of Flutter declared the efficient airway clearance.

From the results we can see that the improvement reached in all parameters due to using flutter was because it is an easy to use physiotherapy device whose positive effects proved to cause pressure-related bronchial expansion involving a separation of the bronchial mucus from the bronchial walls, decreases the collapsibility of the airways, easing of expectoration due to intermittent respiratory flow acceleration, shearing of mucus from airway wall by oscillatory action, stabilization of airways preventing early airway closure, facilitation of cephalic flow of mucus, and, perhaps, changes in mucus quantity and rheology, reduction in sputum viscoelasticity and thus improves mucus clearance, promotes correct breathing patterns with effective distribution of ventilation which improves gaseous exchange, increase and a reduction in unequil ventilation may lead to an improvement in gas exchange and, hence, oxygenation, expiration against resistance leads to contraction of the abdominal musculature, which tenses and arches the diaphragm, reduces dyspnoea and eases expectoration.

Conclusion:
It was concluded that the oscillatory positive expiratory pressure using flutter device improved exercise capacity and Peak expiratory flow rate in moderate COPD men patients who had chronic sputum production that led them to be more independent in the society.

References
16- EATON T., YOUNG P., ZENG I. and KOLBE J.: A Randomized evaluation of the acute efficacy, acceptability


