

## ORIGINAL RESEARCH

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## SHORT TERM EFFECT OF ACUPUNCTURE-TENS ON LUNG FUNCTIONS AND DYSPNEA FOR SUBJECTS WITH MODERATE COPD

<sup>1</sup>Vinod Babu .K<sup>2</sup>Akshata Akalwadi<sup>3</sup>Sai Kumar .N<sup>4</sup>Mansi Dilipkumar Brahmhatt

## ABSTRACT

**Background:** Acupuncture TENS is used to improve pain instead of invasive acupuncture. Acupuncture shown to improve dyspnoea and lung functions in COPD (Chronic Obstructive Pulmonary Disease) patients. The purpose of the study is to determine Short term effectiveness of Acupuncture-TENS in reducing dyspnea and improving lung functions for subjects with moderate COPD.

**Method:** An experimental study design, selected 30 geriatric subjects with COPD randomized 15 subjects into each Study and Control group. Study group received Acu-TENS for 45 minutes for total 5 sessions, while control group received placebo TENS. Outcome measurements such as breathlessness using Modified Borg Scale (MBS), Lung functions using Pulmonary Function Test (PFT) was measured before and after intervention.

**Results:** Analysis from pre-intervention to post-intervention within study group found that there is statistically significant change in means of MBS, FEV1, FEV1/FVC ratio and within control group there is a statistically significant change in means of MBS, but there is no statistically significant change in means of FEV1, FVC and FEV1/FVC ratio. When post-intervention means were compared between the groups there is no statistically significant difference in means of MBS and FEV1, FVC and FEV1/FVC ratio.

**Conclusion:** It is concluded that one week of Acu-TENS on EXL1 point found no significant effect on improving dyspnea and lung functions in subjects with moderate COPD in geriatric populations.

**Key words:** Acupuncture TENS, Placebo TENS, COPD, Pulmonary Function Test, Dyspnea, Modified Borg Scale.

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<sup>2</sup>Associate Professor,

<sup>3</sup>Professor & Principal,

<sup>4</sup>Physiotherapist,

K.T.G. College of Physiotherapy and KTG Multi Specialty Hospital. Bangalore. India. Affiliated to Rajiv Gandhi University of Health Sciences, Karnataka. India.

## CORRESPONDING AUTHOR

<sup>1</sup>VINOD BABU .K, MPT, MD(AM)

Associate Professor,  
K.T.G. College of Physiotherapy and KTG Multi Specialty Hospital,  
Bangalore-560 091, India.

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## INTRODUCTION

The Global Initiative for Chronic Obstructive Lung Disease (GOLD), defines chronic obstructive pulmonary disease (COPD) is a disease state characterized by air flow limitation that is not fully reversible. The airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases.<sup>1,2</sup> Prevalence of COPD in India is widely variable in different population, round off median prevalence is 5% for males & 2.7% for females over age of 30 years and percentage is more with older age group.<sup>3</sup>

The symptoms of COPD are persistent cough, sputum or mucus production, wheezing, chest tightness, and tiredness. People with COPD typically first notice dyspnea during vigorous exercise when the demands on the lungs are greatest. Over the years, dyspnea tends to get gradually worsen so that it can occur during milder, everyday activities such as housework. In the advanced stages of COPD, dyspnea worsen and it occurs during rest.<sup>4,5</sup>

Invasive Acupuncture has been used as an alternative management for breathlessness in COPD patients. Application of Transcutaneous Electrical Nerve Stimulation (TENS), a non invasive modality instead of giving an invasive acupuncture, found to have same effect as acupuncture on acupoints (ACU-TENS).<sup>6</sup> According to traditional Chinese medicine, dyspnoea results from a deficiency in the flow of 'Qi' (energy) in the lungs and application of an appropriate acupuncture technique is thought to restore the 'Qi balance'. This concept led to the use of a combination of points including those that were believed to restore energy and improve the flow of Qi.<sup>6</sup>

Western medicine states that signals from stimulation of peripheral nerve fibers (possibly through acupuncture points) can influence hypothalamic functions via the dorsal periaqueductal grey fibers, and thereby influence the respiratory centre in the medulla, modifying respiration. Investigation of the relationship between acupuncture and neural activity has been reported.<sup>7</sup> Stimulation of vision-related acupoints has been shown to be associated with activation of the occipital lobe using functional magnetic resonance imaging. Electroencephalography has been used to demonstrate a relationship between acupuncture and brain activity. There is also speculation that the decrease in dyspnoea resulting from acupuncture is mediated by endogenous

opiate release as a consequence of hypothalamic stimulation.<sup>7</sup>

Application of TENS, at a tolerable intensity in humans, has been shown to stimulate A $\alpha$  and A $\beta$  nerve fibers. It was found that the application of TENS over Acu points may induce signal transmission similar to acupuncture.<sup>6</sup> B.Vyas,S.Shah et.al studied the effect of Acu-TENS on FEV1, six minute walk distance and dyspnea in patients with chronic obstructive pulmonary disease. It was found that, Low TENS with Frequency - 4 Hz; Pulse Width - 200 micro seconds; Intensity - highest tolerable by the participant is given at acupuncture point which is 0.5 cun lateral to C7 shown to have immediate effect on improving dyspnea.<sup>8</sup>

Therefore, the present study with research question, Does the Acupuncture-TENS will have a short term effect on improving lung functions and dyspnea for subjects with moderate COPD? Hence, the purpose of the study is to find the short term effect of Acu-TENS on lung functions and dyspnoea for subjects with moderate COPD. It was null hypothesized that there will be no significant short term effect of Acupuncture-TENS on improving lung functions and dyspnea for subjects with moderate COPD.

## METHODOLOGY

An experimental study design, pre and post-test measurements with two groups- Acu-TENS and placebo TENS group. As this study involved human subjects the Ethical Clearance was obtained from the Ethical Committee of KTG College of Physiotherapy and K.T.G. Hospital, Bangalore as per the ethical guidelines of Bio-medical research on human subjects. This study was registered under Rajiv Gandhi University of Health Sciences for subject for registration for dissertation with registration number 09\_T031\_47134. Subjects included in the study were Moderate airflow obstruction, which Global initiatives for chronic Obstructive Lung Disease (GOLD) have graded as GOLD 2: 50%  $\leq$  FEV1  $\leq$  80% predicted<sup>8</sup> using Lower Limit of Normal<sup>9</sup> performed by Pulmonary Function Test, geriatric age group above 65 years, both male and female subjects, History of exacerbation during stair climbing that reduces with rest or short acting drugs, Subjects who might produce small quantities of tenacious sputum after coughing bouts, Subjects with score  $\leq$  7 in Body mass index (B), Airway obstruction (O), Dyspnea (D) and Exercise capacity(E) i.e. BODE index.<sup>10,11</sup> Subjects were excluded with co-morbid conditions- cardiovascular disease, neurological deficit, respiratory infections such as pneumonia,

tuberculosis, Cor pulmonale which present with ankle swelling, subjects who presented with history of severe exertion, angina or pain in six minute walk test, subjects suffered from episode of acute exacerbation of obstructive airway and hospitalization within one month prior to data collection, subjects with Earlier exposure to TENS or acupuncture around the thoracic region. Subjects were recruited and study was conducted at KTG Hospital, Bangalore. Subjects who met inclusion criteria were recruited by Simple random sampling method using closed envelopes, randomly allocated subjects into two groups. Subjects who meet inclusion criteria were informed about the study and a written informed consent was taken. Total 30 Subject (n=30), 15 in each group completed the study. The treatment session was conducted for 45 minutes per session for one week with total of five sessions.

#### **Procedure for intervention for Acu-TENS group:<sup>6,7</sup>**

The group subjects had received 45 minutes of Acu-TENS for 5 days at bilateral acupoints ExB1 (known as DingChuan in Traditional Chinese medicine), located at 0.5 cun lateral to the spinous process of 7<sup>th</sup> cervical vertebra, where a cun is the distance between the proximal and distal crease of the interphalangeal joint of an individual's middle finger.<sup>6</sup> The intervention was performed with the patient was sitting on the chair. Each acupoint was cleaned with an alcohol swab to reduce resistance to passage of current and marked. A non conducting plastic film was punctured in the middle creating pore of small diameter. This film was then placed over the carbon electrodes. Then the carbon electrodes with the pores were placed directly over the marked acupoints. So that TENS affects on acupoints only. Then bilateral electrodes was attached to TENS machine. The patient was explained to be relaxed and that they would feel the current and they would have to tolerate as much as they can. Then the machine was switched on.

Parameters of Acupuncture TENS: Frequency – 4Hz, Pulse width – 200 microseconds, Intensity – Highest tolerable by the participant short of discomfort, Duration – 45 min/session, Sessions – One session everyday for one week, Electrodes – Carbon electrodes, TENS Machine – TAPSI.

#### **Procedure for intervention for Placebo TENS Group:<sup>6,7</sup>**

This group was given 45 minutes of Placebo-TENS. In which a plastic film electrode with no central pole was placed on the skin over each mark acupoints. Participants could see the output light

but no current was transmitted to the acupoint throughout the intervention.

Parameters of Placebo TENS: Frequency – 0Hz, Pulse width – 0 microseconds, Intensity – Patient was not feeling anything as no current was passed from the machine. So explained them that they will not feel anything but it produces its effect, Duration – 45 min/session, Sessions – One session everyday for one week, Electrodes – Carbon electrodes with non conducting plastic film, Machine – TAPSI.



Figure-1: TENS Machine



Figure-2: Electrode Placement for Acu-TENS

#### **Outcome Measurements:**

Lung Function<sup>12</sup> such as FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC ratio using spirometer and Dyspnea using Modified Borg Scale<sup>13</sup> was measured pre intervention and at the end of one week post intervention.

#### **1. Pulmonary Function Test (PFT) (FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC):**

Pulmonary function test was taken pre and post training as per the standard outlined by American Thoracic Society.<sup>14</sup> Position of the patient: Patient was given comfortable position on table and fully relaxed prior to the pulmonary function test. Final measurements: For measurement of the pulmonary function tests, subjects were given a comfortable starting position as described above, a soft nose clip was placed to prevent air escaping from nose and test was performed. For measurement of FEV<sub>1</sub> in Liters (L) and FEV<sub>1</sub>/FVC %, patients were asked to take the deepest breath as much as possible than place the mouthpiece in mouth with lips sealing it and immediately exhale hard and fast for as long as possible, preferably at

least 6 seconds followed by a rapid inspiration from the mouthpiece. Three trials were given for each procedure and best trial was selected. The trial was considered “unacceptable” if it showed evidence of cough, early termination of expiration or inconsistent effort. After calculation the machine showed the results in form of printed graphs showing one of the 4 patterns: Normal, obstructive, restrictive or combined.

## 2. Modified Borg Scale (MBS):<sup>15</sup>

This scale was used after six minute walk test. Six minute walk test<sup>16</sup>: Patients were explained about the importance and procedure of 6 minute walk test before starting. The 30 meter lane was marked and every 3 meter distance chair was placed. Patients were instructed to walk as far as the test possible and if any excessive shortness of breath or discomfort found in between stop or pause before 6 minute. The pre and post test HR, RR, dyspnea and fatigue were measured.

After six minute walk test dyspnea score was measured. The patient was asked to experience about dyspnea ratings score, after 6 minute walk test. Score was selected between 0 to 10 on the scale. (0 is nothing to all and 10 is very, very severe or maximal dyspnea)

### Statistical Methods

Descriptive statistical analysis was carried out in the present study. Out Come measurements analyzed are presented as mean  $\pm$  SD. Significance is assessed at 5 % level of significance with p value was set at 0.05 less than this is considered as statistically significant difference. Paired ‘t’ test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analysis the variables pre-intervention to post-intervention with calculation of percentage of change. Independent ‘t’ test as a parametric and Mann

Whitney U test as a non-parametric test have been used to compare the means of variables between groups with calculation of percentage of difference between the means. The Statistical software namely SPSS 16.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

## RESULTS

The study carried on total 30 subjects (Table-1) in study Group there were 15 subjects with mean age 72.8 years and there were 7 males and 8 females were studied in the study. In control group there were 15 subjects with mean age 72.53 years and were 9 males and 6 females were included in the study. There is no significant difference in mean ages between the groups.

When means were analyzed within the groups (Table-2 & 3) shows that in study group there is a statistically significant change in means of MBS, FEV1, FVC and FEV1/FVC ratio when means were analyzed from pre intervention to post intervention. There is clinical significant improvement with small to medium effect size in study group. In control group when means were analyzed from pre intervention to post intervention there is a statistically significant change in means of MBS, there is no statistically significant change in means of FEV1, FVC and FEV1/FVC ratio. There is clinical significant improvement with small to medium effect size in study group.

When pre intervention means and post intervention means were compared between study and control groups (Table-4) shows that there is no statistically significant difference in means of MBS and FEV1, FVC and FEV1/FVC ratio.

**Table 1:** Basic Characteristics of the subjects studied

Basic Characteristics of the subjects studied		Study Group	Control Group	Between the groups Significance <sup>a</sup>
Number of subjects studied (n)		15	15	--
Age in years (Mean $\pm$ SD)		72.8 $\pm$ 4.27 (64-79)	72.53 $\pm$ 3.90 (65-78)	p= 0.738 (NS)
Gender	Males	7	9	
	Females	8	6	
BMI		23.63 $\pm$ 1.45 (20.54-24.97)	23.92 $\pm$ 0.70 (22.45-24.83)	P = 0.448 (NS)

-a Pearson Chi-Square



**Table 2:** Analysis of MBS and lung functions within study Group (Pre to post test analysis)

	Pre intervention Mean $\pm$ SD (min-max)	Post intervention Mean $\pm$ SD (min-max)	Percentage of change	t value <sup>a</sup> Parametric Significance P value	Z value <sup>b</sup> Non- Parametric Significance P value	95%Confidence interval of the difference		Effect Size (r)
						Lower	Upper	
<b>MBS</b>	2.33 $\pm$ 1.61 (0.5- 5.0)	1.20 $\pm$ 1.25 (0.0-3.0)	-48.49%	7.179 P < 0.000**	-3.443 P = 0.001**	0.794	1.471	+ 0.36 (Medium)
<b>FEV1</b>	1.45 $\pm$ 0.25 (1.21- 1.98)	1.67 $\pm$ 0.29 (1.09- 2.16)	15.17%	-5.002 P < 0.000**	-3.068 P = 0.002**	-0.312	-0.124	+ 0.37 (Medium)
<b>FVC</b>	2.36 $\pm$ 0.42 (1.90- 3.24)	2.65 $\pm$ 0.51 (1.64-3.33)	12.28%	-3.789 P = 0.002**	-2.726 P = 0.006**	-0.448	-0.124	+ 0.29 (Small)
<b>FEV1/FVC</b>	61.65 $\pm$ 3.64 (51.45-66.48)	63.84 $\pm$ 3.61 (54.12- 67.76)	3.55%	-4.518 P < 0.000**	-3.408 P = 0.001**	-3.228	-1.150	+ 0.28 (Small)

\*\* Statistically Significant difference p < 0.05; NS- Not significant; a. Pared t test. b. Wilcoxon signed rank test

**Table 3:** Analysis of MBS and lung functions within control Group (Pre to post test analysis)

	Pre intervention Mean $\pm$ SD (min-max)	Post intervention Mean $\pm$ SD (min-max)	Percentage of change	t value <sup>a</sup> Parametric Significance P value	Z value <sup>b</sup> Non-Parametric Significance P value	95%Confidence interval of the difference		Effect Size (r)
						Lower	Upper	
<b>MBS</b>	2.16 $\pm$ 1.86 (0.5-5.0)	1.70 $\pm$ 1.54 (0.0- 4.0)	-21.29%	4.090 P = 0.001**	-2.739 P = 0.006**	0.222	0.711	+ 0.13 (Small)
<b>FEV1</b>	1.45 $\pm$ 0.18 (1.22- 1.83)	1.49 $\pm$ 0.16 (1.29- 1.90)	2.75%	-2.003 P = 0.065(NS)	-1.907 P = 0.057(NS)	-0.089	0.003	+ 0.11 (Small)
<b>FVC</b>	2.26 $\pm$ 0.31 (2.09- 2.79)	2.30 $\pm$ 0.27 (1.94- 2.84)	1.76%	-1.343 P = 0.201(NS)	-.882 P = 0.378(NS)	-0.110	0.025	+ 0.06 (Small)
<b>FEV1/FVC</b>	64.50 $\pm$ 5.51 (51.45-70.59)	65.05 $\pm$ 4.92 (52.85- 70.56)	0.85%	-2.487 P = 0.026(NS)	-1.931 P = 0.053(NS)	-1.024	-0.075	+ 0.05 (Small)

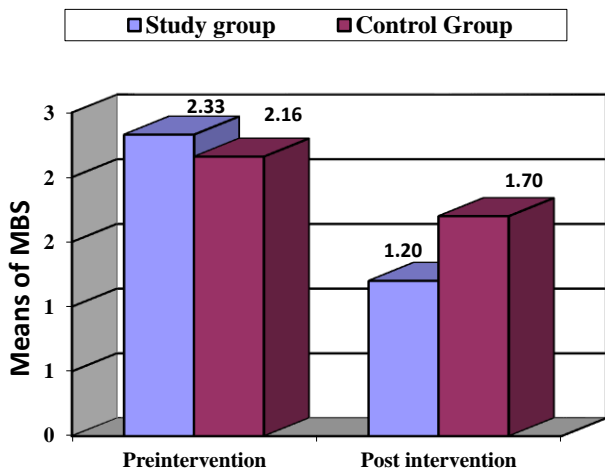
\*\* Statistically Significant difference p < 0.05; NS- Not significant; a. Pared t test. b. Wilcoxon signed rank test

**Table 4:** Comparison of means of MBS and lung functions between study and control Groups (PRE AND POST INTERVENTION COMPARISION)

	Percentage of difference	t value <sup>a</sup> Parametric Significance P value	Z value <sup>b</sup> Non-Parametric Significance P value	95%Confidence interval of the difference		Effect Size (r)
				Lower	Upper	
PRE INTERVENTION COMPARISION						
<b>MBS</b>	7.57%	0.262 P = 0.795 (NS)	-0.254 P = 0.799(NS)	-1.137	1.471	+ 0.04 (Small)
<b>FEV1</b>	0.00%	0.024 P = 0.981 (NS)	-0.540 P = 0.589(NS)	-0.165	0.169	+ 0.00 (Small)
<b>FVC</b>	4.52%	0.750 P = 0.459 (NS)	-.519 P = 0.604(NS)	-0.177	0.383	+ 0.13 (Small)
<b>FEV1/FVC</b>	-4.51%	-1.666 P = 0.107 (NS)	-1.806 P = 0.071(NS)	-6.33	0.651	+ 0.29 (Small)
POST INTERVENTION COMPARISION						
<b>MBS</b>	34.48%	-0.974 P = 0.338(NS)	-.930 P = 0.352(NS)	-1.55	0.551	+ 0.17 (Small)
<b>FEV1</b>	11.39%	2.035 P = 0.051(NS)	-2.055 P = 0.040(NS)	-0.001	0.355	+ 0.35 (Medium)
<b>FVC</b>	-14.14%	2.300 P = 0.029(NS)	-2.095 P = 0.036(NS)	0.037	0.655	+ 0.39 (Medium)
<b>FEV1/FVC</b>	1.87%	-0.762 P = 0.452(NS)	-.975 P = 0.329(NS)	-4.433	2.028	+ 0.13 (Small)

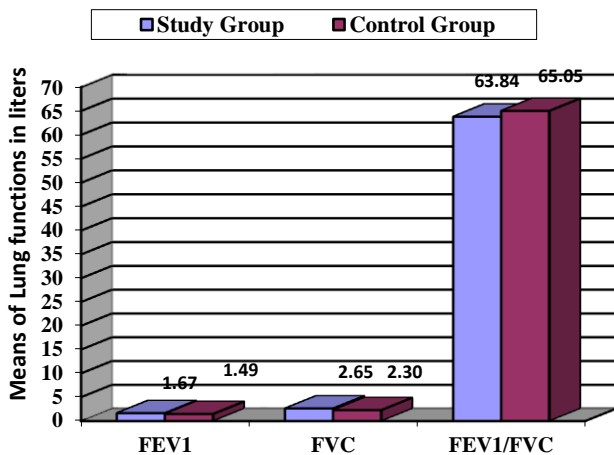
\*\* Statistically Significant difference p < 0.05; NS- Not significant; a. Independent t test; b. Mann-Whitney Test

**Graph- 1:** Analysis of MBS between study and control Groups (Pre and post test comparative analysis)



The above graph shows that there is no statistically significant difference in means of MBS when pre intervention means and post intervention means were compared between study and control groups.

**Graph - 2:** Analysis of Lung function between study and control Groups (Post test comparative analysis)



The above graph shows that there is no statistically significant difference in means of FEV1, FVC and FEV1/FVC ratio when post intervention means were compared between study and control groups.

## DISCUSSION

The finding from present study found that there is no statistically significant short term effect of intervention on improvement of lung functions and dyspnoea in study group who received Acu-TENS and control group who received placebo TENS.

In study group, there is significant improvement in lung functions and dyspnoea with small to medium effect size. The improvement in dyspnoea could be because of the acupuncture type effect of Acu-TENS. Dyspnoea in COPD is associated with

increased bronchial and systemic inflammation. Airflow limitation has been associated with changes in levels of inflammatory mediators such as tumor necrosis factor and interleukin-8. Inflammation increases cytokine levels which are transmitted to hypothalamus via sensory pathways. A suppressive effect on the release of cytokines was caused by the release of Acetylcholine. Cytokine synthesis is suppressed by release of glucocorticoids via negative feedback. Thus, dyspnoea might have reduced by suppression of inflammatory mediators either via afferent or efferent vagus nerve stimulation. According to traditional Chinese medicine, dyspnoea results from a deficiency in the flow of 'Qi' (energy) in the lungs and application of an appropriate acupuncture technique thought to restore the 'Qi' balance'.<sup>6,7</sup> This concept led to the use of a combination of points including those that were believed to restore energy and improve the flow of Qi. Western medicine hypothesise that signals from stimulation of peripheral nerve fibers (possibly through acupuncture points) can influence hypothalamic functions via the dorsal periaqueductal grey fibers, and thereby influence the respiratory centre in the medulla, modifying respiration. There is also speculation that the decrease in dyspnoea resulting from acupuncture is mediated by endogenous opiate release as a consequence of hypothalamic stimulation.<sup>6,7</sup>

The proposed effect of Acu-TENS on FEV1 may be through central processing of neural signals whereas its action on airways, if any, is indirect.<sup>17</sup> Low frequency TENS was associated with increased  $\beta$  endorphin, endomorphin and met-enkephalin levels through an action on  $\mu$  and  $\delta$  opioid receptors. Improvement in FEV1 and reduction in dyspnoea score together could be because of increased  $\beta$  endorphin level.<sup>18</sup> The improvement in FEV1 after Acu-TENS could be associated with changes in autonomic nervous system activity.<sup>19</sup> The improvement in FEV1 might be because of relaxation of hyperactivated respiratory muscles and the correction of autonomic tone might cause beneficial effect on pulmonary function.<sup>20</sup> Ken SL Lau and Alice YM Jones studied the immediate effect of a single 45-minute session of Acu-TENS on lung function and dyspnoea in patients with COPD. They conducted that Acu-TENS may be a useful non-invasive adjunctive intervention in the management of dyspnoea in patients with COPD.<sup>17</sup> Ngai et., al studied the effect of Acu-TENS on forced expiratory volume, in patients with asthma on 30 subjects, after exercise. They concluded that adjunctive Acu-TENS therapy appears to reduce decline of FEV1

following exercise training in patients with asthma.<sup>18</sup> Shirley P.C. et.,al studied the effect of Acu-TENS on forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) on 11 healthy males after sub maximal exercise. They concluded that Acu-TENS was associated with a higher post exercise FEV1 and a prolongation of sub maximal exercise.<sup>19</sup> Therefore, in present study, the Acu-TENS has shown significant effect of improving dyspnea and pulmonary functions.

In control group, there is no statistically significant difference in means of FEV1, FVC and FEV1/FVC ratio. This could be due to placebo TENS that may not be effective in improving lung functions in COPD patients. Dyspnoea could be affected by physiological, psychological, social and environmental factors as well as it is a subjective scale. The demeanor of clinician also affect the dyspnoea. A calm, confident demeanore of clinician help diminish the anxiety and improve dyspnoea. Counseling and support also helps in reducing anxiety and improve dyspnoea.<sup>21</sup> So in the control group the improvement in dyspnoea might be because of such reasons. A placebo activated endogenous opioids have been shown to produce respiratory depression. Which might be another reason for improvement in dyspnoea in control group.

Subjects receiving Acu-TENS showed reduction in rate of perceived exertion by 48.49% and improvement in FEV1, FVC and FEV1/FVC ratio by 15.17%, 12.28% and 3.55%. Whereas control group showed reduction in rate of perceived exertion by 21.29% and improvement in FEV1, FVC and FEV1/FVC ratio by 2.75%, 1.86% and 0.85%. Though there is a significant greater percentage of change in improvement within the study group that of control group, there is no significant difference between study and the control group with small effect size.<sup>22</sup>

Based on the findings the present study found that there is statistically significant difference in pre and post intervention findings within the study group, but no statistically significant difference on outcome measures between the study group and control group. Hence, the present study accepts null hypothesis.

### **Limitations of the study**

Subjects with age group between 65 to 80 years of age were considered for the study, thus results cannot be generalized to all the groups. The study was carried for short duration only for one week. Co-morbidities associated with COPD in geriatric population that influences the Dyspnea was not considered in the study.

### **Recommendations for Future Research:**

Further study is needed to find the influences of co-morbidities associated with COPD in geriatric population that influences the Dyspnea during acu-TENS and studies are needed on different age group with COPD. Long term effects of the intervention with follow up are needed. This study includes patients with moderate COPD only. Further study can be done on subjects with mild/severe COPD.

### **CONCLUSION**

It is concluded that one week of Acu-TENS on EXL1 point found significant effect on improving dyspnoea and lung functions in subjects with moderate COPD in geriatric populations. There is no difference in effect of Acu-TENS compared to placebo TENS. Further long term studies are required to find the effect of Acupuncture TENS in subjects with COPD considering the influences of co-morbidities that influences the Dyspnea.

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**Conflicts of interest:** None

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