A comparison of autogenic drainage and the active cycle of breathing techniques in patients with acute exacerbation of chronic obstructive pulmonary disease

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ABSTRACT

Purpose: The effect of a short term treatment of autogenic drainage (AD) and active cycle of breathing techniques (ACBT) were evaluated in patients with acute exacerbation of chronic obstructive pulmonary disease (COPD)

Methods: Thirty male COPD patients with acute exacerbation were trained and randomly assigned into two groups and they performed each technique on successive days in a within subject randomized two day cross over design. The experiment was conducted in ward / IMCU in Escorts hospital, Faridabad. Following dependent variables were measured before treatment, during treatment, immediately after treatment and 30 minutes after treatment, sputum volume, SpO2, heart rate, PEFR, respiratory rate, VAS and patients preference.

Results: Data was analyzed using SPSS 11.5 for window version. Between the treatment means analyzed for difference using paired t-test. General linear model repeated measure of variance (ANOVA) was used to examine the changes in dependent variables; level of significance was set at $p < 0.05$. There was statistically significant difference SpO2, HR, and VAS between the treatments however none of these changes was clinically significant. Within treatment analysis showed both the treatments were equally effective in removing secretion, improving oxygenation and thereby decreasing dyspnea.

Conclusion: The results of this study indicates that AD is as effective as the ACBT in acutely clearing secretions and improving oxygen saturation without causing any undesirable effects on heart rate respiratory rate and breathlessness in patient with acute exacerbation of COPD. These techniques can be used in COPD exacerbations according to patients' and the physiotherapists' preferences.

Key words: Autogenic drainage, active cycle of breathing techniques, acute exacerbation of COPD, airway clearance techniques

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality. It affects about 4-10% of the global population[1]. The World Health Organization estimates that COPD causes 4.7 million deaths annually, making condition the fifth leading cause of global mortility.[2] About 18 million Indians 5 percent men and 2.75 percent women above the 30 years of age are already suffering from this disease.[3] Cigarette smoking is the most important factor for COPD: 15-20% of smoker develop clinically important airway obstruction.[4]

Global initiative of chronic obstructive lung disease (GOLD) [5] defined COPD as "a disease state characterized by air flow limitation that is not fully reversible. Airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lung to the noxious particles or gases". In addition to their chronic disease patients with COPD often experience regular acute exacerbation (typically around 2-3 per year). [10,11] Anthonisen et al.[12] in1987, defined acute exacerbation of

COPD (AECOPD). This definition is based on the presence of specific symptoms in patient with COPD, namely increased dyspnea, sputum volume and sputum purulence. Airway mucus hyper secretion is a cardinal feature of COPD. Mucus hyper secretion, implicit in term chronic bronchitis, is one of the physiological entities comprising COPD. The increased mucus is associated with goblet cell hyperplasia and submucosal gland hypertrophy. The number of ciliated cells and ciliary length is decreased in patient with chronic bronchitis[6]. These abnormalities coupled with mucus hyper secretions are associated with reduce mucus clearance and airway obstruction. Retained airway secretions can form mucous plugs and bronchial casts that cannot be expelled by coughing. Airway plugging causes impaired ventilation, resulting in lower ventilation – to-perfusion ratios. Increased airway resistance to airflow and air trapping result in hyperinflation of the chest and inspiratory loading of the respiratory muscles, leading to fatigue.[7]

Chest physiotherapy (CPT) is effective in clearing secretions from the lung of the patients with copious secretion. The conventional treatment for many years was postural drainage (PD) with percussion. Deleterious effects have been associated with manual techniques including arterial desaturation, bronchospasm, atelectasis, increased oxygen consumption and metabolic and hemodynamic disturbances.[8] In recent years new method have been adopted among which are Autogenic drainage (AD) and Active cycle of breathing technique (ACBT). The AD has been compared with postural drainage and chest clapping and it was concluded that the AD was less likely to produce oxygen desaturation may be better tolerated by patients while producing similar benefits.[9]Short term effect of postural drainage (PD), FLUTTER and expiration with glottis open in the lateral posture (ELTGOL) compared in acute exacerbation of chronic bronchitis and concluded that all the treatments were safe and effective in removing secretion causing undesirable effect on oxygen saturation but FLUTTER and ELTGOL techniques were more effective in prolonging secretion removal than PD method.[10] Savci et al. studied the effect of long term treatment of AD and ACBT in 30 male stable COPD patient and concluded that AD is as effective as ACBT in clearing secretion and improve lung function[11]

The literature is confusing with comparison between and among regimens making the interpretation difficult. No studies to date have determine the efficacy & which of these two techniques is superior for improving oxygen saturation, sputum production, pulmonary function, patient tolerance & patient choice of treatment in acute exacerbation of COPD. This study was designed to compare the short-term effect of AD &ACBT in acute exacerbation of COPD. Based on the findings, appropriate airway clearance techniques could be used in these patients.

Methods

Patients : Thirty male COPD patients age group of 41-65 years with mean ±SD age 54.46 ± 7.69 yrs, height of 1.68 ± 6.45 m, and weight of 63 ± 7.07 kg. All were admitted in the hospital for treatment of there acute exacerbations were included in the study.

The acute exacerbation of COPD was defined as "1 of 3 symptoms i.e. worsening of dyspnea; increase in sputum purulence; increase in sputum volume[12] as well as 1 of the following: upper respiratory tract infection in past 5 days; fever without apparent cause; increased wheezing; increased cough; or increase respiratory rate or heart rate by 20% above base line."[13] subjects with coexistent medical problem like angina, neurological deficit, orthopedic abnormality, uncontrolled diabetes or hypertension, TB, asthma, bronchiectasis, indication for ventilatory support, hemodynamic instability, cor pulmonale, GOLD stage iv, pulmonary embolism, previous abdominal surgery, hernia, pneumothorax, polycythemia, CHF, were excluded from the study.

Interventions : On the day autogenic drainage was performed patient was advised to sit and relax with neck slightly extended. He was also asked to clear the upper airways (nose or throat) by huffing or blowing nose the patient began by performing the diaphragmatic breathing at low lung volume inspiration was

slow with a pause of three seconds, and expiration was done as a sigh with an open glottis and with high velocity as possible but no forced expiration. During this low lung volume breathing, expiration was encouraged down to the expiratory reserve volume. When the patient felt secretions to be moving, the volume of inspiration became deeper and expiration did not go down as far as expiratory reserve volume. As the secretions moved up the bronchial tree to the large airways the patient performed higher lung volume breathing, tidal volume to inspiratory reserve volume. Only when the secretions were felt to be as high as possible did expectoration occur. The patients were taught to suppress the cough to allow this the cycle of breathing exercise was repeated through out the 30-minute treatment session

On the day ACBT was performed, the patients' position was sitting with back supported. ACBT was performed several times, commencing with tidal volume breathing with the lower chest (breathing control) for approximately six breaths, followed by 3-4 deep inspirations of full capacity, and then another period of breathing control. Finally, the patient performed one or two forced expirations (huffs) from mid to low lung volume. If secretions were felt to be high enough in the proximal airways a huff was performed at higher lung volume. Patients were encouraged to cough and expectorate only if secretions were high enough. After the huff and or cough a further period of gentle lower chest breathing control was performed, and the cycle repeated through out the 30-minute treatment session

Data acquisition and measurements:

Subjects meeting inclusion /exclusion criteria received proper training of AD and ACBT. Training was one to two initial one- hour sessions with or without one to three 30-40 minute follow-up sessions. As the subject trained, was randomly assigned to a group. Subjects in 'Group A' treated with AD on the first test day and ACBT on the second test day. Subjects in 'Group B' treated with ACBT on first test day and AD on the second test day. All the treatment sessions were performed under supervision and at the same time of the day. All the usual medications were administered during the study days; the inhaled and/or nebulised treatments were standardized and administered before the study interventions and were the same on all study days.

Following dependent variables were collected before treatment, 15 minutes after treatment, immediately after treatment and 30 minutes after treatment.

Expectorated sputum

Any sputum produced during and following either the treatment was collected into the same plastic beaker (labeled mL scale) and volume measured in milliliters.

Arterial oxygen saturation and heart rate

The content of oxygen combined with hemoglobin in the arterial blood and hart rate were measured with a standard pulse oximeter (NANOX 2).

Peak expiratory flow rate (PEFR)

A Mini Writ's Peak Flow Meter was used .All the subjects were encouraged to produce maximal effort and the procedure was demonstrated. The meter was made to zero. Subjects were asked to inhale completely, quickly place the peak flow meter into the mouth and to make a seal around the mouthpiece with the lips. It was made sure that the mouthpiece was past through the patients teeth and not occluded by the tongue. Immediately then the subjects exhaled completely with maximal force the reading was taken as shown in the Peak Flow Meter. This measurement was repeated for two more times. The best one was taken for the record.

Respiratory Rate (RR)

Respiratory rate was recorded as observation of number of thoracic excursion for one minute.

Visual Analog Score (VAS)

Immediately prior to treatment the subject received the same instructions in the use of a 10 cm horizontal visual analog scale with anchor descriptors of 'Not at all breathless' and 'Severely breathless'. The subject was then requested to rate the intensity of their breathlessness by marking a point on the line. This was repeated immediately following

treatment without the subject viewing the initial recording

Patient preference

At the end of the second treatment day subjects were asked which treatment they preferred and recorded.

Data analysis

Data analysis was performed using the software package SPSS for windows version 11.5 (SPSS Inc., Chicago, U.S.A) and STATA 7.0. STATA was used to find mean and standard deviation of Age, Height, and BMI of all patients and of the variables. Paired t- test was used to compare Sputum Volume, Heart Rate, PEFR, Respiratory Rate, VAS between the two treatments (AD& ACBT) at Before Treatment, During Treatment, Immediately After Treatment, 30 Minutes After Treatment (same subject design). Paired t- test was used to compare VAS scores before and after treatment for both the techniques.

The general linear model, repeated measure analysis of variance (ANOVA) was used to examine changes in all dependent variables; the within subject factor was time which was measured at four intervals: before treatment, during treatment, Immediately after treatment and 30 min. after treatment. The significant level set for this study was 95% ($p< 0.05$).

Results

Sputum Volume : The mean volume of sputum expectorated during AD was greater than of the ACBT and was not affected by the order in which the treatment were given (Figure 1) but this difference was very small and found statistically non significant ($p >0.05$). However, intra- treatment multiple pairwise comparisons were made i.e. post hoc analysis was done that revealed that both the treatments were equally effective in removal of secretion the significance level was same for AD ($p = 0.00$) as well as ACBT ($p= 0.00$).

Arterial Oxygen Saturation (SpO2) : The men SpO2 gradually increases during treatments. Immediately after treatment the mean Spo2 for AD and ACBT were 94.2 and 92.7 respectively. This difference between two treatments was statistically significant with $p = 0.043$ (Fig. 2) Within treatment analysis shows significant increase in SpO2 in both the treatments when compared to their base line values ($p<0.05$).

Heart Rate (HR) : The mean heart rate increases gradually during the treatments. (Fig.3) However, the increase in HR was more in AD than in ACBT mean 83.7and 82.2 respectively. This difference was very small but found statistically significant ($p=0.043$). Heart rate tends to decrease gradually after treatment and at 30min after treatment it reaches nearly to its baseline.

Peak Expiratory Flow Rate (PEFR) : There were no significant differences in PEFR comparing both the treatments. (Fig.4) Within treatment analysis shows significant increase in PEFR during ACBT ($p=0.000$) however, it was non significant during AD treatment ($p>0.05$).

Respiratory Rate (RR) : There was no significant difference between the treatments for the respiratory rate with $p >0.05$ (Fig.5), intra treatment analysis multiple pairwise comparison made that is post hoc analysis was done that revealed non significant change in respiratory rate in both the treatments immediately following treatment. Respiratory rate significantly decrease 30 min after treatment when compared to their baseline values, in AD and ACBT significance level was $p = 0.001$ and $p = 0.016$ respectively.

Visual Analog Scale (VAS) : Paired t-test was used to compare resting VAS scores with immediately after treatment VAS scores for both the treatments. (Fig.6) In AD and ACBT after treatment VAS scores decreased significantly with significance level $p = 0.000$ and $p =0.008$ respectively. In AD the mean VAS score decrease more than ACBT this difference was statistically significant with $p = 0.007$.

Patient Preference : Twelve patients preferred autogenic drainage, fourteen patients preferred ACBT, three patients preferred both, and one patient had no preference.(Fig.7)

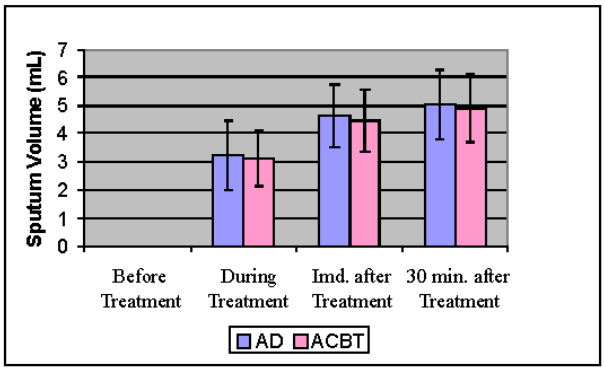

Fig. 1 Comparison Of Sputum Volume Between Two Treatments

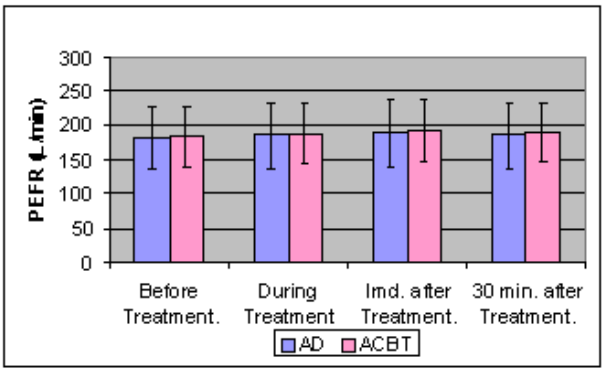

Fig. 4 Comparison Of Peak Expiratory Flow Rate Between Two Treatments

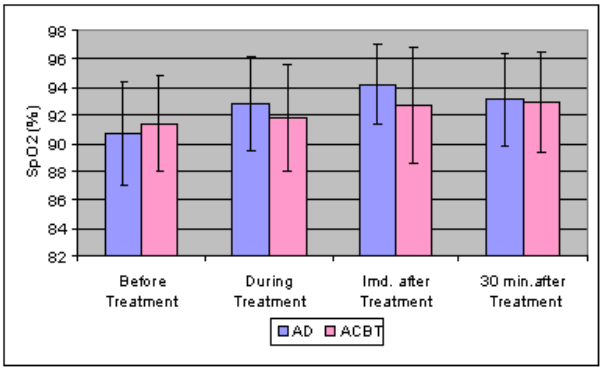

Fig. 2 Comparison Of Arterial Oxygen Saturation Between Two Treatments

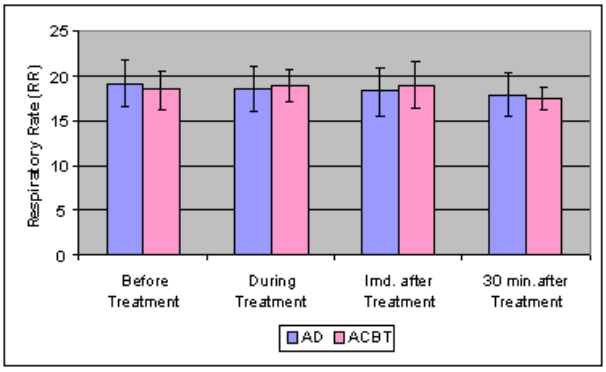

Fig. 5 Comparison Of Respiratory Rate Between Two Treatments

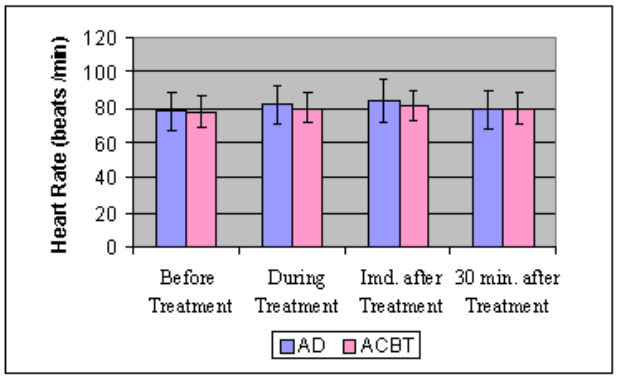

Fig. 3 Comparison Of Heart Rate Between Two Treatments

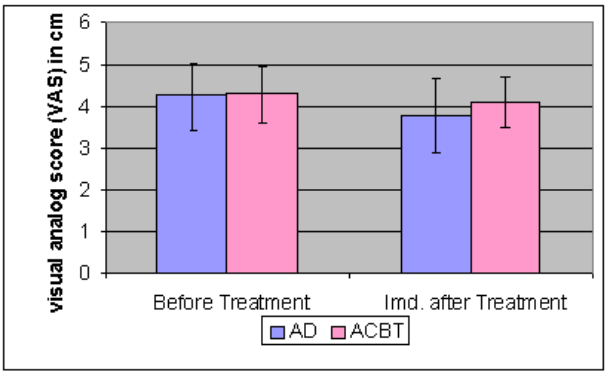

Fig.6 Comparison Of Visual Analog Score Between Two Treatments

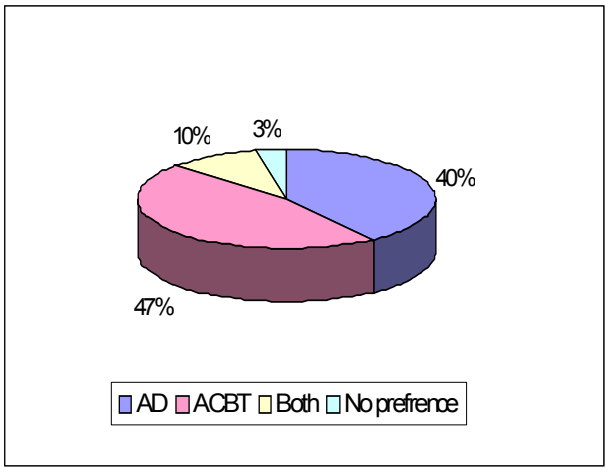

Fig. 7 Patients' Preference For The Treatments

Discussion

This study was designed to compare the effectiveness of two airway clearance techniques in acute exacerbation of COPD. It was a randomized crossover study .The results clearly demonstrated that there was no over all difference between the two treatments. In this study both the treatments found equally effective in sputum clearance however, no significant difference was found in sputum volume between the treatments. Similar observations have been reported by Millar et al[14] comparing AD with ACBT in cystic fibrosis patients, observed no significant difference in sputum weight between the two methods.

In this study sputum volume is measured because it is a simple non- invasive short-term clinical outcome measures of the effectiveness of airway clearance technique. It has been suggested that sputum volume or weight is misleading, as unknown quantity of saliva may be included.[15] Radio aerosol tracer[16] method has been suggested to evaluate the secretion clearance, but it raises serious ethical concerns and is therefore, being used in very few centers. It is further suggested that sputum volume is misleading as it may be swallowed or individual have difficulty in expectorating. [17] The subjects in this study were accustomed to expectorating sputum and treatment sessions were supervised by physiotherapist who discouraged subjects from swallowing sputum.

We cannot say whether the changes found in our study were independent of treatment, although we are looking for definite improvement in airway clearance rather than simply changes.

In this study subjects were demonstrated a significant improvement in oxygen saturation in both the treatments. However, the tendency towards higher oxygen saturation was with AD than ACBT and therefore, the difference found statistically significant. This was very much in accordance to finding of Savci et al[11] who found that in AD treatment, the increase in oxygen saturation was significantly higher than in ACBT. In contrast Miller et al[14] found no significance difference in oxygen saturation between the treatments in cystic fibrosis patients. However, no patients dropped saturation in either method. Increase in oxygen saturation might have been the results of removal of retained mucus plugs from the airways, lead to improved alveolar ventilation, optimized ventilation- perfusion mismatch, and finally improved oxygen transport to the tissue. Elizabeth Dean.[18]

Furthermore, the reason of comparatively increased oxygen saturation during AD is not well known. However, it can be suggested diaphragmatic breathing at different lung volumes might have been the result of increased alveolar oxygen tension due to carbon dioxide washout from overall hyperventilation

As per the results, the heart rate increased in both the treatments significantly. This increase had no clinically significant impact and soon showed a trend back towards baseline, as seen by continuous monitoring of heart rate. Comparison of heart rate between two treatments yielded small but significant difference ($p = 0.043$) but this difference had no clinical relevance because immediately after treatment means of AD and ACBT were 83.70 bpm and 81.26 bpm respectively. It indicates that both the treatments were not stressful enough to cause a considerable increase in heart rate. The reason of this increase in heart rate can be explained by this theory which says that 'at low level of exercise, heart rate increases almost exclusively via vagal withdrawal, with little evidence for systemic increases in

sympathetic nerve activity until the intensity of exercise is at or above the maximal steady state'[17,19].

In airway clearance techniques PEFR is a useful outcome measure of any change in airway obstruction following short-term intervention. Both FEV_1 and PEFR are most widely used and reproducible measures of force expiration. The $FEV_1$and PEFR are well correlated but FEV_1 does not measure average flow rate over the large volume than PEFR.[20]

There was seen a substantial increase in PEFR in both the treatments. In AD, this increase in PEFR was found non significant. However, ACBT showed greater improvement in PEFR than AD. No significant difference was found comparing both the treatments. Similar findings have been reported by Savci et al[11] comparing AD with ACBT in a stable COPD patient they found increased PEFR in both the treatments, and PEFR increased more in AD than in ACBT.

There is still much controversy on correlation of sputum clearance and pulmonary function. Mucus hypersecretion can be an important contributing factor to airway obstruction. There is little doubt that copious sputum in the airways increase resistance to airflow and by blocking bronchial secretion can impair gas exchange within the lung. In patients with copious sputum, various measures of airflow resistance can be improved by airway clearance Clarke et al. [21]

Our subjects were found to have no significant change in respiratory rate during the treatments. However, both the treatments showed there is a small but significant decrease in respiratory rate 30 minutes after the treatment, reflect that both the treatments does not cause increase in respiratory rate and therefore may be safe in acute exacerbation.

Breathlessness significantly decreased in both the treatments after removal of secretion. However, this decrease was more in AD than in ACBT. Although, the difference was less but found statistically significant. This difference had no clinically significant impact because the mean difference was very less.

Future research

To give these treatments a more grounded base of practice future research need to be carried out by taking a large sample including both male and female patients.

Due to unavailability of resource this study could not included radio- aerosol tracing, continuous blood pressure monitoring, ECG during treatment, and complete PFT, future research can be embark upon with documentation of these readings.

Conclusion

The results of this study indicates that AD is as effective as the ACBT in acutely clearing secretions and improving oxygen saturation without causing any undesirable effects on heart rate respiratory rate and breathlessness in patient with acute exacerbation of COPD. These techniques can be used in COPD exacerbations according to patients' and the physiotherapists' preferences.

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