Review Article

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Effect of Transcutaneous Electrical Nerve Stimulation (TENS) on Lung Function among Covid-19 Patients- A Review Study

Physiotherapy Section

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ABSTRACT

Corona Virus Disease (COVID-19) is a highly contagious disease mainly affecting the respiratory system, the virus is transmitted from person-to-person through large droplets from coughing, sneezing or rhinorrhea, it remains viable for at least 24 hours on a hard surface and up to eight hours on a soft surface. If it enters into the human respiratory system, it attacks the lungs and induces serous fluid, fibrin exudates, and leads to hyaline membrane formation in the alveoli which highly affects the respiratory system. The aim of this review is to collect the present evidence on effect of Acupuncture-Transcutaneous Electrical Nerve Stimulation (Acu-TENS) on pulmonary function which can help the clinicians to do further clinical trials and recommend the usage of Modality TENS which can significantly improve lung function among COVID-19 patients. Till now, it is found that few breathing techniques improve lung function among hospitalised COVID-19 patients but yet no study has been found which shows the effect of modality like TENS on lung function among COVID-19 patients. TENS is a non-invasive and inexpensive peripheral stimulation technique that markedly improves lung function after a single session of 30-45 minutes. Hence, usage of TENS can be recommended for COVID-19 patient treatment.

Keywords: Acu-transcutaneous electrical nerve stimulator, Coronavirus, Physiotherapy, Physical therapy, Pulmonary

INTRODUCTION

COVID-19 is a disease caused by the new SARS-Cov-2 (Severe Acute Respiratory Syndrome Coronavirus). It is a highly contagious disease affecting the respiratory system, which in subsequent stages leads to its insufficiency and a decrease in the physical and mental capacity of patients. On 30th January 2020, the World Health Organisation (WHO) declared an epidemic and on 11th March 2020, COVID-19 was defined as a pandemic [1]. The virus is transmitted through respiratory secretion. Droplets from coughing, sneezing or rhinorrhea lands on the surface within 2 mm of the infected person, which remain viable for 24 hours up to eight hours. The virus is transferred through hand contact on the contaminated surface followed by touching the mouth, nose, or eye. Aerosol airborne-infected particles created during sneeze or cough remain viable in the air for <3 hours [2]. If it enters into the human respiratory system, it attacks the lungs and induces serous fluid, fibrin exudates, and leads to hyaline membrane formation in the alveoli [3].

As per the National Health Commission of China, COVID-19 is classified into four levels based on the severity of symptoms: mild, moderate, severe, and critical. Mild patients only present mild symptoms without radiographic features. Moderate patients present with fever, respiratory symptoms, and radiographic features. Severe patients meet one of three criteria: 1) dyspnea, Respiratory rate>30 times/min; 2) oxygen saturation <93% in ambient air; 3) PaO_2/FiO_2<300 mmHg. Critical patients meet one of three criteria: 1) respiratory failure; 2) septic shock; 3) multiple organ failure [4]. As the respiratory involvement is high, respiratory physiotherapy may play a major role in reducing detrimental effects on lung function.

The purpose of this article is to promote clinical trials on Acu-TENS so that standard operating procedure can be made for the use of Acu-TENS in COVID-19 to improve the lung function. The evidence present shows that lung function of the hospitalised patient can be improved by performing breathing technique but being an predicated and new pandemic virus no study have ever been conducted to test the efficacy of Acu-TENS on lung function among COVID-19 patient.

ACU-TENS

It was found that TENS is highly effective on improving lung volume and capacities among patient with respiratory disorders like Chronic Obstructive Pulmonary Diseases (COPD), bronchial asthma.

TENS is a non-invasive and inexpensive peripheral stimulation technique used in various medical conditions. TENS passes electrical current across the intact skin to activate underlying nerves via electrode pads attached to the skin surface. TENS current can be adjusted by many parameters like frequency, intensity, pulse size, and application interface. Depending upon these parameters they are divided into three types [5]:

1. Conventional TENS (Low Intensity, High Frequency).
2. Acupuncture-like TENS (High Intensity, Low Frequency).
3. Intense TENS (High Intensity, High Frequency).

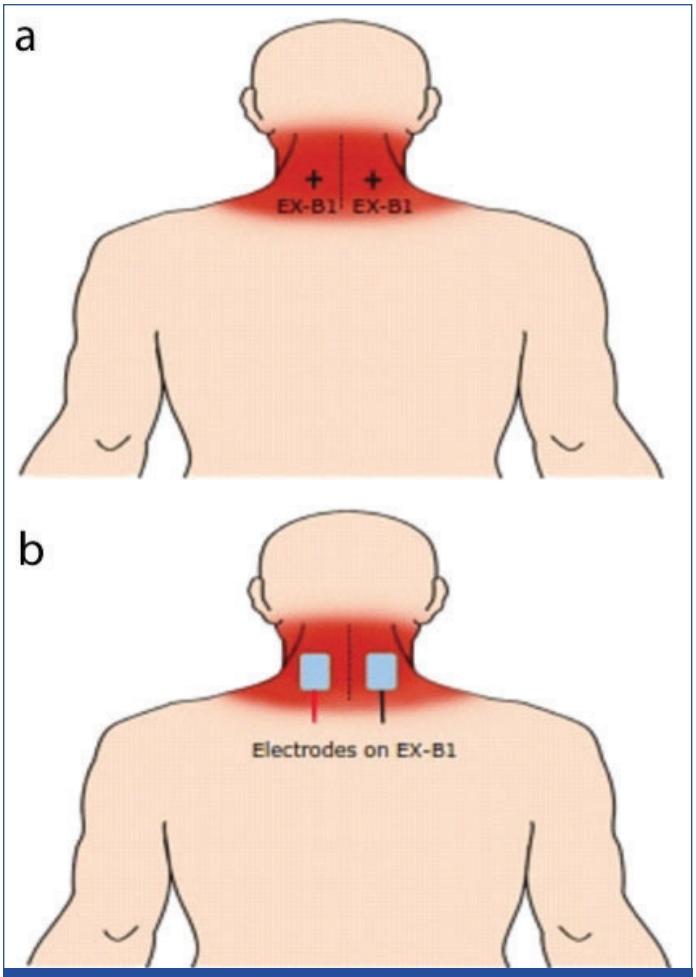
The evidence present shows that out of these 3 types of TENS, acupuncture-like TENS, also known as Acu-TENS have significant effect in improving lung function [5].

Method of Applying Acu-TENS [6]

The patient should be in sitting or lying position. The two electrodes are placed bilaterally, 3 cm lateral to the spinous process of the seventh cervical vertebrae (Acupoint). The electrodes are then attached to the Acu-TENS machine [Table/Fig-1]. The frequency of the machine is set at 4Hz, a pulse width of 200 microseconds is set. Here the intensity is set at the highest tolerance level of the patient. Only a single session is required per patient. Treatment is given for the duration of 30-45 minutes.

Overview of Existing Literature

Zhao F et al., investigated the effect of Transcutaneous Electrical Acupoint Stimulation (TEAS) on one-lung ventilation-induced injury in patients undergoing oesophageal cancer operation and concluded that TEAS could effectively increase the levels of PaO_2/FiO_2 and Interleukin-10, reduce the levels of Alveolar-arterial Oxygen gradient ($A\text{-}aDO_2$) Tumouur Necrosis Factor alpha (TNNF-α), and IL-6, and reduce the incidence of pulmonary complications. TEAS



[Table/Fig-1]: Representation of acupuncture points and placement of electrodes. a) Acupuncture points EX- B1; b) Electrode placement over EX-B1

also could shorten the removal time of thoracic drainage tube and the length of hospital stay [7].

Mahendiran M and Mahesh R conducted a study to find the effect of TENS over acupoints (Acu-TENS) on lung functions and dyspnea among COPD patients. It was concluded that Acu-TENS has significant effect on improving lung function and reducing symptoms of dyspnea among COPD patient after giving a single session of 30-45 minutes [6].

Elnohze FM and Rifaat N conducted a study to find the effect of Acu-TENS on lung functions and dyspnea scale among patients with Bronchial Asthma for three sessions/week for four weeks (45 minutes/sessions) and concluded that Acu-TENS is highly effective in improving lung functions and reducing dyspnea among such patients [8].

A randomised, double-blinded, crossover study done by Ngai SPC et al., concluded that Acu-TENS alleviated dyspnea during walking in people with COPD did not increase walking duration [9].

A systemic review done by de Alvarenga GM et al., concluded that physiotherapy techniques used in patients hospitalised for COPD exacerbation, were the high frequency chest wall oscillation on the chest, relaxing massage and active exercise electrical stimulation via electro acupuncture, strengthening of the quadriceps, the slow expiration with glottis open in infralateral decubitus position (ELTGOL), bronchial drainage technique and an incentive spirometer [10].

Oncu E and Zincir H concluded that adding TENS therapy to pharmacotherapy in patients with acute exacerbation of COPD, provided clinical improvement in forced expiratory volume in one second (FEV1) and added benefit in exercise capacity, but no significant effect on the other outcomes measured [11].

Babu VK et al., concluded that one week of Acu-TENS on ExB1 (Dingchuan -acupoint located 0.5 cun lateral to the spinous process of 7th Cervical vertebra) point has no significant effect on improving dyspnea and lung functions in subjects with moderate COPD in geriatric populations [12].

Hunag S et al., conducted a randomised, double-blinded, placebo-controlled trial on 80 Video Assisted Thoracic Surgical (VATS) lobectomy patients. It was concluded that TEAS at 2/100 Hz can reduce intraoperative opioid dosage and slow the decrease of PaO_2 during one-lung ventilation. It can also effectively reduce pain score, extubation time, and Post Anesthesia Care Unit (PACU) stay immediately after surgery. Further, 100 Hz TEAS can reduce Post-operative Nausea and Vomiting (PONV) morbidity [13].

Liu X et al., conducted a study using Acu-TENS on 50 patients with stable COPD. The result of this study showed an improvement of FEV1% predicted and significant decrease in COPD Assessment Test (CAT) score ($p<0.05$) and Dyspnoea Visual Analogue Scale (DVAS) score ($p=0.039$). So, they concluded that acu-TENS over acupoints of bilateral EXB-1 (Dingchuan Acupoint), BL-13 (Feishu Acupoint), BL-23 (Shenshu Acupoint) and ST-36 (Zusanli Acupoint) improve FEV1% predicted and reduces DVAS and CAT score on patients with stable COPD, suggesting Acu-TENS as a novel option treatment strategy in COPD [14].

A study conducted by Vyas BM et al., on 55 patients suffering from COPD that were provided with Acu-TENS. It showed that there was an increase in FEV1, Forced Vital Capacity (FVC) and six minute walk distance by 4.37% (95% CI2.71 to 6.04), 0.65% (95%CI-0.40 to 1.71) and 14.32 metres (95% CI 10.67 to 17.99) and decrease in dyspnea by 1.29 mm, whereas dyspnea was decreased by 1.29 mm (95% CI-3.00 to 0.41) in experimental group. They concluded that Acu-TENS may be useful non-invasive alternative in the management of dyspnea in patients with COPD [15].

Ngai SPC et al., conducted a study to investigate the effect of acu-TENS on FEV1, dyspnea, and β-endorphin; levels on 44 patients diagnosed with COPD, and concluded that there is an relationship between improvement of FEV1 and dyspnea score with concurrent increase in β-endorphin level in patient with COPD [16].

A randomised control trial conducted by Ngai SPC et al., on 28 patients received 4-weeks of 45 minute, 5 days/week, of either Acu-TENS, placebo TENS or sham TENS showed that acu-TENS group attained significant improvement in FEV1 ($p=0.046$), physical activity _$p=0.007$) and total SGRQ score ($p=0.058$) [17].

Lau KSL and Jones AYM concluded that a single session of Acu-TENS increases FEV1 and reduces dyspnea in patients with COPD [18].

The Mechanism Behind the Effectiveness of Acu-TENS

Acu-TENS is a non-invasive and safe modality. Signal from stimulation of peripheral nerve fibers (possibly through acupuncture points) can influence hypothalamic function via the dorsal periaqueductal grey fibers. This modifies respiration by influencing the respiratory centre in medulla [12].

This mechanism was based on three things [14]:

1. Acu-TENS may initiate nerve stimulation of hypothalamus leading to endorphin release from respiratory centers. This expands the bronchi making respiration easy.
2. Acu-TENS leads to changes in the parasympathetic output signal of hypothalamus. This leads to acetylcholine release in the parasympathetic nervous ending and inhibiting release of inflammatory cells.
3. Acupoints stimulation may stimulate muscles. This triggers the sympathetic nervous system, inducing the release of endorphin substances. Endorphins then reduce the airway resistance.

CONCLUSION(S)

So, if Acu-TENS is useful in improving lung function among COPD, bronchial asthma, and other medical condition than it may also useful if it is given to COVID-19 patients, as it decreases the dyspnea and improves lung volumes and capacities. This article suggests the

need for further research to create clinical evidence in support for or for rebuttal.

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