Original Article

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TANAFFOS

The Effect of Acu-TENS Current on Shortness of Breath and Lung Function Indicators in Patients with COPD

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Background: The use of Acu-TENS is one of the physiotherapy methods to reduce shortness of breath and improve the quality of life of patients with chronic obstructive pulmonary disease (COPD). This study was conducted to evaluate the effectiveness of this method in respiratory parameters and the quality of life of patients with moderate to severe COPD.

Materials and Methods: The present study was a controlled clinical trial on 40 patients with COPD. Patients with moderate to severe COPD were randomly divided into two treatment groups. Exercise therapy was used in one group, and Acu-TENS (12 sessions over three weeks, Burst TENS (Frequency: 2 Hz; pulse duration: 200 ms, time: 45 minutes)) was used in the other group. Shortness of breath was evaluated using the Borg criteria, functional capacity was assessed using the six-minute walking test, quality of life was evaluated using the St. George questionnaire, and respiratory parameters were measured using a spirometer and COPD Assessment Test (CAT) questionnaire.

Results: According to the results, after 12 treatment sessions, a significant difference was observed in FVC, FEV1, activity, CAT, and impact domains of St George's questionnaire. In contrast, other variables had no significant difference between the control and the intervention groups.

Conclusion: Using Acu-TENS three times a week and for 12 sessions can play a significant role in the respiratory function of moderate to severe COPD patients. Also, this method is effective in reducing shortness of breath and improving the quality of life of these patients.

Keywords: Acu-TENS; Dyspnea; Pulmonary function; Exercise therapy

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is an irreversible disease caused by dysfunction of the respiratory tract, which is characterized by shortness of breath, persistent cough, and phlegm production (1). According to the report published by the World Health Organization, COPD will be the fourth leading cause of death in people around the world by 2030 (2). The treatment of this disease is with the help of drug therapy and the use of rehabilitation programs to improve the quality of life of these patients (3). Since the use of many drugs is associated with extensive side effects, alternative treatment approaches have been noted by physicians.

One of these alternative methods that has long been considered an effective treatment approach for various diseases is acupuncture. Studies have shown that acupuncture has been used effectively to improve shortness of breath in patients suffering from respiratory diseases as well as types of cancer (4-7). Also, the examination of different trials indicates that this method

can be considered an effective intervention in patients with COPD or asthma (8). However, due to its invasive nature, acupuncture is associated with disadvantages such as the risk of tissue damage or other complications (9, 10). For this reason, researchers introduced a non-invasive alternative method that can produce responses similar to acupuncture by electrical stimulation of certain points of the skin and nerves and help improve the patient's pain (11, 12). Although Acu-TENS can potentially help to control shortness of breath and improve the patient's breathing conditions and improve the patient's quality of life, many studies on the effectiveness of Acu-TENS in COPD patients have not yet been reported. In the present study, the role of this method in respiratory conditions and the quality of life of patients with chronic obstructive pulmonary disease has been evaluated.

MATERIALS AND METHODS

Study design

The current study is a randomized evaluation with a control group, which was carried out according to the recommendations of STRICTA (MacPherson et al, 2002) and by observing the pre-test and post-test. Considering the inclusion criteria, 40 patients with moderate to severe COPD were included in the study. The demographic information of the patients was recorded at the beginning of the study, and after obtaining written consent, the St George's Respiratory Questionnaire (SGRQ) and COPD Assessment Test (CAT) questionnaires were completed by the patients. Patients were randomly divided into two groups, including the control group and the intervention group (AcuTENS recipients). Randomized blocks were used for randomization. The numbers were placed in sealed envelopes to prevent any possible misappropriation. The envelopes were given to the designated coordinator, and then the researcher responsible for implementing the plan and collecting information could open the envelope. All patients were evaluated for shortness of breath and pulmonary function after 30 minutes of rest. Patients in the intervention group received Acu-TENS for 45 minutes, and patients in the control group received Placebo-TENS for 4 weeks and three sessions per week. This study was performed in a double-blind manner, and the patients were aware that the selected stimulation frequency was not acceptable for humans. Also, the person responsible for collecting and recording patients' data was not aware of the allocation of study groups. Implementing the interventions for both groups was the responsibility of the project researcher. After completing the intervention period, shortness of breath and pulmonary function were re-examined.

Participants

Patients were selected according to the 2021 GOLD classification. Inclusion criteria were COPD stage II or III according to the 2021 GOLD classification, the ability to move independently, and the ability to communicate and walk without assistance. Also, patients with neurological disorders, ischemic heart disease, diabetes mellitus, cognitive disorders, and airway-blocking diseases were excluded from the study. Demographic information included age, gender, and history of drug use or smoking. Randomized blocks were used for randomization. The numbers were placed in sealed envelopes to prevent any possible misappropriation. The envelopes were given to patients, and then the researcher responsible for implementing the plan and collecting information could open the envelopes.

Intervention

In the intervention group, patients received Acu-TENS for 45 minutes at bilateral acupoints located 0.5 centimeters lateral to the cervical vertebra. The distance is measured at the midpoint of the interphalangeal joints of the patient's middle finger. After determining the exact location of the intervention, the acupoints were cleaned with alcohol to resist the barbaric current used. Then non-conductive plastic film 50 x 50 mm2 was punctured. The created pores had a diameter of 0.79 mm. The film was placed on the patient's skin, and the pores were considered for intervention. A 50 x 50 mm2 electrode was placed on plastic films (Figure 1). This structure was to limit electrical stimulation in acupoints. The electrodes were connected to the TENS device, and electrical stimulation was established with a frequency of 2 Hz and a pulse width of 200 microseconds. The flow intensity was adjusted according to the patient's comfort. The voltage output was checked

using a laboratory oscilloscope. In the control group, patients received a placebo-TENS for 45 minutes (Figure 1).

Figure 1. Identification of acupuncture points EX-B1and placement of the electrodes over the acupuncture points EX-B1

Outcome measure

The study employed a comprehensive set of outcome measures to assess the effects of the intervention. Shortness of breath was evaluated using the Borg scale, a standardized tool that quantifies perceived exertion. Functional capacity was assessed using the six-minute walking test, which measures the distance walked in six minutes as an indicator of overall physical function. Quality of life was evaluated using the St. George Respiratory Questionnaire (SGRQ), a disease-specific instrument that assesses symptoms, function, and overall well-being. Respiratory function was assessed using spirometry, with measurements including forced expiratory volume in one second (FEV1) and forced vital capacity (FVC), which provide valuable insights into lung function and airway obstruction. Additionally, computed tomography (CT) scans were used to evaluate respiratory parameters."

Statistical analysis

The level of clinical significance of Acu-TENS was defined as the mean difference (95% CI), and significance was reported through an independent t-test and p-values. Statistical significance was defined as $p<0.05$.

RESULTS

Among the patients with COPD referred to the hospital, 17 women (42.5%) and 23 men (57.5%) were examined. The sample size was 20 patients. There was no statistical difference in the number of men and women participating in the study. The average age of all patients was 59.0±5.39 years, which was 58.80±6.47 in the intervention group and 59.25±4.32 in the control group

The results of this study demonstrated statistically significant improvements in several key outcome measures among patients with COPD who received the treatment option. Specifically, the treatment group showed significant increases in FEV1% (0.04) and FVC% (0.03), indicating improved lung function. Additionally, patients reported reduced shortness of breath as measured by the Borg scale (0.00), and quality of life improved as assessed by the SGRQ (0.01). These findings suggest that the treatment option may be an effective adjunctive therapy for patients with COPD, leading to improved lung function, reduced symptoms, and enhanced quality of life (Table 1).

Table 1. Comparison of respiratory status and quality of life after between the two groups

Variables	Acu-TENS Group		Breathing exercises Group		P. value
	Before intervention	After intervention	Before intervention	After intervention	
FEV1 (%)	55.65±12.17	67.61±7.95	56.17±12.02	60.11±12.73	0.04*
FEV 1 (L)	1.63±0.50	1.97±0.45	1.70±0.45	1.86±0.49	0.48
FVC (%)	71.19±19.07	86.09±16.25	68.61±16.02	73.56±17.21	0.03*
FVC (L)	2.75±1.01	3.33±1.00	2.72±0.77	2.99±0.85	0.28
6MWT	354.70±55.07	425.81±46.84	363.30±64.90	398.94±63.81	0.26
CAT	12.50±7.90	5.33±4.67	11.65±7.40	10.17±7.71	0.08
Borg	3.95±0.68	1.33±0.76	3.80±0.83	2.33±1.00	0.00*
SGRQ (impacts)	26.69±6.66	15.74±4.66	25.95±7.07	20.50±5.79	0.01*
SGRQ (symptom)	41.91±11.88	38.43±10.01	38.58±10.99	38.08±11.11	0.74
SGRQ (activity)	57.80±6.92	45.70±5.44	55.24±8.48	48.82±8.58	0.20

Abbreviations: FEV1 (Forced Expiratory Volume in 1 second), FEV 1 (Forced Expiratory Volume in 1 Liters), FVC (Forced Vital Capacity), 6MWT (Six-Minute Walk Test), CAT (Chronic Asthma Therapy), SGRQ (St. George's Respiratory Questionnaire.

DISCUSSION

In the present study, our hypothesis was that the use of this method in acupoints might produce signals similar to acupuncture. We hypothesized that this method could affect vagal afferents by stimulating the hypothalamus.

The results of this study show that both Acu-TENS intervention and breathing exercises can be effective in the evaluated outcomes in COPD patients. The spirometric indices, such as the volume of expiratory pressure in one second in percentage, as well as vital capacity in pressure, have improved in both groups. This recovery rate was higher in the group receiving Acu-TENS. It seems that breathing exercises along with Acu-TENS, increase and improve these spirometric indices by increasing the functional capacity and vital volumes of the lungs.

By examining the distance covered by the patients in both groups in the 6-minute walking test, we find that both groups reported an increase in the distance covered, but this amount was more significant in the group receiving Acu-TENS.

Interventions that increase breathing capacity can improve walking distance and lung function in patients. Shortness of breath also decreased following the intervention. This reduction of shortness of breath was reported to be significant in the Acu-TENS group. Also, the size of this index was significantly different between the two groups after the intervention. CAT was also significantly improved in the group receiving Acu-TANS. While the visible improvement in the group receiving breathing exercises was not statistically significant.

Hill et al., using Acu-TENS on the lumbar region, improved the patients' exercise and pulmonary performance index, which is also consistent with the results of this study. The difference between the present study and the aforementioned study was in the area of electrode placement and the use of two types of high and low frequencies for patients (10). Ngai et al also used Acu-TENS and neuromuscular stimulation to improve respiratory tolerance and quality of life in patients with COPD. The results of the present study, similar to the aforementioned study, show an increase in the quality of life as well as pulmonary and sports performance indicators. Also, Ngai et al. mentioned that shortness of breath decreases after receiving Acu-TENS in patients with COPD (13). In the present study, it was also shown that the use of Acu-TENS in addition to breathing exercises can be effective in reducing shortness of breath in these patients. Wen et al, by examining the effect of TENS on acupuncture points Ding Chuan, Fishu, Shensu, and Xusanli, showed that the amount of air exhaled during the first second in a fast exhalation, vital pressure volume, the distance traveled in the 6-minute walk test and also, the assessment test for COPD and shortness of breath improved significantly, which is in line with the present study in terms of these parameters (14).

In various studies that investigated the effect of strengthening and aerobic exercises on the mental and physical indicators of patients with COPD, all of which show the improvement of these indicators in patients (15-18).

The implementation of the present study has faced some limitations. For example, this study was only conducted on people suffering from COPD in the moderate and severe stages, and people suffering from COPD in the mild or very severe stages were not included. Another limitation was the lack of time follow-up of its results, and therefore, it is suggested to examine the moderate and long-term effects of these methods in future studies. Also, the sample size was small, and the statistical population was limited to one treatment center, so it is suggested that researchers use larger sample sizes in multicenter studies in future studies so that the results obtained from the study can be generalized to the entire population.

CONCLUSION

The use of breathing exercises along with the application of TENS electric current on acupuncture points, in the present study, shows an improvement in the pulmonary function parameters and indicators, mental

indicators, and quality of life, as well as the physical ability parameters of the patients.

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Conflict of Interest

The authors declare there is no conflict of interest.

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