Effect Of Flutter Versus Active Cycle Of Breathing Techniques On Blood Gases In COPD Patients: A Comparative Study

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Abstract_

Background: In patients with COPD there is an acute worsening of respiratory symptoms with significant increase in morbidity and mortality. Abnormal secretion production leads to airway obstruction and sputum retention.

Aim of the study: To compare between the effect of flutter device versus active cycle of breathing technique on arterial blood gases in COPD patients.

Subject and Methods: Forty male patients were randomly assigned into two groups equal in number. Group (A**):** consisted of 20 patients received their medical treatment in addition to flutter device. Group(B): consisted of 20 patients received their medical treatment and active cycle of breathing technique. Their arterial blood gases were analyzed before and after 4 weeks of training program for both groups.The training protocol was done 3 times/week .

Results: Group (A) flutter group, showed a statistical significant improvement in ABG parameters (PH, Sp02, Paco2 and Pao2) that were (0.5%, 3.3%, -15.1%, 13.2%) respectively, more than the improvement in group (B) ACBT group, that were (0.1%, 1.1%, -7.2%, 4.5%) respectively. **Conclusions:** It was concluded that both flutter device and ACBT showed significant improvement in ABG in COPD patients but the flutter more is effective than ACBT

Keywords—Flutter device, Active cycle breathing technique, Chronic obstructive pulmonary disease, arterial blood gases.

I. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major health problem characterized by chronic airflow limitation that is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. It is a leading cause of morbidity and mortality worldwide and results in an economic and social burden **(1)**.

In patients with COPD there is an acute worsening of respiratory symptoms with significant increase in morbidity and mortality. These signs and symptoms are dyspnea, productive cough, mucus hypersecretion, reduced expiratory flow, hyperinflation and impaired lung function due to increase airway thickening and increase intraluminal mucus secretion (2). Abnormal secretion production can potentially lead to airway obstruction and sputum retention, thereby predisposing the airways to infection and inflammation. Treatment methods that aim to clear secretions may decrease the frequency of infections, therefore preventing further airway damage and deterioration of lung function, and potentially reducing the rate of progression of lung disease **(3).**

Patients with COPD should be encouraged to maintain a healthy life style, stop smoking for patients who smoke, weight loss for obese patients (blue bloater), and nutritional supplementation for those thin patients (pink puffers). Comprehensive pulmonary rehabilitation also should be considered which include regular exercise and chest physiotherapy (CPT) (4).

Techniques of efficient clearance of peripheral airways may reduce airway occlusion by excess mucus and inflammatory cells, improving lung function, exercise capacity and reducing exacerbation frequency. So there is an important need for airway

clearance therapy. Methods of clearance of airway mucus includes ; exercise, autogenic drainage (AD), conventional chest physiotherapy (CCPT), active cycle of breathing technique(ACBT), Acapella, flutter, and high frequency chest wall oscillation(HFCWO) (5).

The Flutter is a type of mucus clearance device shaped like a pipe with a hardened mouthpiece at one end. It is a small hand held device containing steal ball inside, when exhalation through mouth piece the ball inside causing vibration inside the lungs The Flutter device is a controlled vibration system, during expiration Flutter produces positive expiratory pressure (PEP) and cyclic oscillation of the airways. Expiration against resistance resultant in increasing the alveolar pressure creating PEP which diminish the airways collapsibility and may reduce peripheral airway resistance. The oscillations induce vibrations within the airway wall to decrease the viscoelasticity of tenacious secretions, as well as, to accelerate airflow, enhance movement of secretions from the peripheral to the central airways lumen, improving lung function and oxygenation **(6).**

Active cycle of breathing technique (ACBT) is a physiotherapy technique used to mobilize and clear excess pulmonary secretions from the lung peripheries without increasing airflow obstruction. It is a combination of thoracic expansion exercise with breathing control followed by forced expiratory technique. The ACBT was an effective technique to improve arterial blood gases (ABG) and other vitals of COPD patients as this technique help in improving lung function, arterial oxygenation, exercise performance and prevent pulmonary complications. **(7).**

Arterial blood gases (ABG) primarily provide information about three vital physiologic processes: oxygenation (i.e. oxygen loading from the lungs into the blood), ventilation (i.e. carbon dioxide off-loading from the blood into the lungs), and acid base status. Oxygenation status can be evaluated by measuring the arterial partial pressure of oxygen (pao2) **(8).**

Hypoxemia refers to a reduction of oxygen in the arterial blood, indicated by Pao2 values below 80 mmHg. The presence of hypoxemia can be life threatening. Any time a low Pao2 is obtained from the patient, the alveolar gas equation should be used to determine the alveolar-arterial (A-a) oxygenation gradient. The A-a oxygen gradient provides a measure of the adequacy of oxygen transport across the alveolar membrane into the pulmonary capillaries perfusing the alveoli (i.e. oxygen loading into blood). **(9)** Most pulmonary diseases alter the ventilation perfusion ratio (V/Q mismatch) of individual alveoli, which leads to a reduction in oxygen loading into the blood and a corresponding lower pao2. V/Q mismatch leads to increase in the A-a oxygen gradient. **(10)**

SUBJECTS AND METHODS:

A. *Subjects*:

Forty men patients with moderate to severe COPD, were included in this study. They were were selected from chest department in EL Demerdash Hospital. The practical work of the study was carried out in the period starting from May 2018 till December 2018.

Inclusion criteria:

All patients were diagnosed as COPD, based on the modified criteria defined in the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines 2018, as stable moderate to severe COPD patients, who have a post-bronchodilator FEV1= (80%≤FEV1<30%) predicted. their age ranged from 41-75 years old and their body mass index (BMI) below 16.99-32.87 kg/m2.

Exclusion criteria:

All patients of the following criteria were excluded:Pneumothorax, very severe COPD, acute exacerbation, respiratory failure, right side heart failure and hematologic disease.

All patients were randomly assigned to two groups equal in number:

Group (A): *included 20 patients were received their medical treatment in addition to flutter device.*

Group (B): included 20 patients were received their medical treatment and active cycle of breathing technique.

Their arterial blood gases were analyzed before and after 4 weeks of training program for both groups.The training protocol was done 3 times/week **.**

B. *Instrumentation :*

Using objective assessment tools including:

Blood gas analyzer

C. *Arterial blood gas test by Blood gas analyzer :*

Steps to take arterial blood gas sample according to Verma and Roach(2010)(11)

- Blood is usually withdrawn from the radial artery as it is easy to palpate and has a

good collateral supply

- The patient's arm was placed palm-up on a flat surface, with the wrist dorsiflexed at 45.
- A towel might be placed under the wrist for support.
- The puncture site should be cleaned with alcohol or iodine, and local anaesthetic should be infiltrated (which make arterial puncture less painful)
- The radial artery should be palpated for a pulse, and a pre-heparinised syringe should be inserted at an angle just distal to the palpated pulse.
- After the puncture, sterile gauze should be placed firmly over the site with direct pressure applied for several minutes.
- It was important to deliver the sample for analysis promptly. If there was any delay in processing the sample, the blood might be stored on ice for approximately 30 minutes with little effect on the accuracy of the results.

C Treatment procedure

Group (A):

Flutter Treatment according to Myers(2007)(12):

1- The patients were seated in erect positions; in a well-supported chair with a neutral lumbar spine to enhance the function of the diaphragm and head was slightly tilted upward so the upper airway is wide open.

2- They were instructed to inhale deeply and hold their breath for 2-3 second,

3- The patient placed the flutter device mouthpiece in the mouth and each patient was asked to exhale slowly through the Flutter, which cause oscillations of the steel ball inside the cone of the Flutter.

4-Routinely, three sets of 15 exhalations are performed over 12–20 minutes.

5-After each series of exhalations, patients were instructed to "huff" and cough, thereby aiding expectoration.

As the generation of oscillation and pressure are dependent on the expiratory flow and gravity forces, the frequency of the oscillations was modulated by changing the inclination of the Flutter device slightly up or down from its horizontal position. The neutral position (or zero degrees) is considered the one which the device has an angle of 90 degrees with the head position, i.e., parallel to the ground. In general, with the device turned upward (positive degrees) the pressure and oscillation were increased, while turned the device downward (negative degrees), the pressure and oscillation were decreased.

Group (B):ACBT: according to **(Eaton et al 2007)**, the patient seated comfortably in a standard chair and trained to do the following steps: **(13)**

Stage 1 Chest expansions

1. Breathe gently at normal rate and depth using the lower chest (breathing control)
2. -Breath in slowly and deeply using the lower chest, Pause
3. -Breathe out fully but NOT FORCEFULLY
4. -Repeat for a further two breaths
5. -Return to breathing control
6. -Take three further slow deep breaths as in steps 2–4
7. -Return to breathing control

Stage 2 Sputum Removal (Forced Expiratory Technique)

1. Take a slightly bigger than normal breath in.
2. Open your mouth and keep it O shaped.
3. Breathe out more forcefully using your abdominal muscles to assist. This should sound like a forced sigh. This is described as Huffing.
4. Repeat
5. Return to breathing control
6. Cough to clear sputum if necessary
7. Return to breathing control until you are ready to begin another cycle

End points

1. -Two non-productive cycles plus clear huff, record time and continue to 10 minutes
2. -Two non-productive cycles plus clear huff and completed minimum time (10 minutes)
3. -Terminated by patient or physiotherapist for other reasons
4. -Still productive or huff not clear and reached maximum time (30 minutes)

RESULTS:

Comparison between pre and post according to all parameters in group A: Flutter:

The mean values±SD of **PH** before treatment was 7.37±0.04 and after treatment was 7.41±0.03. The mean difference was 0.04±0.05 and the percent of improvement was 0.5%. There was highly significant difference in PH between pre and post treatment (p <0.001**) shown in table (1).

The mean values±SD of **Spo2** before treatment was 91.91±4.44and after treatment was 94.95±2.67. The mean difference was 3.05±2.89and the percent of improvement was 3.3%. There was highly significant difference in Spo2 between pre and post treatment (p <0.001**) shown in table (1),.

The mean values±SD of **Paco2** before treatment was 46.88±10.50 and after treatment was 39.82±7.79. The mean difference was -7.06±6.and the percent of improvement was -15.1%. There was highly significant difference in Pac02 between pre and post treatment (p <0.001**) shown in table (1).

The mean values±SD of **Pao2** before treatment was 69.30±18.24 and after treatment was 78.45±11.94. The mean difference was 9.15±8.24 and the percent of improvement was 13.2%. There was highly significant difference in Pa02 between pre and post treatment (p <0.001**) shown in table (1)

Table (1): Comparison between pre and post according to all parameters in group A: Flutter

Parameters	Pre *(n=20)*	Post *(n=20)*	Diff.	Change%	Paired t-test	p-value
pH	7.37±0.04	7.41±0.03	0.04±0.05	0.5%	-3.782	<0.001**
Spo2%	91.91±4.44	94.95±2.67	3.05±2.89	3.3%	-4.719	<0.001**
PACO2 (mmHg)	46.88±10.50	39.82±7.79	-7.06±6.30	-15.1%	5.008	<0.001**
PAO2 (mmHg)	69.30±18.24	78.45±11.94	9.15±8.24	13.2%	-4.965	<0.001**

Comparison between pre and post according to all parameters in group B: ACBT:

A. *The mean values±SD of **PH** before treatment was 7.39±0.06 and after treatment was 7.40±0.04.The mean difference was 0.00±0.03and the percent of improvement was 0.1%. There was no significant difference in PH between pre and post treatment (p=0.575) shown in table (2), figure (2)*

The mean values±SD of **Spo2** before treatment was 92.71±3.89 and after treatment was 93.71±2.87. The mean difference was 93.71±2.87 and the percent of improvement was 1.1%. There was significant difference in Spo2 between pre and post treatment (p= 0.014*) shown in table (2), figure (2)

The mean values±SD of **Paco2** before treatment was 47.83±11.13 and after treatment was 44.39±9.96. The mean difference was -3.44±3.12 and the percent of improvement was -7.2%. There was highly significant difference in Pac02 between pre and post treatment (p <0.001**) shown in table (2)

The mean values±SD of **Pao2** before treatment was 73.00±13.15 and after treatment was 76.25±13.02. The mean difference was 3.25±2.67 and the percent of improvement was 4.5%. There was highly significant difference in Pa02 between pre and post treatment (p <0.001**) shown in table (2)

Table (2): Comparison between pre and post according to all parameters in group B: ACBT

Parameters	Pre *(n=20)*	Post *(n=20)*	Diff.	Change%	Paired t-test	p-value
pH	7.39±0.06	7.40±0.04	0.00±0.03	0.1%	-0.571	0.575
Spo2%	92.71±3.89	93.71±2.87	1.01±1.66	1.1%	-2.709	0.014*
PACO2 (mmHg)	47.83±11.13	44.39±9.96	-3.44±3.12	-7.2%	4.926	<0.001**
PAO2 (mmHg)	73.00±13.15	76.25±13.02	3.25±2.67	4.5%	-5.438	<0.001**

DISCUSSION:

This study was assigned to compare the effect of flutter versus active cycle of breathing technique on arterial blood gases in COPD patients.. Forty men patients with moderate to severe COPD were included in this study. All patients assigned randomly into two equal groups of 20 patients in each group. Group (A):included 20 patients were received their medical

treatment and flutter device. Group(B): included 20 patients were received their medical treatment and active cycle of breathing technique. Their arterial blood gases were analyzed before and after 4 weeks of training program for both groups.The training protocol performed 3 times/week .

The results of the present study represent percentage of improvement for group (A) and (B): Group(A) flutter group, showed a statistical significant improvement in ABG parameters (PH, Sp02, Paco2 and Pao2) that was (0.5%, 3.3%, -15.1%, 13.2%) respectively, more than the improvement in group (B) ACBT group, that was (0.1%, 1.1%, -7.2%, 4.5%) respectively.

According to **(Farag and EL-Syed 2018)** whose results got strong evidence about the effectiveness of high frequency chest wall oscillation (HFCWO) vest system and Flutter devices in the treatment of patients with AECOPD. Post treatment assessment for both HFCWO and Flutter groups demonstrated that oxygenations parameters (PaO2, SaO2 %) they concluded that Both vest HFCWO and Flutter device are highly effective in treatment of patients with AECOPD in terms of improvement in ventilatory function and oxygenation parameters with better exercise tolerance, which agreed with the result of this study. **(6)**

The results shown by **Jahan et al (2015)** which evaluated the effects of short term treatment of flutter device and autogenic drainage (AD) in patient with chronic obstructive pulmonary disease (COPD). They observed significant change in oxygen saturation but there was no statistically significant difference between the groups. There was an improving oxygen saturation (Spo2) in both groups, which comes in agreement with this study. **(14)**

Also, the results declared by **Sheraz et al (2015)** who studied the blood gases and oxygen saturation response to active cycle of breathing techniques in COPD patients during phase 1 of cardiac rehabilitation. There was highly significant difference in ABG, oxygen saturation, and other vitals of the patients after the treatment with ACBT as compared to conventional chest physical therapy. (15)

Moreover **Puneeth et al 2012**in their study concluded that both Postural drainage and ACBT have significant effect in clearing airways and thereby improving pulmonary function in bronchiectasis, Active cycle of breathing technique has a better effect in clearing the airways than postural drainage and thereby improving pulmonary function in patients with bronchiectasis. The ACBT increased forced vital capacity, peak expiratory flow rate, arterial oxygenation and exercise performance. And this was evident through Arterial Blood gas analysis,which coincided with the result of this study. **(16)**

The results of this study coincided with the results shown in **Finder 2010** who reported that most airway oscillation devices (Acapella, Flutter and others), which deliver OPFP (Oscillatory positive expiratory pressure) are effort dependant. The OPEP achieved by using the flutter facilitate the opening of the airways and loosening of trapped mucous.**(17)**

Also **Savcı S. (2006):** concluded that active cycle of breathing technique (ACBT) improves oxygen saturation through improved arterial oxygenation, functional capacity. Both physiotherapy methods ACBT and incentive spirometer (IS) had similar effects on the rate of atelectasis, pulmonary function and oxygen saturation, which coincided the results of this study.**(18)**

The results of the study declared by **(Samir 2001)** who reported that the flutter device in combination with postural drainage had the effect of lowering PaCo2, improving ventilator function and exercise tolerance in COPD , which coincided with the results of this study. **(19)**

Also **Moiz JA et al (2007):** in their study on comparison of autogenic drainage and the active cycle of breathing techniques in patients with acute exacerbation of COPD concluded that AD is as effective as ACBT in clearing secretions and improving oxygen saturation, which comes with agreement with the results of the current study **(20)**

On the contrary of the results declared by (**Richa et al 2010)** who find that flutter is as effective as the ACBT in improving oxygen saturation without causing any undesirable effects on respiratory rate in patients with acute exacerbation of COPD . the current study showed significant improvement in Spo2 in flutter more than ACBT.**(22)**

Conclusion:

It was concluded that both flutter device and ACBT showed significant improvement in ABG in COPD patients but the flutter more is effective than ACBT. As flutter (expiratory training) produces oscillatory positive expiratory pressure that influences ABG through enhancing movement of secretions, improving lung function and oxygenation.

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