

Effects of Neuromuscular Electrical Stimulation [NMES] On Quadriceps Muscle to Improve the Functional Exercise Capacity and Quality Of Life in Mild to Moderate COPD Patients

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ABSTRACT

Background: Prevalence of COPD is common in INDIA, though there are various means used for the treatment of this condition; NMES is still not included in usual rehabilitation of these patients. Since the beneficial effects of NMES on functional capacity are evident through various studies, we would like to evaluate the effect of the same in short treatment duration.

Specific Objective: To find out the effectiveness of Neuromuscular electrical stimulation with usual pulmonary rehabilitation on functional exercise capacity and quality of life in mild to moderate COPD patients.

Study Design: Quasi experimental study (pre-test and post-test with control group)

Study Setting: Institute of Pulmonology - Pulmonology Rehabilitation, PSG Hospitals, Coimbatore. **Participants:** 30 mild to moderate COPD patients.

Sampling: Convenience Sampling

Study Duration: 6 months

Treatment Duration: Group A – 45 minutes of usual pulmonary rehabilitation (short term package of PSG Institute of pulmonology) daily for 6 days. Group B – 30 minutes of NMES and 45 minutes of usual pulmonary rehabilitation (short term package of PSG Institute of pulmonology) for 6 days

Measurement Tools: Six minute walk test (6MWT), Peak expiratory flow rate (PEFR), Modified BORG dyspnea scale, Physical activity index

Results: The pre and post-test values for SMWT, PEFR, modified BORG dyspnea scale and PAI of Group A and Group B were documented and analyzed using paired 't' test to compare the outcomes within the group and between the groups it was analyzed and

compared using independent 't' test. The calculated values of paired 't' test for SMWT, PWFR, modified BORG dyspnea scale and PAI for group A is 8.910, 4.465, 3.205, 3.22 and that of group B is 7.898, 7.534, 10.738, 4.039 which are more than the table value at $p < 0.05$ and this shows there is a significant difference within the groups. Based on SWMT, PEFR, and Modified BORG dyspnea scale, calculated 't' values for independent 't' test 3.901, 2.44, and 3.638 are greater than the 'p' value, and the value of PAI is 0.735 which is lesser than the 'p' value indicating there is significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients.

Conclusion: Based on the paired and independent test results of the study, it is concluded that combination of NMES with usual pulmonary rehabilitation shows significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients.

Keywords: Neuro Muscular Electrical Stimulation, Chronic Obstructive Pulmonary Disease, Physical activity index

INTRODUCTION

GOLD guidelines define COPD as "a diseased state characterized by persistent airflow limitation that is usually progressive, and is associated with an enhanced inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients". Patients with mild to moderate COPD limit their physical activity and adapt a sedentary life style due to

symptoms such as breathlessness. This leads to muscle de-conditioning and shift to anaerobic metabolism. This further leads to accumulation of lactate and carbon dioxide which stimulates ventilation and worsens breathlessness. [1] Precipitating factors of peripheral muscle dysfunction in COPD are Disuse, hypoxemia, malnutrition and oxidative stress. Quadriceps muscle wasting exists in patients with mild as well as advanced COPD and independently associated with physical inactivity in GOLD stage I disease. [2]

NEED FOR THE STUDY: To prove that NMES can be included in the usual pulmonary rehabilitation to improve the functional exercise capacity of life in and quality mild to moderate COPD patients.

OBJECTIVE OF THE STUDY: The objectives of our study are to improve the functional exercise capacity and quality of life in mild to moderate COPD patients.

HYPOTHESIS:

NULL HYPOTHESIS:

There will be no significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients following NMES with usual pulmonary rehabilitation.

ALTERNATE HYPOTHESIS:

There will be significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients following NMES with usual pulmonary rehabilitation.

MATERIALS & METHODOLOGY

MATERIALS:

- Peak flow meter
- Stethoscope
- Sphygmomanometer
- Stopwatch
- Cones
- Pulse oximeter
- Neuromuscular electrical stimulator
- Treatment and skin resistance lowering trays

STUDY DESIGN: Pre-test and post-test quasi experimental study with 2 comparative groups. With the help of quasi

experimental study design pre-test and post-test were assessed for both the groups before and after the intervention and were compared. In the current study, the values of six minute walk test and PEFR, Physical Activity Index (PAI), BORG dyspnea score are taken before and after the intervention.

STUDY SETTING: Institute of Pulmonary medicine-Pulmonology Rehabilitation, PSG Hospitals, Coimbatore, India.

POPULATION AND SAMPLING: 30 COPD patients (mild to moderate) from institute of pulmonary medicine, PSG HOSPITALS were chosen as population for the study. The subjects were selected according to inclusion criteria by convenience sampling method and were allotted into 2 different groups. A total of 30 patients with mild to moderate COPD with 15 patients in each group are planned to be included for the study. Group A: 15 mild to moderate COPD patients with usual pulmonary rehabilitation & NMES (Experimental group). Group B: 15 mild to moderate COPD patients with usual pulmonary rehabilitation (control group).

STUDY DURATION: 6 months.

TREATMENT DURATION: Group A – 45 minutes of usual pulmonary rehabilitation (short term package of PSG Institute of pulmonology) for 6 days. Group B – 30 minutes of NMES with 45 minutes of usual pulmonary rehabilitation (short term package of PSG Institute of pulmonology) daily for 6 days. **INCLUSION CRITERIA:** Mild to moderate COPD patients with the Age group of 30-60 years. **EXCLUSION CRITERIA:** Cognitive dysfunction, Recent Myocardial Infarction (< 3 weeks), Severe PAH. Chronic orthopedic conditions of lower limbs, Metal implants and artificial pacemakers were excluded.

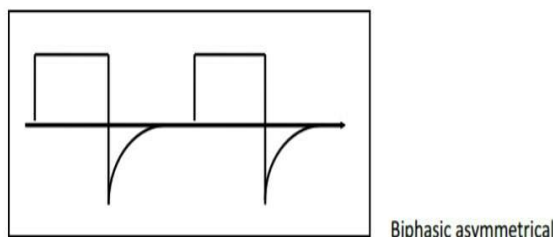
INSTRUMENTS AND TOOL FOR DATA COLLECTION: Six Minute Walk Test work sheet, PEFR, Modified BORG dyspnea scale, Physical Activity Index (PAI),

TECHNIQUE FOR DATA COLLECTION: In Group A, who received

usual pulmonary rehabilitation alone Six Minute Walk Test, PEFR, Modified BORG dyspnea scale, PAI were measured before and after the treatment session. In Group B, who received NMES along with usual pulmonary rehabilitation Six Minute Walk Test, PEFR, Modified BORG dyspnea scale, PAI were measured before and after the treatment session. Functional exercise capacity was measured using six minute walk test. PEFR was measured using peak flow meter. Severity of dyspnea was measured based on Modified Borg dyspnea scale. Quality of life was measured based on Physical Activity Index.

NMES STIMULATOR SETTING PARAMETERS

There is increasing application of long term (chronic) electrical stimulation in order to modify or change muscle function. The mechanism of this intervention relates primarily to muscle fibre type and stimulation frequency, though there are certainly other parameters that have an influence (waveform, stimulation pattern, electrodes etc.)



Duty cycle (ON:OFF ratio) – 1:1
8 seconds of contraction followed by 8 seconds of rest.

❖ RAMP

Gradually increase stimulation strength in the beginning and gradually decrease at the end of stimulation train.

❖ ELECTRODES PLACEMENTS

Inactive – on femoral triangle
Active – on the motor point of quadriceps

Large electrodes are used
(Less current density, less discomfort)

Treatment duration (wk)	1
No. Of session	5
Session duration (mins)	30
Pulse duration(ms)	0.4
Stimulation frequency (Hz)	60-80
Intensity (mA)	20 (upto 60)
Contraction time, (s)	8
Resting time (s)	8
Duty cycle (%)	50

❖ ELECTRICAL STIMULATION PATTERN: Synchronous firing pattern

❖ EFFECTS OF ELECTRICAL STIMULATION

Short term

- Brings about muscle contraction
- Altered blood flow in the muscle

Long term

- Strengthening
- Structural changes
- Biochemical changes

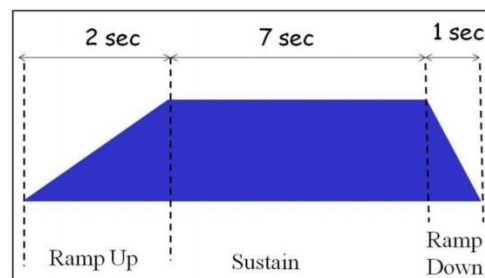
❖ MECHANISM

NEURAL (due to spread of response and lack of volume changes)

❖ WAVEFORM

Biphasic – most effective

❖ STIMULATION PARAMETERS



Data Analysis and Interpretation: The pre and post-test values for SMWT, PEFR, modified BORG's dyspnea scale, PAI were obtained from 30 mild to moderate COPD patients before and after our treatment duration were presented in tables. Mean, standard deviation, paired 't' test values were used to find out whether there was any significant difference between pre and post-test values within the groups. The independent 't' test values were used to find

the significance of the difference between the groups. Paired 't' test was used to measure the difference between pre-test and post-test values. Independent's 't' test was used to measure the post-test values of both the groups. The data obtained from 30 mild

to moderate COPD patients who received either usual pulmonary rehabilitation alone or usual pulmonary rehabilitation with NMES were analysed statistically using independent 't' test as follows:

TABLE01&Fig01-INDEPENDENT 't' TEST VALUE FOR SMWT

SMWT	n	MEAN	MEAN DIFFERENCE	SD	't' VALUE	'p' VALUE
GROUP A	15	281.3	45.03	30.188	3.90	0.01
GROUP B	15	326.33				

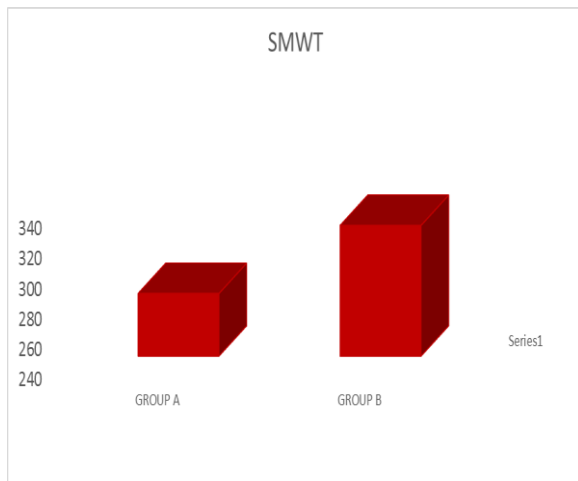


Fig 01

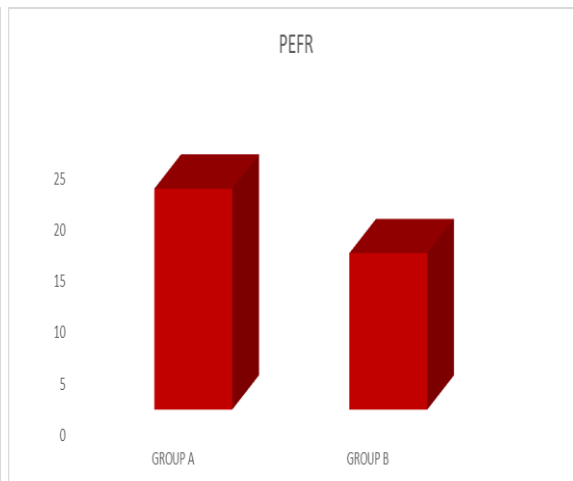


Fig 02

TABLE02&Fig02-INDEPENDENT 't' TEST VALUE FOR PEFR

PEFR	n	MEAN	MEAN DIFFERENCE	SD	't' VALUE	'p' VALUE
GROUP A	15	464	190	13.44	2.44	<0.05
GROUP B	15	274.66				

TABLE03&FIG03-INDEPENDENT 't' TEST VALUE FOR BORG DYSPNEA SCALE

BORG DYSPNEA SCALE	n	MEAN	MEAN DIFFERENCE	SD	't' VALUE	'p' VALUE
GROUP A	15	5.33	0.399	0.556	3.638	<0.05
GROUP B	15	4.93				

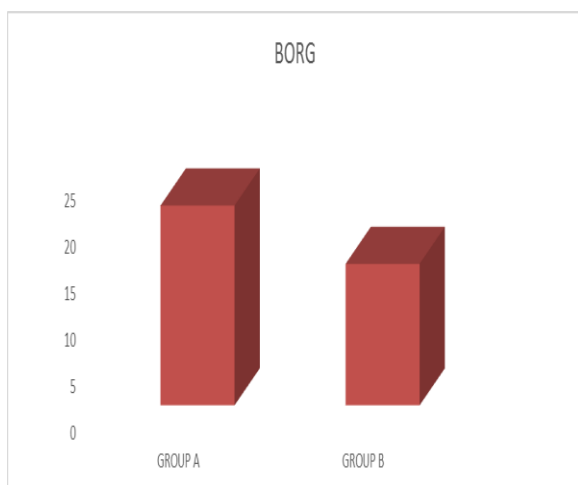


Fig 03

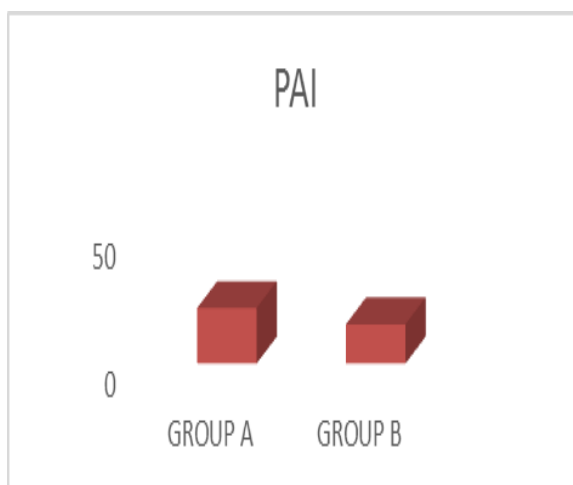


Fig 04

TABLE04&FIG04-INDEPENDENT 't' TEST VALUE FOR PHYSICAL ACTIVITY INDEX

PEFR	n	MEAN	MEAN DIFFERENCE	SD	't' VALUE	'p' VALUE
GROUP A	15	21.46	6.26	22.898	0.7345	>0.05
GROUP B	15	15.20				

RESULTS & DISCUSSION

RESULTS: The pre and post-test values for SMWT, PEFR, modified BORG's dyspnea score and PAI of Group A and Group B were analyzed using paired 't' test and independent 't' test. The calculated values of paired 't' test for SMWT for group A is 8.910 and that of Group B is 7.898 which is more than table value at $p < 0.05$ and this shows there is a significant difference within both the groups. The calculated values of paired 't' test for PEFR for Group A is 4.465 and that of Group B is 7.533 which is more than the table value at $p < 0.05$ and this shows there is a significant difference within both the groups. The calculated values of paired 't' test for Modified BORG's dyspnea score for Group A is 3.205 and that of Group B is 10.738 which is more than the table value at $p < 0.05$ and this shows there is a significant difference within both the groups. The calculated values of paired 't' test for Physical activity index for Group A is 4.039 and that of Group B is 3.22 which is more than the table value at $p < 0.05$ and this shows there is a significant difference within both the groups. Independent 't' test was performed between the post test values of two groups to analyze the significance of combination of NMES with usual pulmonary rehabilitation. Based on SMWT, PEFR, Modified BORG's dyspnea scale and PAI, calculated 't' values 3.901, 2.44, 3.638 and 0.735 are greater than the 'p' value, indicating there is significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients. From the above data it is clearly understood that combination of NMES with usual pulmonary rehabilitation shows significant improvement in functional exercise capacity and quality of life in mild to moderate COPD patients.

DISCUSSION

In 2012, Zanotti E, Bizzarri C et al, concluded that pulmonary rehabilitation and neuromuscular electrical stimulation may further improve exercise capacity and

quadriceps strength with respect to pulmonary rehabilitation alone. [1] This study additionally analysed quality of life with the help of physical activity index scale (PAI) along with the functional exercise capacity and dyspnoea level. This study mainly focused on improving quadriceps muscle weakness in mild to moderate young COPD patients. Because, Kharbanda et al, (2015) states that majority of the COPD patients were suffering from quadriceps weakness and they belonged to young age group who were suffering from mild disease. [4] In another reviewed article Sunita Mathur, DinaBrooks et al (2014) concluded that 30-40% of individuals with COPD experience muscle mass depletion. The associated changes are decreased proportion and size of type I fibres, reduced oxidative capacity and mitochondrial density in quadriceps, [3] this study results also shows some positive changes with the quadriceps muscle strength and functional capacity. Limitations of this study are the age of the patients in the inclusion criteria is limited with lesser number of cases and there was no withdrawal of drugs during the treatment session which may also affect the patient's functional outcome. Furthermore this study recommends, large sample size is suggested for finding the significant improvements. As the prevalence of COPD is more common in elderly patients (>60 years) the effect in those subjects can be studied. The number of sessions increased for reducing the reversibility of the condition. Regular follow up is recommended.

CONCLUSION

There is significant difference in the pre and post-test values within and between the groups in the six minute walk distance, PEFR and modified BORG'S dyspnea scale. Though there are no significant changes in PAI, it is evident that there is significant improvement in the patient's condition following NMES with usual pulmonary rehabilitation. Therefore it is concluded that combination of NMES with usual pulmonary rehabilitation shows significant

improvement in functional exercise capacity and quality of life in mild to moderate COPD patients.

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How to cite this article: Mahendiran M, Manivel A, Sandhya G et.al. Effects of neuromuscular electrical stimulation [NMES] on quadriceps muscle to improve the functional exercise capacity and quality of life in mild to moderate COPD patients. International Journal of Science & Healthcare Research. 2019; 4(4): 201-206.
