ORIGINAL ARTICLE

RC-Cornet with Active Cycle of Breathing on Pulmonary Function and Cough Difficulty in Chronic Bronchitis

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ABSTRACT

Aim: To evaluate combined effects of RC-Cornet and active cycle of breathing techniques on the following outcomes: pulmonary functions and cough difficulty scores in patients with chronic bronchitis.
Methods: Forty with moderate COPD patients (chronic bronchitis) were chosen in this study. They had 28 to 40 years old. They were divided into: Group (A; n=20{10 women, 10 men}) received an active cycle of breathing techniques (ACBT) with using The RC-Cornet, and group (B; n= 20 {10 women, 10men}) received an active cycle of breathing techniques (ACBT) only 3 times per week for 12 weeks. All patients were received postural drainage technique and continuously encouraged to maintain their medical treatment regimen throughout the study. Pulmonary functions [PEFR and the (FEV1/FVC) ratio, cough severity levels and 6MWD were determined before and after the end of the study for each patient.
Results: There was a significant increase in PEF, FEV1\FVC ratio and 6MWT after treatment in both groups compared with that before treatment but in favor to group A. There was a significant diminish in cough difficulty score after treatment in both groups compared with that before treatment but in favor to group A.
Conclusion: The combined effects of RC-Cornet and active cycle of breathing techniques have a positive impact on pulmonary function and cough difficulty scores in chronic bronchitis while ACBT only is likewise important but with less positivity.
Keywords: OPEP, Airway clearance, PEFR, exercise capacity, COPD.

INTRODUCTION

Chronic Bronchitis (CB) is a one of chronic airflow limitation which is defined by presence of chronic coughs with expectoration for at least a 3-month, which maintains for at least 2 consecutive years[1].

Chronic obstructive pulmonary disease (COPD) is defined spirometrically by a reduced pulmonary functions[2-3]. Lung function and functional capacity can be progressively worse in those patients[4].

RC-Cornet is a bended cylinder which is made of plastic comprising of a semi- elastic latex-free hose. Breathing out through the device leads to the hose to flex, buckle and unbuckle, accomplishing vibration (oscillatory PEP) in the airways. It is utilized in any position (sitting, half lying) as Cornet is not depending on gravity. Secretions can be movable to the central airways which are got out by coughing or huffing [5-6]**.**The pressure and flow rate are modified by twisting the mouthpiece which inside the tube. The Cornet device has been lowered sputum cohesiveness so it improved airway clearance. It has been advantages over the other OPEP[7].

RC-Cornet with drug therapy leads to increasing parameters of the pulmonary function test by decreasing airway resistance after 2 years in patients with chronic obstructive pulmonary disease[8].

Active cycle of breathing technique comprises of breathing control, from three to four repetitions of thoracic expansion practices then breathing control, and the expiratory method (forced expiratory technique). Active cycle of breathing technique (ACBT) can be modified according to its frequency of its components [9]. ACBT and Cornet device (as one of oscillatory devices) were used for airway clearance[10]**.**

Active cycle of breathing technique was effective in sputum expectorated easily in addition to lung function improvements in adults with bronchiectasis[11]**.** Breathing control as a part of ACBT was confirmed to improve oxygen saturation and cause bronchial dilatation while the thoracic expansion exercises assisted in the loosening of secretions, and the improvement of ventilation[12]**.**

Therefore, the purpose of this study was to evaluate effects of combined effect of RC-Cornet and active cycle of breathing techniques on the following outcomes: pulmonary functions and cough difficulty scores in patients with chronic bronchitis.

SUBJECTS AND METHODS

Subjects: Forty patients from both sexes (20 women and 20 men) were diagnosed clinically as a moderate COPD with age ranged from 28- 40 years enrolled in the study for 12 weeks. All patients fulfilled the following criteria: (1) under regular medical remediation and clinically stable, (2) Both men and women are selected (3) cooperative and motivated, and always ready for regular pursuance in outpatient clinic for 12 weeks. Obese patient, nonsmoker, Patients with heart disease, musculoskeletal (Kyphosis, scoliosis) or psychological abnormalities were excluded. They were written consent form before treatment which was followed by clinical examination then Patients were randomly split into two groups; Group A (n=20 {10 women, 10 men}) received the active cycle of breathing technique (ACBT) with The RC-Cornet 3 times/week for 12 weeks and Group B (n=20 {10 women, 10 men}) The (ACBT) 3 times/week for 12 weeks. Percussion and/or vibration were used accompanied with postural drainage in both

groups. This study was conducted from June 2018 to September 2019.

Study Design: This was twelve-week randomized controlled study.

Measurements

Anthropometric measures: The subjects' body weight, and height were obtained by weight and height scale. Body mass index (BMI) was determined with the formula; BMI = the subject's body weight [kg]/height^2 [m^2] to exclude obese subjects.

Pulmonary function test: Pulmonary functions were used to assess Forced Expiratory Volume in one second (FEV1) / Force Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR) for each patient pre-treatment and at the end of treatment for both the groups using spirometer.

Cough difficulty score evaluate (CDS : A subjective evaluates the degree of cough difficulty score was measured through a scale with five points: "very easy, easy, no change, with difficulty and very difficult"].

6-Minute walk test: The walk tests were directed in a temperature-controlled, estimated and marked hall (8 meter). The turnaround focused points were set apart with a brighten taps on ground. The tape blemishes on the floor from the starting highlight point to the highlight endpoint (every 8-m). Causes for stopping a test include: Chest pain or tightness, unbearable dyspnea, or patient with pale face. Estimations: patient should sit at rest in a seat, situated close to the starting highlight point, for 15 minutes preceded the test. Patient was asked to walk like his maximal routine walking, attempting to go however much distance as could reasonably be expected inside 6 minutes. They were instructed at regular intervals (30 sec.) to walk quickly without running, the examiner recorded the time using stopwatch and the distance walked was calculated[14].

Interventions

ACBT: The ACBT includes breathing control, thoracic expansion exercises, and the forced expiration technique (FET) [15]:

1- At first, **breathing control** is applied by each patient through gentle quite breathing, at his or her rate and depth.

2-Then, Thoracic expansion exercises which consist of deep breathing during breath-in then hold the air inside the lung for 3-4 seconds after that breathing out passively. **Thoracic expansion exercises** repeated for 2 times then asking patient to do breathing control for 2 times which is followed by 2 times of **Thoracic expansion exercises then** breathing control for 2 times.

3-At the last, the one or two **huffs** are interspersed with a breathing control .Huffing includes deep inspiration without holding the air then active expiration from mouth through a forced sigh after that ask patient to cough (if needed)which is followed by breathing control. Huffing helps secretions to get out from the periphery. Then repeat the previous all cycle.

Each cycle lasted for 2 minutes and ACBT was repeated for 20 min with postural drainage positions (using also, percussion and /or vibration).

RC-Cornet: The Cornet comprising of a semi-circular tube containing a flexible latex- free hose. Patients were instructed to hold her/his lips onto the mouthpiece firmly from sitting or half lying position and take a deep breath in through nose and blow through RC-Cornet. A rough, low-pitched sound and vibration will be felt in the patient's chest; this was replicated 10 repetitions for 6 sets (10 minutes) with relaxation in between them, and then Pursued by huff and cough. The vibration and PEP in the airway was elevated by turning the mouthpiece of the RC-Cornet. In addition to generation of pressure and airflow oscillations during breathe out[16-17].

Statistical analysis: Descriptive statistics and t-test were carried in for comparison of subject criteria between both groups. Normal data distribution was determined though the Shapiro-Wilk tests. Levene's test for homogeneity of variances was carried in because of testing the homogeneity between groups. Two-way MANOVA was performed to compare within and between groups effects on PEF, FEV1\FVC and 6 MWT. Post-hoc tests by using the Bonferroni correction were carried out for subsequent multiple comparison. Modified cough difficulty score was compared between groups by Mann–Whitney U test and between pre and post treatment in each group by Wilcoxon Signed Ranks. The level of significance at $p < 0.05$ was used. Statistical analysis was carried by SPSS version 25

Ethical approval: The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the principles of the Declaration of Helsinki, and was approved by the Ethics Committee of Scientific Research of the Faculty of Physical Therapy, Cairo University.

Informed consent: Informed consent was received from all participants involved in this investigation.

RESULTS

Subject criteria: Table (1) showed the subject criteria of the study and untreated groups. There was no significant difference between both groups in the mean age, weight, height and BMI ($p>0.05$).

Table 1.: Comparison of subject criteria between the group A and B:

	x̄±SD		MD	t-value	p-value
	Group A	Group B			
Age (years)	34.95 ± 3.67	36 ± 4.3	-1.05	-0.82	0.41
Weight (kg)	70.7 ± 5.78	69.85 ± 7.4	0.85	0.4	0.68
Height (cm)	162.6 ± 4.83	163.8 ± 7.83	-1.2	-0.58	0.56
BMI (kg/m^2)	26.73 ± 1.88	25.96 ± 1.64	0.77	1.39	0.17
Females/Males	10/10	10/10			

x̄, Mean; SD, Standard deviation; MD, Mean difference; p-value, Probability value

Effect of treatment on PEF, FEV1\FVC and 6 MWT: Two-way MANOVA revealed that there was a significant interaction of treatment and time (F=9.34, p=0.001). There was a significant main effect of time (F=212.1, p=0.001).There was a significant main effect of treatment (F=3.12, p=0.03). Table 2 showed descriptive statistics of PEF, FEV1\FVC and 6 MWT changes and the significant level of comparison between groups as well as significant level of comparison between before and after treatment in each group.

Regarding within group comparison, there was a significant increase in PEF, FEV1\FVC and 6 MWT after treatment in the group A and B compared with that before treatment (p<0.001).

Regarding between group comparisons, there was no significant difference between two groups prior to treatment (p>0.05). A comparison between groups after treatment reported the significant increase in PEF, FEV1\FVC and 6 MWT of the group A in comparison to group B (p<0.05).

Effect of treatment on cough difficulty score: There was a significant decrease in cough difficulty score after treatment in the group A and B compared with that before treatment (p<0.001). There was a significant decrease in cough difficulty score of the group A compared with that of the group B after treatment (p=0.03), table 3).

Table 2**:** Mean PEF, FEV1\FVC and 6MWT before and after treatment of the group A and B:

	Group A	**Group B**		
	x̄±SD	**x̄±SD**	**MD (95% CI)**	**P-value**
PEF(L\min)				
Before treatment	140.35 ± 25.85	135.2 ± 16.21	5.15 (-8.66:18.96)	0.45
After treatment	179.9 ± 17.8	164 ± 15.16	15.9 (5.31:26.48)	0.004
MD (95% CI)	-39.55 (-48.28: -30.81) ***p = 0.001***	-28.8 (-37.53: -20.06) ***p = 0.001***		
FEV1\FVC (%)				
Before treatment	59.95 ± 4.53	60.75 ± 3.32	-0.8 (-3.34:1.74)	0.52
After treatment	68.1 ± 2.91	64.8 ± 2.85	3.3 (1.45:5.14)	0.001
MD (95% CI)	-8.15 (-9.44: -6.85) ***p = 0.001***	-4.05 (-5.34: -2.75) ***p = 0.001***		
6 MWT (meter)				
Before treatment	247.95 ± 23.8	240.15 ± 19.97	7.8 (-6.26:21.86)	0.26
After treatment	290.5 ± 24.73	273.65 ± 18.97	16.85 (2.73:30.96)	0.02
MD (95% CI)	-42.55 (-47.89: -37.2) ***p = 0.001***	-33.5 (-38.84: -28.15) ***p = 0.001***		

$\bar{X}$, Mean; SD, Standard deviation; MD, Mean difference; CI, Confidence interval; p-value, Level of significance

Table 3**:** Median values of cough difficulty score before and after treatment of group A and B:

	Group A	Group B		
Cough difficulty score	**Median** (IQR)	**Median** (IQR)	U- value	p-value
Pre treatment	5 (5,4)	4(5,4)	148.5	0.12
Post treatment	1 (2,1)	2 (2,1)	128	0.03
Z- value	4.17	4		
	p = 0.001	*p = 0.001*		

IQR, inter quartile range; U- value, Mann-Whitney test value; Z- value, Wilcoxon signed ranks test value; p-value, level of significance

DISCUSSION

Our study showed that an active cycle of breathing techniques (ACBT) with using The RC-Cornet device were more effective in airway clearance in cases of COPD (chronic bronchitis). Pulmonary functions, cough difficulty scores and 6MWD after using ACBT with The RC-Cornet were showed greater improvement than ACBT alone.

This improvement is due to the explanation of Muthukumar and Thekkinkattil[18] who reported that the oscillating pressure created inside cornet could dilate the bronchi and bronchioles, leading to moving the secretions from the bronchial walls and the cornet could make mucus thinner so diminishing its viscosity. During breathing out, the pressure of the first valve increased, so the air entered inside the second component and the air opened the valve of cornet in the same time the first valve closed. The mouth piece could be changed in any direction leading to rotation of the hose. So, the oscillation pressure was elevated causing mucus to vibrate more and directed it from distal to proximal.

Regarding effect of cornet on the pulmonary function; the significant increase in the RC-Cornet with ACBT group is consistent with the study by Cegla et al[8] who reported that the PFT was increased by decreasing

airway resistance in a long-term study (2 years) for COPD using RC-Cornet with drug therapy[8]. The pressure and airflow oscillations generated by expiration through RC-Cornet are imparted to the bronchial tree by way of mouthpiece, causing caliber fluctuations in the bronchi and thus helping to prevent respiratory tract collapse[19]. So pulmonary function augmented similar to our study.

Cegla et al[5] appreciated that RC-Cornet is a comfortable and effective for patients with COAD. They found that hyperventilation and residual volume were significantly deceased and the subjective sputum improved but with no statistically significant because of short duration of study for about one week [5].

Regarding effect of cornet on the cough difficulty scores; Depending on the study of **Muthukumar and Thekkinkattil** [18] who reported that cornet device is more effective to clear the thick secretions in pneumonia as it caused improvement of chest x-ray in lower lobe. Also, respiratory rate and dyspnea was diminished due to improvement in gases exchange after clearance of secretions. They reported that Cornet device was easy to use as a home program.

Prasad et al. [7] reported that the Cornet had favor over than other devices because of producing more pressure constant and more flow rate throughout breathing out so sputum cohesiveness would reduce[7]. So sputum was easy to dislodge from airways then getting out through cough[20].

The Cornet device affects airways distally through pores of Kohn and it destroys the cross linking bonds such as the disulphide bridges and changes of macro molecules to micro molecules[20-21]. This effect can be physiologically explained by 1) Oscillating positive pressure prevent airway collapse through causing increases in the airways diameter. 2) The pressure causes vibrations within the airways that displace the secretions into the airway lumen. 3) Repetitive acceleration of exhaled air flow resulting in forced secretions from the distal to central airways[21-22]**.**

Regarding effect of OPEP devices on the PEFR and 6MWD; the effective results for alternative chest physiotherapy devices a study done by El-Nahas et al[23] who studied the effect of OPEP device on improvement of peak expiratory flow rate and the 6MWD of COPD; they declare that, the benefit of removal of secretions improves the ventilation perfusion ratio which also reflects the view with our study.

Regarding effect of ACBT on the pulmonary function; Results of this study showed significant improvement in the PFT parameter according to Jaiswal and Das[24] who concluded that FEV1 improvement was due to decreasing in the airway resistance and the air reaches the periphery due to relaxation and expansion produced by ACBT. For FVC, it was due to opening of the alveoli which assisted in reducing the airway resistance through clearance of the secretion.

Mikelsons[25] proved that the use of FET (as a part of ACBT) has additionally been pronounced to be powerful in getting out of sputum in COPD which improved the FEV1/FVC parameters. Also, Muselema et al[26] supported that improvement in FEV1/FVC ratio after 12 weeks of treatment with ACBT.

Nisha and Shinde[27] conducted that body position maintained opening of airways in COPD patients during forced expiration in standing, the higher lung recoil and chest wall combined with more pressure produced by contractions of abdomen which pushed the air at fast speed by the narrowing airways leading to higher PEFR.

Also, Patterson et al[28] appreciated that the improvement of PEFR after single sessions of treatment with ACBT in patients with bronchiectasis. In recent studies by Utama[29] who supported us through declaring that there was an increase of PEFR grade following the treatment with ACBT in asthma patients after the third week and the fourth week[29]. The immediate impact of ACBT in airway clearance in chronic bronchitis subjects showed significant increase in PEFR[30].

Paneeth et al. [31] stated that active cycle of breathing technique combined with postural drainage improved the lung function related to FVC, FEV1and SPO2 in cases with bronchiectasis but in favor to ACBT.

Eaton et al. [15] who had suggested that efficacy of ACBT with postural drainage within a week was superior to both ACBT alone as evaluated by acute sputum production [15].

Regarding effect of ACBT on cough difficulty scores; Üzmezoğlu et al[32] stated that after 4 weeks of ACBT, It was associated with a decrease in the number of patients who had cough, wheezing, and fatigue. The large amount of sputum got out easily after using ACBT.

Pryor et al[33] designed a long-term (one year) to compare the ACBT, RC-cornet, flutter, and PEP which was supported that the effectiveness of previous techniques in adults for airway clearance.

Panaligan et al[34] reported that the mean sputum volume was increased after 3 days of ACBT among patients with COPD. In addition to sputum got out easily than before using ACBT.

Regarding effect of ACBT on 6MWD; Elsayed et al[35] reported that there was a significant progress in 6 minute walk distance and decreases in dyspnea after 3 times/week of ACBT in patient with bronchiectasis for two months. Also, Monisha and Muthukumar[36] came in agree with that using ACBT improved 6 minute walk distance.

CONCLUSION

The combined effects of RC-Cornet and active cycle of breathing techniques have a positive impact on pulmonary function and cough difficulty scores in chronic bronchitis while ACBT only is likewise important but with less positivity.

Disclosure statement: The author does not have any financial interest or any financial means from this research

Conflict of interest: None

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