Effect of Acu-TENS on Pulmonary Functions in Patients With Acute Exacerbation of Chronic Obstructive Pulmonary Disease

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ABSTRACT

Background: Acu-TENS has been used to relieve dyspnea and to improve pulmonary function in a variety of respiratory disease patients. There is limited evidence for the use of Acu-TENS in patients with acute exacerbation of chronic obstructive disease.

Purpose: The purpose of the present study was to find out the effect of Acu-TENS on pulmonary function in patients with acute exacerbation of COPD.

Design: Randomized pretest-posttest experimental design.

Methods: Total thirty COPD patients with acute exacerbation, were randomly assigned to receive either Acu-TENS or Placebo Acu-TENS for 5 days. Dyspnea score, FEV1 and FVC were measured on 1st, 3rd and 5th day.

Results: Data analysis was performed by SPSS 16. It was found that a statistically significant improvement occurred in dyspnea score, FEV1 and FVC in both the groups. This improvement was significantly higher in patients in Group A as compared to that in Group B.

Limitations: The results of the spirometery were subjected to patient's effort and motivational factor; and effect of TENS or placebo TENS over acupuncture points was compared rather than TENS applied over non acupuncture points.

Conclusion: Results of the study offer an exciting new opportunity to provide a non-pharmacological and non-airflow dependent treatment modality to emergency department practice for acute exacerbation of COPD.

Keywords: *Acute exacerbation, COPD, Dyspnea, FEV1, FVC, Acu-TENS.*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major cause of death and disability world wide[1]. WHO predicts that it will be the fourth leading cause of death world wide by 2030. COPD is characterized by airflow limitation which is progressive and reduced exercise capacity and associated with symptoms such as dyspnea, excessive sputum production and chronic cough[2].

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The health of patients with COPD is influenced by the presence and frequency of acute exacerbations[3]. Some patients are prone to frequent exacerbations, which are important cause of hospital admissions and readmissions, and which have a considerable impact on quality of life and ADLs. Patients with acute exacerbations of COPD typically present with increased cough, changes in sputum volume and purulence, and greater breathlessness, wheezing, and chest tightness[4, 5]. Dyspnea as a limiting symptom reflects disequilibrium between ventilatory capacity and ventilatory demand[6]. Factors that increase demand on the ventilatory system are likely to result in dyspnea when the ventilatory capacity is inadequate to meet heightened ventilatory needs[7].

Management of COPD includes pharmacotherapy for relief of symptoms, pulmonary rehabilitation programs for health education, and exercise to improve exercise tolerance and dyspnea (GOLD 2007). Complementary and alternative medicines has been used to relieve dyspnea in a variety of patients' example COPD, asthma, cancer and AIDS, include acupuncture, acupressure, Acu-TENS, progressive muscle relaxation and psychoanalysis etc[8].

Researchers have found acupuncture to be an effective mode of management for relieving dyspnea and improving functional capacity in COPD patients. Acupuncture is thought to evoke a suppressive effect on inflammatory mediator levels either via afferent (pre-synaptic) or (post-synaptic) vagus nerve stimulation thereby decreasing dyspnoea[9]. But acupuncture is an invasive procedure and always carries some risk of injury therefore its use is limited, not possible to routinely use in outpatient settings[10].

TENS, which is a non invasive modality, has been widely used for relieving pain in both acute and chronic conditions and application of TENS, over specific acupuncture points. Acu-TENS is believed to elicit similar responses to manual acupuncture in relieving dyspnoea[2]. Only few studies that have examined the efficacy of Acu-TENS in improving pulmonary functions in patients with respiratory disorders. For instance Lau KSL, Jones AYM (2008) found that a single session of Acu-TENS increased FEV_1 and reduced dyspnea significantly in stable COPD patients [2]. But there is no scientific data till date that has studied the effect of Acu-TENS in patients with acute exacerbation of COPD. Hence the purpose of the study was to find out the effect of Acu-TENS on pulmonary functions in patients with acute exacerbation of COPD.

METHODS

Design-A randomized, placebo-controlled, pre-test and post-test design was carried out with a sample of 30 acute exacerbations of COPD patients. Patients were randomly allocated using sealed envelope method to receive either Acu-TENS or placebo Acu-TENS.

Participants – Patients were recruited from the ICU's in PARAS Hospital, Gurgaon. Clinically diagnosed acute exacerbation patients were included in the study. Inclusion criteria included COPD patients with acute exacerbation, FEV_1< 50% of predicted and Age group: 45-75 years. Subjects with following conditions were excluded from the study:- Patients with history of heart disease like ischemic heart disease, cardiac pacemaker, cardiomyopathy etc., Insensitive skin or skin abrasion at place of application of TENS electrode., Having neurological deficit, cognitive dysfunctions.

INTERVENTION

The experimental group (group A) received 45 min of Acu-TENS along with conventional physiotherapy and pharmacotherapy for 5 days. Acu-TENS was given at bilateral acupoints Ex B_1. Acupoint Ex B_1 was located at 1.2 cm lateral to the spinous process of 7th cervical vertebra. A non-conductive plastic film 50 × 50 mm^2 was puncture in the middle creating a pore of diameter 0.79 mm. This film was then placed over the participant's skin, with the pore directly over the marked acupoints. A 50 × 50 mm^2 electrode was then placed over each plastic film. Stimulation was given at frequency of 5 Hz and pulse width of 200 microseconds with highest tolerable intensity.

The control group (group B) received 45 min of Placebo Acu-TENS along with pharmacotherapy and conventional physiotherapy for 5 days. Placebo Acu-TENS was given at bilateral acupoints Ex B_1. Participants could see the output light flashing but no current was transmitted to the acupoints.

Outcome and Measurements

Dyspnea score was measured by the use of Modified Borg Scale, all subjects were explained verbally about the use of values and the scores marked on the Modified Borg scale ranging from 0 (no breathlessness) to 10 (maximum breathlessness).

FEV_1 and FVC were measured according to ATS guidelines using a spirometer. All measurements were recorded in sitting position.

All outcomes variable were recorded on 1st, 3rd and 5th day.

Results: - Data analysis was performed by SPSS 16. Comparison between the groups for all the variables (dyspnea, FEV_1 and FVC) on 1st day, 3rd day and 5th day was done using unpaired't' test. Comparison of effect of treatment within the group on day 1st, 3rd, and 5th for all the variables was done using repeated measures ANOVA followed by post hoc analysis. The significance level was set at 95% (p d" 0.05). No adverse events were reported during whole study period. There is no statistically significant difference in the baseline dyspnea score, FEV_1 and FVC value of Subjects (p> 0.05).

Table 1: Change in Dyspnea score in Group A and Group B

	Mean ± S. D.			
Group	Day 1	Day 3	Day 5	F-value
Group A	8.066^{b} ±0.798	5.933^{ab} ±0.961	4.333^{a}±0.975	867.828**
Group B	7.866^{b}±0.743	6.333^{ab}±0.723	5.333^{a}±0.975	2016.587**

*Means with different superscripts in a column differ significantly (p<0.05)

** Highly significant at p < 0.001

Within group analysis showed that there was highly significant reduction in dyspnea score in group A and group B on 3rd and 5th day (p<0.001).

Table 2: Comparison of Dyspnea score in between Group A and Group B

Day	Group A	Group B	t-value
Day 1	8.066 ± 0.798	7.866 ± 0.743	0.710NS
Day 3	5.933 ± 0.961	6.333 ± 0.723	1.288NS
Day 5	4.333 ± 0.975	5.333 ± 0.975	2.806*

* Significant at p d" 0.05

NS – Non significant

Table: 3. Change in FEV1 in Group A and Group B

	Mean ± S. D.			
Group	Day 1	Day 3	Day 5	F-value
Group A	0.393b ±0.135	0.501ab ±0.158	0.638a ±0.156	204.917**
Group B	0.375b±0.106	0.426ab±0.119	0.478a ±0.115	221.348**

Means with different superscripts in a column differ significantly (p < 0.05)

** Highly significant at p < 0.001

Within group analysis showed that there was highly significant improvement in FEV_1 value in group A and group B on 3rd and 5th day (p<0.001).

Table 4: Comparison of FEV1 value in liters between Group A and Group B

Day	Group A	Group B	t-value
Day 1	0.393 ± 0.135	0.375 ± 0.106	0.404NS
Day 3	0.501 ± 0.158	0.426 ± 0.119	1.442NS
Day 5	0.638 ± 0.156	0.478 ± 0.115	3.188*

* Significant at p d" 0.05

NS – Non significant

Table 5: Change in FVC in Group A and Group B

	Mean ± S. D.			
Group	Day 1	Day 3	Day 5	F-value
Group A	0.504b ±0.172	0.621ab ±0.173	0.755a ±0.186	230.833**
Group B	0.489b±0.136	0.561ab±0.162	0.624a±0.149	218.758** \

Means with different superscripts in a column differ significantly (p < 0.05)

** Highly significant at p < 0.001

Within group analysis showed that there was highly significant improvement in FVC value in group A and group B on 3rd and 5th day (p<0.001).

Table 6: Comparison of FVC value in liters between Group A and Group B

Day	Group A	Group B	t-value
Day 1	0.504 ± 0.172	0.489 ± 0.136	0.270 NS
Day 3	0.621 ± 0.173	0.561 ± 0.162	0.978 NS
Day 5	0.755 ± 0.186	0.624 ± 0.149	2.118*

*Significant at p d" 0.05

NS – Non significant

DISCUSSION

Dyspnea is the most distressing symptom during a COPD exacerbation[5]. In acute exacerbation of COPD, both the increase in airway resistance and the decrease in inspiratory to expiratory time ratio lead to hyperinflation[11], impeding the ventilatory pump by decreasing the efficiency of the respiratory muscles thereby contributing to the breathlessness experienced during acute events[12].

Several non pharmacological approaches have been found to be an effective adjunct mode in relieving dyspnea in a variety of patients. These approaches include Acu-TENS, breathing retraining, breathing counselling, psychoanalysis, music therapy, acupuncture and acupressure[8]. Addition of these techniques to an existing program of care may thus improve the pulmonary functions and hasten the recovery process.

Cynthia X[8], Pan et al 2005 in their review study found that acupuncture is effective in relieving dyspnea in a variety of patients including oncology, asthma, COPD and AIDS etc. The findings of a study by Masao Suzuki[13] et al 2008 revealed that Borg Scale scores, 6MWD and mean SpO_2 significantly improved in COPD patients treated with acupuncture. Thomas J. Hoffman[14] et al 2009 also reported that vagus nerve stimulation by percutaneous electrode insertion reduced the dyspnea in asthmatic patient.

While acupuncture has demonstrated its beneficial effects in disease modulation, it is an invasive procedure and carries some risks of pneumothorax, infection and neurovascular injury, and other unavoidable consequences such as bleeding, haematoma, needling pain, dizziness and drowsiness[15]. To avoid these risks use of Acu-TENS, a low frequency and high intensity stimulation that can stimulate the acupoints in the deeper region, elicit the effect similar to that of acupuncture[2].

Use of Acu-TENS which is non-invasive procedure has been advocated. It has been found to be an effective alternative mode of management of dyspnea in a variety of respiratory disease patients[1, 16]. But the effect of Acu-TENS on lung function in patient with acute exacerbation has not been investigated much. So the present study was conducted to investigate the effect of Acu-TENS on pulmonary functions in patients with acute exacerbation of COPD.

In our study baseline lung functions of the patients with acute exacerbation of COPD as evaluated by Modified Borg Scale & spirometry were found to be significantly reduced in all the patients included in the study.

Results revealed that patients in Group A who had received Acu-TENS for 5 days exhibited subjective clinical improvement in dyspnea score and even physiologic improvement in FEV1 & FVC. There was a statistically significant improvement in dyspnea score by 26.44% and 46.26%, FEV1 by 27.48% and 62.34%, and FVC by 23.21% and 49.80%, on 3rd & 5th day respectively. This improvement was significantly higher in patients in Group A as compared to that in Group B.

Positive effect of Acu-TENS on dyspnea has been reported previously also. Shirley[16] PC et al 2009 studied the effect of Acu-TENS on forced expiratory volume in patients with asthma, after exercise. SL Lau[2] et al 2008 in their study found that single session of 45 min Acu-TENS led to a significantly higher improvement in FEV1 and more decrease in the dyspnea score in the experimental group than in the control group.

There is speculation that the decrease in dyspnea resulting from Acu-TENS is mediated by endogenous opiate release as a consequence of hypothalamic stimulation[17]. Indeed, opiates are prescribed as respiratory depressants to modulate the sensation of breathlessness[18]. Application of Acu-TENS stimulates the A´ fibers which release encephalin, ²-endorphin and dynorphin[20]. We thus hypothesize that the application of TENS over acupoints may induce signal transmission similar to acupuncture, influencing vagus afferents via hypothalamic stimulation, thereby improving the physical and mental status of the patients.

Patients in Group B who received placebo TENS also showed a statistically significant improvement in dyspnea, FEV_1 and FVC over a period of 5 days. The reason for this improvement could be that these patients were also receiving the routine care of treatment that included pharmacotherapy and conventional physiotherapy, in addition to placebo-TENS. The comparison between groups, therefore suggests that the use of Acu-TENS is effective in managing the patients during the acute exacerbations of COPD.

In summary the results of our study confirming that the use of Acu- TENS is beneficial in improving the lung functions in patients with acute exacerbation of COPD.

LIMITATIONS OF STUDY

The results of the spirometery were subjected to patient's effort and motivational factor. Effect of TENS or placebo TENS over acupuncture points were compared rather than TENS applied over non acupuncture points and therefore it is difficult to draw conclusions on whether the positive effect of Acu-TENS was in fact acupoints specific or general effect of TENS.

Relevance to clinical practice

The findings of the present study suggest that TENS is a non invasive, low cost, electrotherapy modality, and the application of Acu-TENS may assist dyspnea management in patients with acute exacerbation of COPD to improve activity level and quality of life. The encouraging effect of Acu-TENS in our study suggests that Acu-TENS can be a useful adjunctive intervention in the management of dyspnea in patients with respiratory problem.

FUTURE RESEARCH

We do not have much evidence to support the long term use of Acu-TENS. So future research with larger study population may evaluate the effect of Acu-TENS use on functional capacity and health related quality of life in patients with COPD. Also, the present study did not evaluate the effects of Acu-TENS on other physiological variable such as VO_2 max, minute ventilation, breathing frequency, tidal volume, FRC, and level of inflammatory mediators like cytokine. These finding will be able to clearly demonstrate the mechanism of improvement in pulmonary functions when using Acu-TENS.

So there is a need for well designed, adequately powered, randomized controlled trials to assess the net effects of Acu-TENS to prescribe it in routine care of standard physiotherapy treatment to improve pulmonary functions and quality of life in patients with variety of conditions.

CONCLUSION

Results of the study offer an exciting new opportunity to provide a non-pharmacological and non-airflow dependent treatment modality to emergency department practice for acute exacerbation of COPD as well.

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