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# The effect of lung flute training on functional capacity in patients with chronic obstructive pulmonary disease

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Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is characterized by increased airways mucus secretions. The purpose of this study was to determine the effect of lung flute training on AECOPD. Subjects: Sixty men patients aged from 40-60 years old having AECOPD were included from the Chest department at El Sahel Teaching hospital. Patients were assigned into two equal groups in number. Group (A) received Lung Flute training in addition to traditional chest physiotherapy including (pursed lip breathing , percussion ,vibration , coughing &postural drainage) while group (B) received traditional chest physiotherapy only 3sessions per week for eight weeks . The data concerned with the ventilatory functions included forced expiratory volume in one second (FEV1) ,forced expiratory volume in sixth second (FEV6) , the ratio between forced expiratory volume in one second to forced expiratory volume in sixth second (FEV1/FEV6) and maximum minute ventilation (MMV) were measured at the baseline of training and after training . Six minute walk test and COPD assessment test (CAT) were also calculated. Results: The study group which used the lung flute device showed a statistical significant increase in FEV6, FEV1, MMV and 6MWTand there was no statistical significant difference between the value of difference of FEV1/FEV6 and CAT in the two groups. It was concluded that lung flute training provided an adequate physiotherapy method to the patients with AECOPD, helped in sputum expectoration and improvement of ventilatory functions, enhances patients' compliance and independence.

**Keywords: Key words : acute exacerbation , COPD , Lung flute**

## INTRODUCTION

Chronic Obstructive Pulmonary Disease is characterized by gradually progressive impairment in lung function, which is interrupted with exacerbations of varying severity. Exacerbation can be defined as “a sustained worsening of the patient’s condition, from the stable state and beyond normal day–to-day variations that is acute in onset and necessitates a change in regular medication in a patient with underlying COPD.(Rodriguez-Roisin R2000)

Acute exacerbations of COPD (AE-COPD) are caused by several factors, including respiratory tract infections, air pollution, change in temperature, allergen exposure, and interruption of medications Respiratory tract infections are the most common cause of AE-COPD implicated in 50%-80% cases (Murphy et al.,1992) and (Monso et al.,1995) .It is prevalent in COPD patients that there is mucus hyper secretion and impaired mucociliary clearance which contributes significantly to affect the quality of life (vestbo et

al.,1996) and ( Miravittles et al.,2006)

The Lung Flute is a new small self-powered audio device that has been classified by the Food and Drug Administration (FDA) to the family of Oscillatory Positive Expiratory Pressure (OPEP)devices, which includes the Flutter® and the Acapella ®(App et al.,1998) and (Patterson et al.,2005)

However, unlike traditional OPEP devices that use oscillatory back pressure, the Lung Flute has a unique mechanism of action based on acoustic energy. When blown in to with an exhalation vigorous enough to make the reed oscillate, the Lung Flute generates a sound wave of 16 to 22 Hz with an output of 110 to 115 dB using 2.5 cms H2O of pressure. This sound wave has the ability to travel down the tracheobronchial tree and vibrate tracheobronchial secretions. This vibration enhances mucociliary clearance of the lower respiratory tract hereby resulting in the induction of sputum. This functionality of the Lung Flute has been applied to sputum induction for diagnostic testing and for the enhancement of mucus clearance from the lower airways (Dataon file, Medical Acoustics). (Anjumen et al,.2013) and (Fujita et al., 2009)

So the purpose of this study was to determine the efficacy of the Lung Flute training on the functional capacity of the patients suffering from acute exacerbation of COPD.

## MATERIALS AND METHODS

### Subjects and study design:

This study aimed to determine the effect of lung flute training on acute exacerbation of chronic obstructive pulmonary disease. It was conducted in El Sahel Teaching Hospital, Cairo, the study was done from March 2017 to September 2018.Sixty men suffering from AECOPD participated in this study; they were recruited from chest department at El Sahel teaching hospital, there ages ranged from 40-60 years old. All patients were free from cardiovascular and neurological disease. They were assigned into two equal groups in number. Group A (Study Group) received training by the Lung Flute device (trainer) for eight successive weeks, 3 times per week, 5-10 minutes for each session in addition to traditional chest physiotherapy techniques(pursed lip breathing ,percussion ,vibration ,coughing and postural drainage ) 15:20 minutes for each session. Group B (Control Group) received traditional chest physiotherapy techniques (pursed lip breathing, percussion, vibration, coughing and postural drainage) for eight successive weeks, 3 times per week, 15:20 minutes for each session. The study was approved by ethical committee of Faculty of Physical Therapy, Cairo University, approval number; P.T.REC/012/001566.

### For Evaluation:

### Spirometer was used as initial evaluation (Vitalo graph copd6), Manufacturer:

Vitalograph(Ireland),Ennis, Ireland, the dual zones provide an instant indication of both the obstructive index and the COPD classification. Parameters were tested included: forced expiratory volume in first second (FEV1) ,forced expiratory volume in sixth second(FEV6),ratio of forced expiratory volume in one second to forced expiratory volume in sixth second (FEV1/FEV6) and maximum minute ventilation (MMV).Recently, increasing attention has been given to the use of the forced expiratory volume at 6 sec of exhalation (FEV6) as an alternative for FVC (Ferguson et al.,2000)

### The COPD Assessment Test (CAT):

The CAT is a validated, short (8-item) and simple patient completed questionnaire, with good discriminant properties, developed for use in routine clinical practice to measure the health status of patients with COPD, the total score for the 8- items range from 0-40. Higher scores denote a more severe impact of COPD on a patient's life. (Jones, et al., 2009) .Six minute walk test was carried out before and after interventions to determine the patient functional capacity. (ATS, 2002).

### Lung flute device Session:

### For Group A (Study Group):

Patient was sitting in a relaxed position. The patient was sitting up straight so that his back was not touching the bed or the chair. The head was slightly tilted downward so the throat was widely opened; this allowed the acoustic waves produced by the breath to flow from the LUNG FLUTE into the lungs. The patient held the LUNG FLUTE pointing down. The patient inhaled a little deeper than normal then placed his lips completely around the mouthpiece and gently blowed out through the LUNG FLUTE as if he was trying to blow out a candle.

The mouthpiece was removed from mouth and quickly he inhaled again. The mouthpiece

was put back in his mouth and he blowed gently through the LUNG FLUTE. The mouthpiece was removed and he waited five seconds taking several normal breaths .Performed 20 sets of 2 blows each .He was told before the session not to force a cough or use the diaphragm or stomach muscles to try to force out more air. The session lasted from 5-10 minutes depending on the severity of the pulmonary condition. Performing 3'huff ' coughs after each 5 sets of 2 blows assists in clearing secretions.

**Traditional chest physiotherapy Session:**

**For Group B: (Control Group):**

**includes:**

Techniques (pursed lip breathing, percussion, vibration, coughing and postural drainage), each session was about 15-20 min.

**Follow up procedures**

The follow up procedures included vitalograph spirometer assessments for measuring Ventilatory functions, CAT and 6 minute walk test pre and post training for both groups.

**Statistical analysis :**

Results are expressed as mean ± standard deviation. To calculate the actual effect of chest therapy alone or combined with lung flute training program, mean difference is calculated from the equation: after treatment – before treatment or vice versa whenever it was appropriate. Test of normality, Kolmogorov-Smirnov test, was used to measure the distribution of data measured pre-treatment. Accordingly, comparison between variables in the two groups was performed using either unpaired t test or Mann-Whitney test whenever it was appropriate. Comparison between variables measured before and after treatment in the same group was performed using either paired t test or Wilcoxon signed ranks test whenever it was appropriate. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value ≤ 0.05 was considered significant.

**RESULTS**

The mean values of age, weight, height and BMI in control group were 54.07 ± 4.74 yrs., 72.17 ± 12.83 kg, 169.73 ± 7.34 cm and 24.93 ± 3.25 kg/m$^2$, respectively. While in study group they were 54.47 ± 4.23 yrs., 70.40 ± 11.12 kg, 168.43 ± 7.67 cm and 24.69 ± 2.50 kg/m$^2$, respectively. There was no statistical significant difference between the two groups as regard age (t= -0.345; p= 0.732), weight (t= 0.570; p= 0.571), height (t= 0.671; p= 0.505) and BMI (t= 0.314; p= 0.754) (Table1).

Before treatment, there was a statistical significant difference between the mean value of FEV6 in control group (2.74 ± 0.52) and its corresponding value in study group (3.11 ± 0.59) with t value = -2.580 and p value = 0.012 ( Fig.1 )

In control group, there was a statistical significant increase in the mean value of FEV6 measured after treatment (2.99 ± 0.56) when compared with its corresponding value measured before treatment (2.74 ± 0.52) with t value = -3.181 and p value = 0.003 (Fig.1)

Before treatment, there was a statistical significant difference between the mean value of FEV1 in control group (1.95 ± 0.34) and its corresponding value in study group (2.37 ± 0.39) with t value = -4.523 and p value = 0.001 ( Fig. 2)

In control group, there was a statistical significant increase in the mean value of FEV1 measured after treatment (2.15 ± 0.34) when compared with its corresponding value measured before treatment (1.95 ± 0.34) with t value = -4.945 and p value = 0.001 (Fig.2)

Before treatment, there was a statistical significant difference between the mean value of FEV1/FEV6 ratio of control group (71.66 ± 6.97 ) and its corresponding value in study group (76.78 ± 6.19) with t value = -3.012 and p value = 0.004 (Fig.3 )

In control group, there was no statistical significant difference between the mean value of FEV1/FEV6 measured after treatment (72.86 ± 7.10 ) and its corresponding value measured before treatment (71.66 ± 6.97) with t value = -1.133 and p value = 0.266 (Fig.3)

Before treatment, there was a statistical significant difference between the mean value of MVV in control group (72.97 ± 12.68) and its corresponding value in study group (88.86 ± 14.47) with t value = -4.523 and p value = 0.001 (Fig.4 )

In control group, there was a statistical significant increase in the mean value of MVV measured after treatment (80.68 ± 12.80) when compared with its corresponding value measured before treatment (72.97 ± 12.68) with t value =-4.945 and p value = 0.001 (Fig.4)

Before treatment, there was no statistical significant difference between the value of CAT score between control group (25.67 ± 4.26) and study group (25.57 ± 4.11) with Z value = 0.148

and p value = 0.882 (Fig.5)

**Table 1: General characteristics of the two studied groups.**

| | Control group (n= 30) | Study group (n= 30) | t value | P value |
|---|---|---|---|---|
| **Age** (yrs.) | 54.07 ± 4.74 | 54.47 ± 4.23 | -0.345 | 0.732 (NS) |
| **Weight** (kg) | 72.17 ± 12.83 | 70.40 ± 11.12 | 0.570 | 0.571 (NS) |
| **Height** (cm.) | 169.73 ± 7.34 | 168.43 ± 7.67 | 0.671 | 0.505 (NS) |
| **BMI** (kg/m$^2$) | 24.93 ± 3.25 | 24.69 ± 2.50 | 0.314 | 0.754 (NS) |

Data are expressed as mean ± SD.
NS= p> 0.05= not significant.

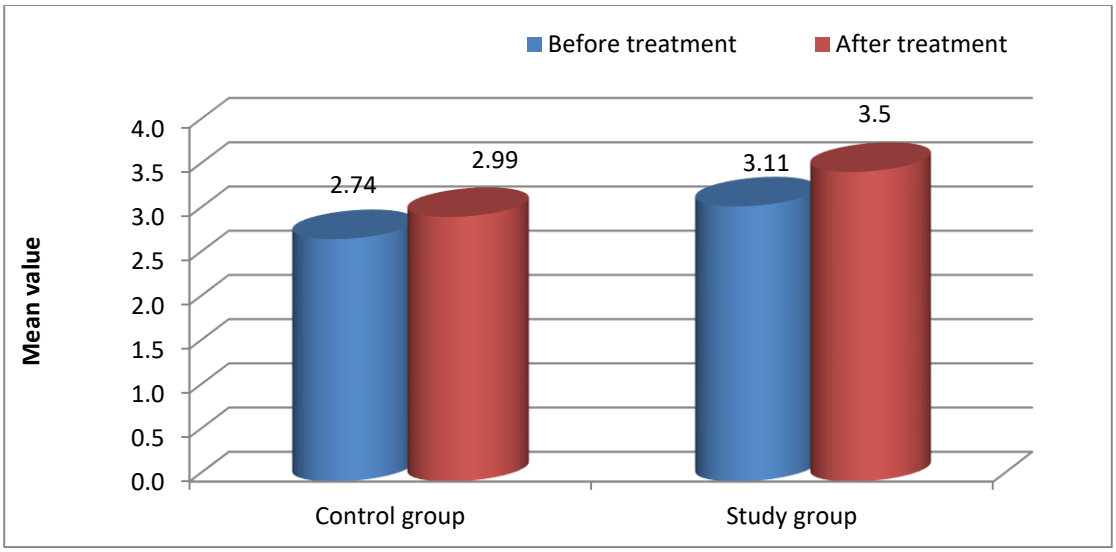


**Figure (1): Mean value of FEV6 in the two studied groups measured before and after treatment.**

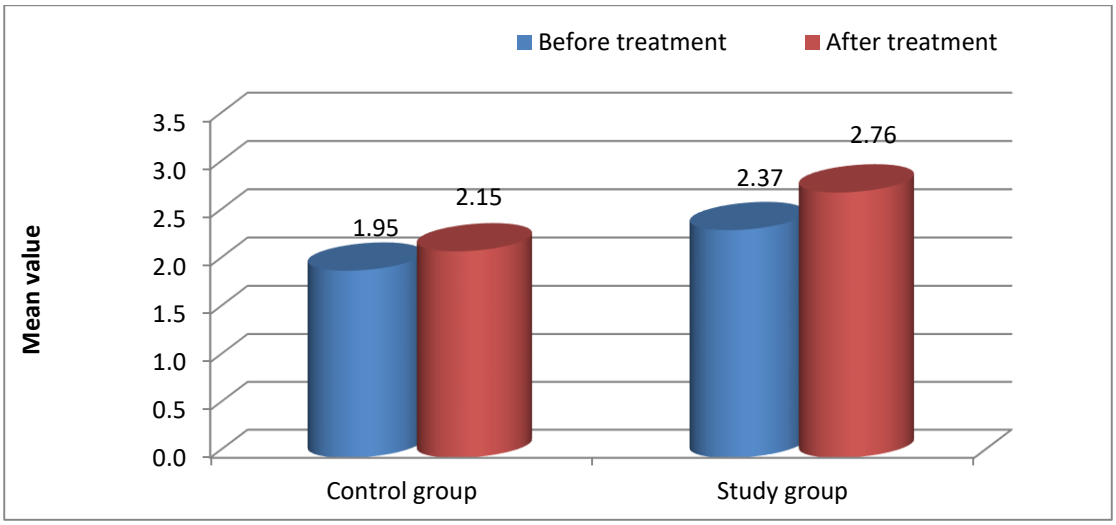


**Figure (2): Mean value of FEV1 in the two studied groups measured before and after treatment.**

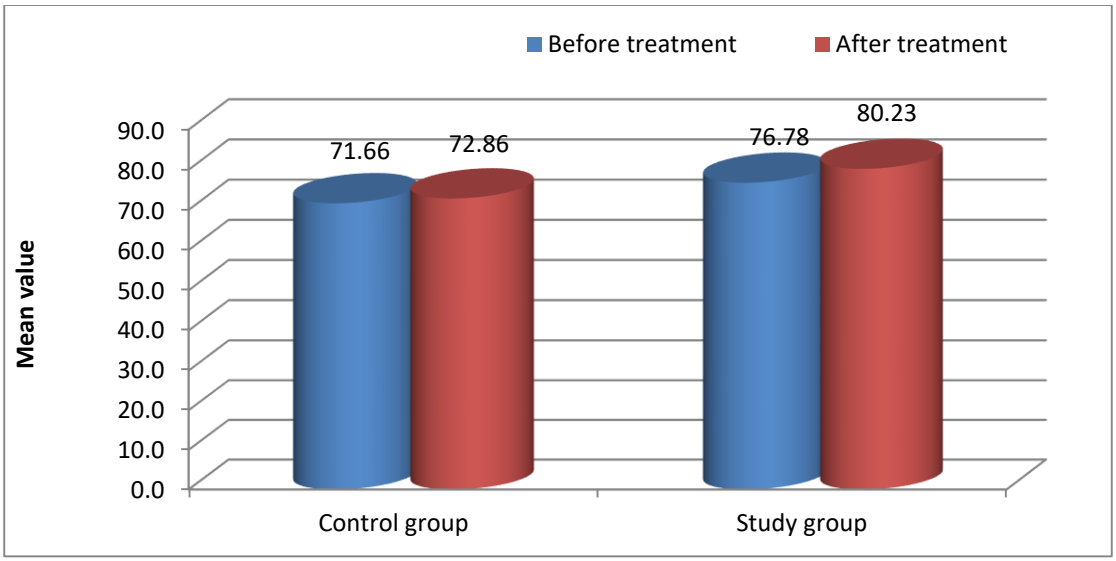


**Figure (3): Mean value of FEV1/FEV6 in the two studied groups measured before and after treatment.**

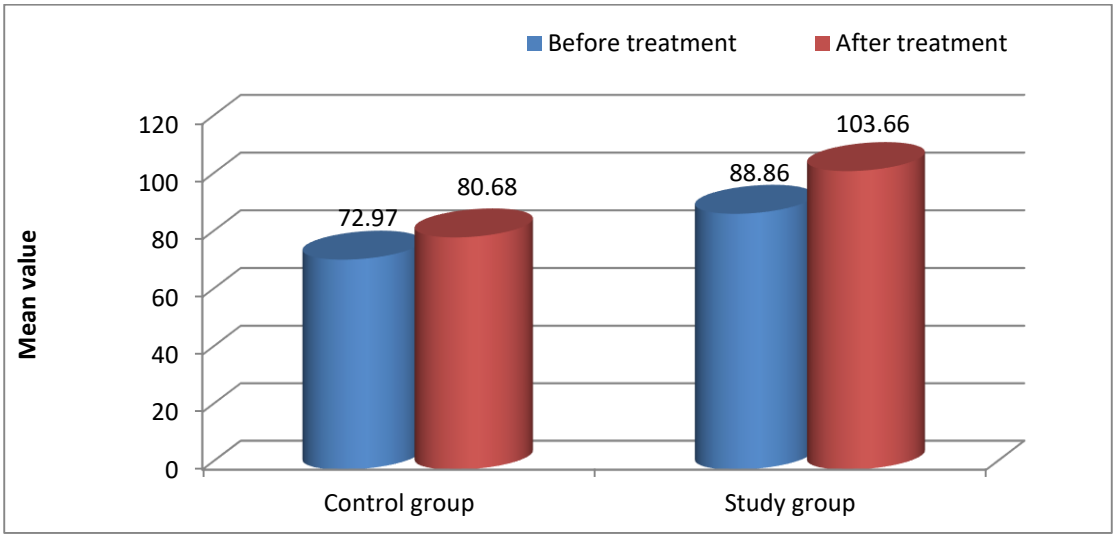


**Figure (4): Mean value of MVV in the two studied groups measured before and after treatment.**

In control group, there was a statistical significant decrease in the value of CAT score measured after treatment (17.10 ± 4.87) when compared with its corresponding value measured before treatment (25.67 ± 4.26) with Z value = -4.789 and p value = 0.001 (Fig.5)

The percentage decrease in the value of CAT scorein both control and study groups were (33.39 %) and (35.2%), respectively. (Table2)

Before treatment, there was a statistical significant difference between the mean value of 6 minute walk test in control group (293.80 ± 40.16) and its corresponding value in study group (245.13 ± 50.39) with t value = 4.137 and p value = 0.001 ( Fig.6 )

In control group, there was a statistical significant increase in the mean value of 6minute walk test measured after treatment (346.20 ± 42.54) when compared with its corresponding value measured before treatment (293.80 ± 40.16 ) with t value =-24.508and p value = 0.001 (Fig.6 )

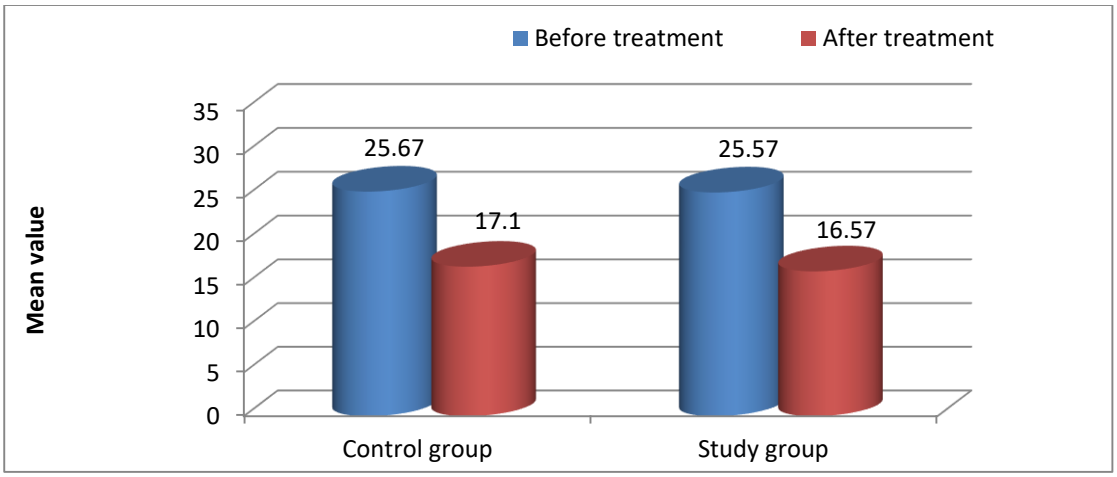


**Figure (5): Mean value of CAT score in the two studied groups measured before and after treatment.**

**Table 2 : Inter and intra-group comparison between mean value of CAT score in the two studied groups measured before and after treatment.**

| | Control group (n= 30) | Study group (n= 30) | $Z^{\#}$ value | P value |
|---|---|---|---|---|
| **Before treatment** | 25.67 ± 4.26 | 25.57 ± 4.11 | 0.148 | 0.882 (NS) |
| **After treatment** | 17.10 ± 4.87 | 16.57 ± 4.08 | ---- | ---- |
| **Mean difference** | 8.57 ± 3.38 | 9.00 ± 2.15 | -0.655 | 0.512 (NS) |
| **% change** | 33.39 ↓↓ | 35.20 ↓↓ | | |
| **$Z^{\#\#}$ value** | -4.789 | -4.794 | | |
| **p value** | 0.001 (S) | 0.001 (S) | | |

Data are expressed as mean ± SD.
$Z^{\#}$= Mann Whitney test.
$Z^{\#\#}$= Wilcoxon Signed Ranks test.
NS= p> 0.05= not significant.
S= p< 0.05= significant.

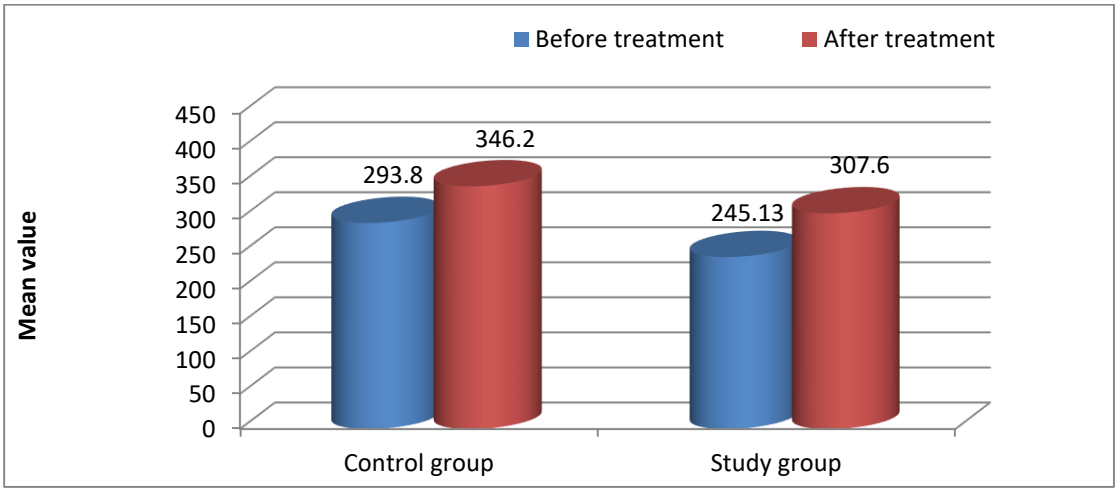


**Figure (6): Mean value of six minute walk test in the two studied groups measured before and after treatment.**

## DISCUSSION

The aim of this study was to determine the effect of LUNG FLUTE training in patients with acute exacerbation of COPD. Sixty men with AECOPD participated in this study assigned into 2 groups.

The results of the current study showed statistical significant difference for the ventilator functions (FEV6 , FEV1, FEV1/FEV6) the percentage of improvement of FEV6 was about 12.54% in the study group & about 9.12% in the control group , and that of FEV1 was about 16.46% for group A (study group) and much less in group B (control group) with 10.26% improvement. While the FEV1/FEV6 ratio showed a percentage of improvement about 4.49% in the study group while in the control group it was about 1.68% , and for the percentage of improvement of the maximum voluntary ventilation in one minute for group A showed statistical percentage of improvement of 16.66 % while in group B showed statistical improvement of 10.57%.

The CAT score declines about 35.2% in the study group and about 33.39%in the control group, and finally; the percentage of improvement of the Six minute walk test was 25.48% in the study group while in the control group it was 17.84%.

The results of this study coincided with Sethi et al., (2014) that concluded that Lung flute improves symptoms and health status in COPD with bronchitis and it therefore represents a welcome addition to armamentarium for the treatment of COPD because of its potential unique mechanism of action ,low cost and safety.The results of this study came in accordance with Sakashita et al., (2017) who demonstrated that the Lung Flute was useful for induction of high quality sputum to diagnose active pulmonary tuberculosis.

In agreement with Ashwini et al., (2015) who demonstrated the effectiveness of lung flute as an OPEP (oscillatory positive expiratory pressure) device for bronchial hygiene in patients with cystic bronchiectasis and it increased the patient compliance and independence in treatment and quality of life in hypersecretory respiratory conditions. However further studies is needed to evaluate its long term benefits.

The results of this study was supported by the results of Mohamed et al., (2015) who concluded that vest clearance (HFCWO) was efficacious to patients with AECOPD &helped in sputum expectoration and improvement of respiratory functions.

The results of this study came in contrast to a study conducted by (Van der Schans,2007) who reported that alternative airway clearance modalities(e.g. high frequancy chest wall compression, oscillating positive expiratory pressure devices and exercise) are not proven to be more effective than conventional chest physiotherapy (CPT) and usually add a little benefit to conventional chest physiotherapy. Only if cough and huff are insufficiently effective should other CPT modalities be considered. The choice between the CPT alternatives mainly depends on patient preference and the individual patient's response to treatment.

## CONCLUSION

The current respiratory device (LUNG FLUTE) provided an adequate physiotherapy method to patients with AECOPD, helped sputum expectoration, contributes in stabilization or improvement of respiratory function, enhance patients' compliance and independence. Assessment of severity of COPD and improvement with treatment modalities can be done with simple tests like dynamic exercise testing such as 6-MWT or with the administration of quality-of-life questionnaires (CAT).

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest".

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

OSA designed and performed the experiment and also wrote the manuscript. NGE ,AFR and MWE performed continuous guidance and suggestions during the performance of the experiment, data analysis and reviewed the manuscript. All authors read and approved the final version.

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