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COMPARISON OF NEUROMUSCULAR ELECTRICAL STIMULATION OF THE LOWER LIMBS COMBINED WITH PULMONARY REHABILITATION VERSUS PULMONARY REHABILITATION ALONE TO IMPROVE EXERCISE TOLERANCE AND QUALITY OF LIFE IN SUBJECTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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ABSTRACT

Background and Objective: Chronic Obstructive Pulmonary is a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible. The prevalence of Chronic Obstructive Pulmonary Disease in India was reported in between 6.6 to 7.7%. In Chronic Obstructive Pulmonary Disease there is reduction of expiratory flow rate and slowed emptying of lungs which leads to reduction in Exercise Tolerance and Quality of life. It is important to improve Exercise Tolerance and Quality of life in Chronic Obstructive Pulmonary Disease patients using a multidisciplinary approach tailored according to the patient's needs. Neuro Muscular Electrical Stimulation and Pulmonary Rehabilitation are proved to be effective in improving Exercise Tolerance and Quality of life in Chronic Obstructive Pulmonary Disease patients.

To our knowledge there were no studies done comparing Neuro Muscular Electrical Stimulation of the lower limbs and Pulmonary Rehabilitation. Hence need of the study arises.

Methods: Quasi Experimental study design, there were 108 subjects with average age of over 45 years, having a clinical diagnosis of Chronic Obstructive Pulmonary Disease were randomly allocated into two groups. Group A (n=54) received Neuro Muscular Electrical Stimulation of lower limb and combined with Pulmonary Rehabilitation and Group B (n=54) received Pulmonary Rehabilitation alone for intervention was given to participants 5 sessions per week for 4 weeks. The outcomes of this Neuro Muscular Electrical Stimulation of the lower limbs combined with Pulmonary Rehabilitation were measured by 6-Minute Walk Test for Exercise Tolerance and St. George Respiratory Questionnaire for Quality of life in subjects with chronic obstructive pulmonary disease.

RESULTS: Independent 't' test was used to compare the mean significance difference between continuous variables. Paired 't' test was used to assess the Statistical difference between pre and post test scores of Neuro Muscular Electrical Stimulation of the lower limb. Statistical analysis of this data revealed that within group comparison both groups showed significant

improvement in all parameters whereas in between groups Neuro Muscular Electrical

Stimulation of the lower limb combined with Pulmonary Rehabilitation group improved better

than the Pulmonary rehabilitation alone group.

CONCULSION: The present study concludes Neuro Muscular Electrical Stimulation of the lower limbs combined with Pulmonary Rehabilitation and pulmonary rehabilitation alone group showed significant improvements in reduction of Exercise Tolerance and Quality of life in subjects with Chronic Obstructive Pulmonary Disease. However, Neuro Muscular Electrical Stimulation of the lower limbs combined with Pulmonary Rehabilitation is more effective than Pulmonary Rehabilitation alone group. Therefore, it may be recommended from these findings that Neuromuscular Electrical Stimulation that may be used as an adjunct to Pulmonary Rehabilitation for treatment of Quality of life in Chronic Obstructive Pulmonary Disease subjects.

KEY WORDS: Chronic Obstructive Pulmonary Disease, Quality of life, Exercise Tolerance, Neuro Muscular Electrical Stimulation, Pulmonary rehabilitation.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable disease which is characterized by persistent pulmonary symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to various noxious particles or gases and influenced by host factors including abnormal lung development. Emphysema and Chronic bronchitis are the pathological terms that is often used clinically and describes the several structural abnormalities and clinical symptoms present in patients with Chronic Obstructive Pulmonary Disease[1].

According to World Health Organization (WHO) Chronic obstructive pulmonary disease (COPD) is a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible. COPD is also known as "smoker's cough" which can be one of the most under- diagnosed, life-threatening lung disease[2].

The worldwide incidence rate of COPD was 8.9/1000 persons. The incidence rate was higher in males and in non-smokers. (2) The prevalence of COPD in India was reported to be between

6.6 to 7.7 % [3].

Globally there are around 3 million deaths annually, with the increasing prevalence of smoking in developing countries, and aging populations in high income countries, the prevalence of COPD is expected to raise over the next 30 years and by 2030 there may be over 4.5 million deaths annually from COPD and related conditions [4].

COPD caused by chronic exposure of genetically susceptible individuals to environmental factors. Tobacco smoke, biomass fuel exposure, passive smoking, exposure to dust and fumes, history of repeated lower respiratory tract infections during childhood, history of pulmonary tuberculosis, chronic asthma, Alpha-1 antitrypsin deficiency, poor nourishment, poor socioeconomic status [5].

When the lungs are exposed to noxious substances such as tobacco, they develop persistent inflammatory response. If the exposure becomes a recurrent process, the lungs develop chronic

inflammatory response which causes lung parenchymal damage (emphysematous changes) and fibrosis leading to air trapping and progressive air flow limitation. The peripheral airway obstruction progressively traps the air in the alveoli during expiration, resulting in hyperinflation. Due to this hyperinflation which reduces inspiratory capacity particularly during exercise leading to increased dyspnea and limitation of exercise capacity [6]

Important symptoms include dyspnea in 84% of individuals, fatigue (81%), running nose (59%), changes in sputum colour (53%) or amount of sputum (47%) and cough (44%) [7].

One of the most common extra pulmonary manifestations of is Chronic Obstructive Pulmonary Disease limb muscle dysfunction which is about 1/3rd of Chronic Obstructive Pulmonary Disease patients.

In Chronic Obstructive Pulmonary Disease patients, the intramuscular characteristics may get deteriorate along with disease severity and thus the proportion of type 1 muscle fibers in Quadriceps muscle is inversely correlated with FEV_1 [9]. Poor exercise capacity is a major complaint among persons with Chronic Obstructive Pulmonary Disease. Furthermore, as exercise capacity worsens patients are more likely to curtail their normal activities and thus, become disabled, consistent with classic models of disablement muscle dysfunction of lower extremities has been identified as a specific cause of exercise impairment in Chronic Obstructive Pulmonary Disease [10].

The diagnosis of COPD is mainly confirmed by Lung function tests considering a ratio FEV_1 / FVC value < 70 % [11]. Spirometry is the standard reference for diagnosing and assessing the severity of COPD, A short acting Bronchodilator should be administered in case of obstruction of spirometry and the patient is retested in 15 minutes to establish the diagnosis incompletely reversible obstruction, a hallmark of Chronic obstructive pulmonary disease [12]. for Chronic Obstructive Pulmonary Disease. peripheral muscle weakness is commonly found in Chronic Obstructive Pulmonary Disease and may play a role in reducing exercise Tolerance.

Recent studies suggests that Neuro muscular electrical stimulation and pulmonary rehabilitation in improving exercise Tolerance and Health - Related Quality of Life in patients with Chronic Obstructive Pulmonary Disease.

Neuro muscular electrical stimulation: Neuromuscular electrical stimulation has been successfully used as a localized training modality in severely disabled patients, in these studies Neuromuscular electrical stimulation was applied to patients with the most severe muscle dysfunction and disease like chronic obstructive pulmonary disease. Neuromuscular electrical stimulation has been suggested as an alternative rehabilitative therapy to enhance exercise performance and skeletal muscle function in chronic obstructive lung disease and to increasing exercise capacity, quadriceps strength, muscle mass, cross-sectional area, and quality of life and decreasing dyspnea in with chronic obstructive lung disease. [13]

Pulmonary rehabilitation: which is a program that helps improve the well-being of people who have chronic breathing problems. It may include, An exercise program, Disease management training Nutritional counseling, psychological counseling. It is considered essential throughout the lifetime management of patients with symptomatic chronic respiratory disease. It requires the coordinated action of a multidisciplinary health care team in order to deliver an individualized rehabilitation program to best effect incorporating multiple modalities, such as advice on smoking cessation, exercise training and self-management education. [14]

They were limited studies in the literature to determine Neuromuscular electrical stimulation of the lower limbs combined with Pulmonary rehabilitation is effective in improving Exercise Tolerance and Health Related Quality of Life in Chronic Obstructive Pulmonary Disease so, this study is aimed at determining the effect of Neuromuscular electrical stimulation of the lower limbs to improve Exercise Tolerance and Quality of Life.

NEED OF THE STUDY

Chronic Obstructive Pulmonary Disease is a systemic disease, in extrapulmonary manifestations including impaired skeletal muscle function leading to decrease muscle strength and endurance. The physical activity thereby causing muscle deconditioning and decrease exercise tolerance which further encourages sedentary life style. The muscular skeletal fatiguability presenting in chronic obstructive pulmonary disease focusing on improvement of exercise tolerance and placed an important role to improve the quality of life.

Neuromuscular electrical stimulation is used in physical therapy to improve muscle strength and endurance, peripheral circulation and to retain motor function. Neuro muscular electrical stimulation stimulate the muscles to a greater extent than voluntary muscle activities, neuromuscular electrical stimulation of lower limbs increases skeletal muscle mass, strength and exercise capacity. Pulmonary rehabilitation eases the symptoms of the condition and produces muscle endurance and it is a exercise programme, which includes overall quality of life and physical performance in chronic obstructive pulmonary disease. Many studies have been proved that to evaluate Exercise tolerance in Neuromuscular electrical stimulation of the lower limbs combined with pulmonary Rehabilitation versus pulmonary rehabilitation alone, but the comparison of this study is minimal.

so, the need of the study arises to compare the effectiveness of Neuromuscular electrical stimulation of the lower limbs combined with Pulmonary Rehabilitation and Pulmonary Rehabilitation alone to improve Exercise Tolerance and Quality of life in subjects with chronic obstructive pulmonary disease.

MATERIALS AND METHODS

STUDY DESIGN: Quasi-Experimental study design.

ETHICAL CLEARANCE AND INFORMED CONSENT: The study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital (Annexure-I), the investigator explained the purpose of the study and given the subject information sheet. The participants were requested to provide their consent to participate in the study (Annexure-II). All the participants signed the informed consent and the rights of the included participants have been secured.

STUDY POPULATION: Subjects clinically diagnosed as chronic obstructive pulmonary disease by an pulmonologist.

STUDY SETTING: The study was conducted at Department of Pulmonology, GSL general hospital, Rajamahendravaram, Andhra Pradesh, India.

STUDY DURATION: The study was conducted for a period of one year.

TREATMENT DURATION: 5 sessions per week for 4 weeks, 20 sessions

STUDY SAMPLING METHOD: convenience sampling method.

SAMPLE SIZE: A total member of 120 subjects for prevalence of 11.36% of COPD were screened in that 108 subjects were recruited who met the inclusion criteria and willing to participate in the study, the recruited participants were explained about the study. After obtaining informed consent form and meeting the criteria, total 108 subjects were allocated into two groups equally by convenience sampling method.

GROUPA: Neuromuscular electrical stimulation of the lower limbs combined with pulmonary rehabilitation (54 subjects).

GROUP B: Pulmonary rehabilitation alone (54 subjects).

GROUP	NO. OF SUBJECTS	TREATMENT
GROUP A	54	NEUROMUSCULAR ELECTRICAL STIMULATION OF THE LOWER LIMBS COMBINED WITH PULMONARY REHABILITATION
GROUP B	54	PULMONARY REHABILITATION ALONE

MATERIALS USED

- Electrical stimulator
- Consent form
- Data collection forms
- Pulse oximeter
- sphygmomanometer
- Stop watch
- Measuring tape
- Recording sheet
- St George Questionnaire
- Assessment proforma

CRITERIA FOR SAMPLE COLLECTION

INCLUSION CRITERIA

- COPD patients who is stable and diagnosed by pulmonologist
- Patients between the ages of 40 - 60 years
- Patients who are on COPD medications [bronchodilators and mucolytics]
- According COPD classification of GOLD Guide line stage 2 (FEV1/FVC<70%,50%<FEV1<80%)

EXCLUSION CRITERIA

- COPD with acute exacerbations
- Neuro-Musculoskeletal disorder
- Previous lung surgery
- Hypertension
- Arrhythmia
- Ventricular tachycardia
- Ischemia during exercise testing
- Cor pulmonale

OUTCOME MEASURES

Six Minute Walk Test: Six Minute Walk Test is a potential patient Centered outcome parameter for therapies aimed at improving exercise capacity in COPD patients. 6- Minute Walk Distance is used for measurement of distance walked during a 6- minute period on a level surface. 6 Minute Walk Test is a practical and simple, which requires a 100-ft hallway but doesn't require any exercise equipment or advanced training. This test measures the distance how quickly walked by the patient on a flat, hard surface in a period of 6- minutes. It is used to evaluate the sub- maximal level of functional capacity. 6MWT was performed indoors in an enclosed corridor with a hard surface that is seldom travelled. The walking course must be 30 meters in length, hence a 100-ft hallway is required. Length of corridor was marked at every 3 meters and turnaround points are marked with a cone (orange traffic cone). A starting line, which marks the beginning, and ends of each 60meters lap, should be marked on floor using a color tape. The intra-and inter-rater reliability (Intraclass Correlation Coefficient, ICC1.1) of 6Minute Walk Test was 0.98 (lower limit 95% CI: 0.94) and 0.96 (lower limit 95% CI: 0.94) [15,16,17,18]

Fig no 1: Measurement of 6minute walk distance

The St. George's Respiratory Questionnaire (SGRQ) – To assess the Health Related Quality of Life (HRQOL). The Saint George 's Respiratory Questionnaire is a self-Administered Health related quality of life measure containing 50 items and 76 weighted responses divided into two components: symptoms, activity, The symptoms component contains items addressing the symptomatology, frequency of cough, sputum production, wheeze, breathlessness, and the duration and frequency of breathlessness or wheeze. The activity component addresses physical activities that either cause or are limited by breathlessness. Scores ranging from 0 to 100 were calculated for each component, as well as a total score that summarizes the responses to all items. A zero score indicates no impairment of health-related quality of life. The questionnaire takes approximately10 min to be filled out.[19]

INTERVENTIONS

This is a 4 weeks study which includes Neuromuscular Electrical stimulation of the lower limbs combined with Pulmonary Rehabilitation for Group-A and Pulmonary Rehabilitation alone for Group-

B. The outcomes were measured by the Six-minute walk test for Exercise Tolerance and the St. George Respiratory Questionnaire for Quality of life, all subjects who were eligible for the criteria were randomly allocated into Group-A and Group-B.

GROUP-A

NEUROMUSCULAR ELECTRICAL STIMULATION:

The procedure consisted of applying the electrodes to closer and distal end points of the muscle belly of the quadriceps and gastrocnemius muscles. A commutative, symmetric rectangular current of 35 Hz frequency was used. And the impulse duration amounted to 0.3 milli sec. Duration of series of impulses (duration of muscle contraction) amounted to 2 s, whereas the pause between the series of impulses lasted 4 s. The neuromuscular electrical stimulation training protocol applied to each leg of the sequence (15 minutes at a time the first week, 30 minutes at a time the further weeks).[20]

Electrode placement lower limb muscle groups bilaterally primarily quadriceps, gastrocnemius frequently also hamstring and calf muscles. Subjects sitting with knee flex 65 - 90 degrees with the waveform biphasic rectangular current of 35 Hz frequency used and the pulse duration of 0.3 milli sec the stimulated part to be exposed, so that observe the muscle contraction neuro muscular electrical stimulation was applied in each thigh 5 times per week, for 4 weeks, lasting 30 min per session. The electrodes were positioned over the motor-point in order to produce skeletal muscle contractions as a result of intra-muscular nerve branch activation.[21,22]

Fig no 2: Neuromuscular Electrical Stimulation to Quadriceps muscle.

Fig no 3: Neuromuscular Electrical Stimulation to Calf muscles

GROUP – B

PULMONARY REHABILITATION:

The pulmonary rehabilitation program consists of breathing techniques emphasis diaphragmatic breathing, deep breathing and forced expiratory techniques. which is beneficial to the removal of secretions and improvement of pulmonary function.

Exercises are composed of four dimensions: warm up (10 min), aerobic training (20 min), resistance training (15 min) and cool down (10 min) which occur 5 sessions per week for 4 weeks.[23,24]

10 minutes of warm up exercises:

The warm up exercises consist of light stretches for 10 minutes which includes stretching of Neck (flexion, extension and lateral extension), Upper limbs (Shoulder flexion, extension and abduction), Thorax (lateral flexion and rotation), Lower limbs (quadriceps, hip flexors and gastrocnemius) and Walk slowly for 3 min.

Aerobic training:

Aerobic training includes jogging or walking fast and Treadmill training for 20 minutes, load adjustment individualized and performed in intervals mode if there is difficulty in sustaining continuous exercise

Resistance training:

Resistance training for 15 minutes which includes Upper limb (Shoulder lift, abduction and horizontal abduction) Lower limb (Squat and sit to stand)

10 minutes of cool down exercises:

End of the session, the subjects were asked to perform cool down exercises followed by stretching exercises

1	Warm up exercises	-Neck: flexion, extension and lateral extension -Upper limbs: Shoulder flexion, extension and abduction -Thorax: lateral flexion and rotation -Lower limbs: quadriceps, hip flexors and gastrocnemius -Walk slowly for 3 min	10 min
2	Aerobic training	-Jogging or walking fast -Treadmill training	20 min
3	Resistance training	-Upper limb: Shoulder lift, abduction and horizontal abduction -Lower limb: Squat and sit to stand	15 min
4	Cool down exercises	Same as warm up exercises	10 min

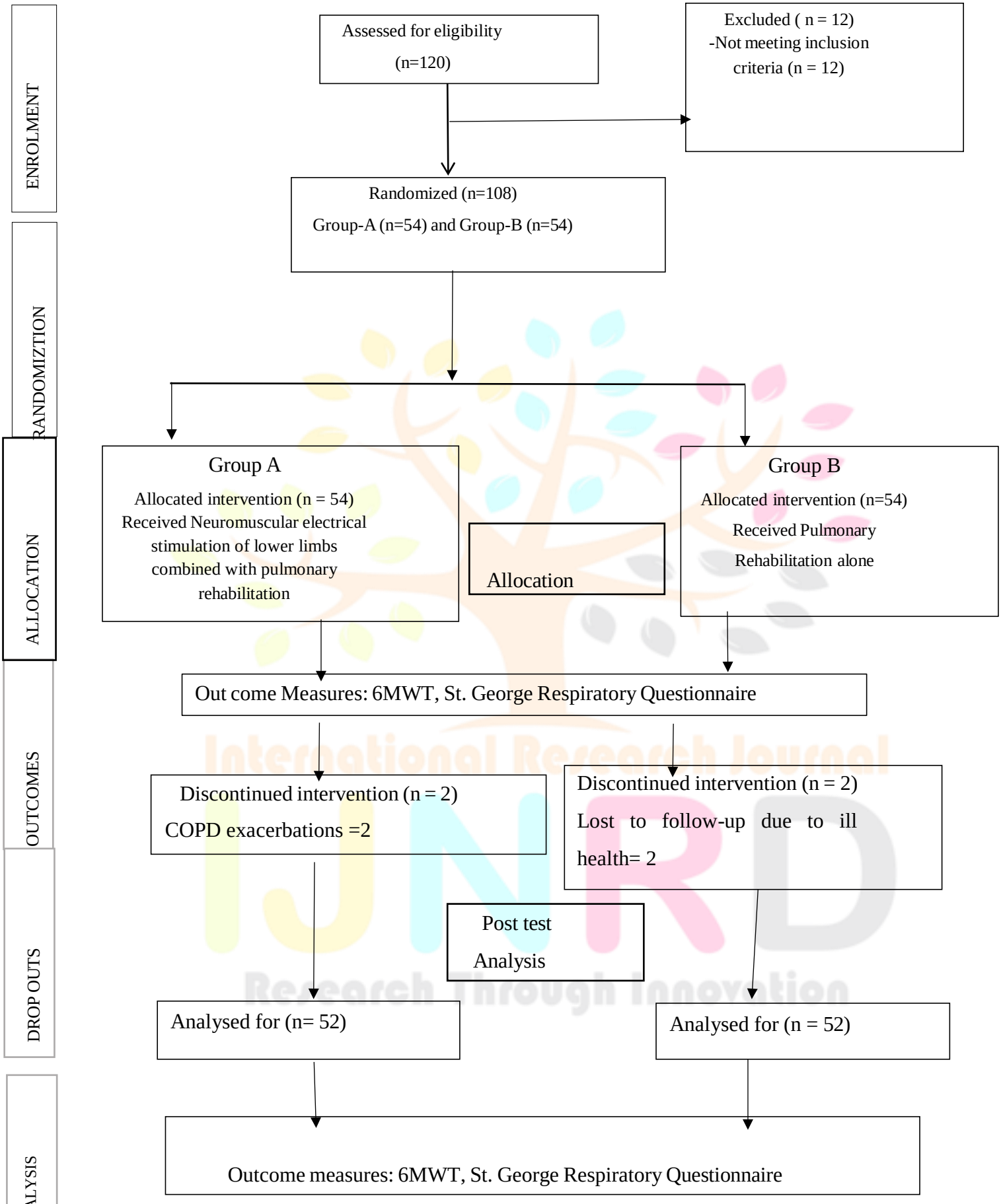
Fig no 4: Subject performing Diaphragmatic Breathing Exercise

Fig no 5 : Subject performing Aerobic Exercise

Fig no 6: Subject performing Resistance Training Exercises

Fig no 7: Subject performing Stretches

FLOW CHART


ENROLMENT
RANDOMIZTION
ALLOCATION
OUTCOMES
DROP OUTS
POS TEST ANALYSIS
Assessed for eligibility (n=120)
Excluded (n = 12) -Not meeting inclusion criteria (n = 12)
Randomized (n=108) Group-A (n=54) and Group-B (n=54)
Group A
Allocated intervention (n = 54) Received Neuromuscular electrical stimulation of lower limbs combined with pulmonary rehabilitation
Allocation
Group B
Allocated intervention (n=54) Received Pulmonary Rehabilitation alone
Out come Measures: 6MWT, St. George Respiratory Questionnaire
Discontinued intervention (n = 2) COPD exacerbations =2
Discontinued intervention (n = 2) Lost to follow-up due to ill health= 2
Post test Analysis
Analysed for (n= 52)
Analysed for (n = 52)
Outcome measures: 6MWT, St. George Respiratory Questionnaire

STATISTICAL ANALYSIS

All Statistical analysis was done by using SPSS software version 21.0 and MS excel -2010. Descriptive data was presented as mean +/- standard deviation and percentages.

Data was tabulated and graphically represented. Data was analyzed by using both descriptive and inferential statistics.

With in the group: Paired 't' test was used to compare the levels of pre and post test scores (nonparametric or parametric accordingly). It was used to assess the statistical difference with in the six-minute walk test and St. George Respiratory questionnaire.

Between the group: Un paired 't' test was used to compare the statistical difference between the mean of two independent groups for six-minute walk test and St. George Respiratory Questionnaire.

For all statistical analysis, $p - value < 0.05$ was considered as statistically significant.

RESULTS

The Results of the study were analyzed by Six-minute walk test and St. George Respiratory Questionnaire to see the improvement in Exercise Tolerance and Quality of life.

The consort flow chart of the study showed the study organization in terms of subjects screening, Random allocation and Analysis following the intervention.

A Total number of 120 subjects with chronic obstructive pulmonary disease were screened for eligibility, among 108 subjects were included in the study trail. All the 108 subjects undergone baseline assessment and subjects who met inclusion criteria were randomized into two equal groups in which Group A consists of 54 subjects and Group B consists of 54 subjects.

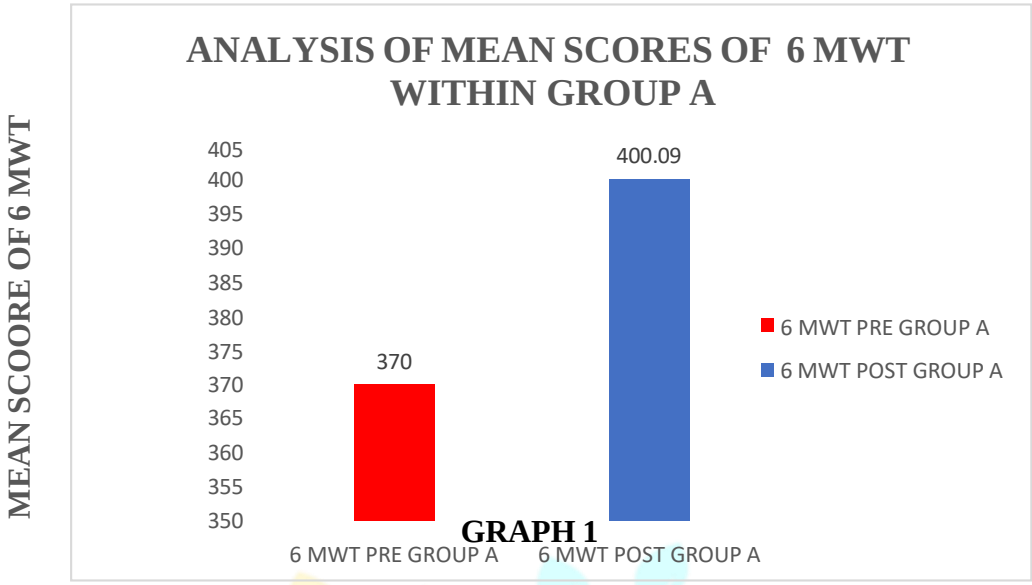
In this study 52 subjects completed training in Group-A and 52 subjects completed training in Group- B with dropouts of 2 and 2 in respective groups, results showed that there is a statistical difference in two groups.

Comparison was done both within the group as well as in between the two groups so, as to evaluate the intra group and inter group effectiveness of Neuro Muscular Electrical Stimulation of lower limbs combined with pulmonary rehabilitation and pulmonary rehabilitation alone. Which are under the considerations in the present study.

ANALYSIS OF MEAN SCORES OF 6MWT WITHIN GROUP A

Group-A		Mean	Standard Deviation	P - Value	Inference
6 MWT	Pre	370	20.93	0.001	Highly significant
	Post	400.09	28.86		

TABLE – 1



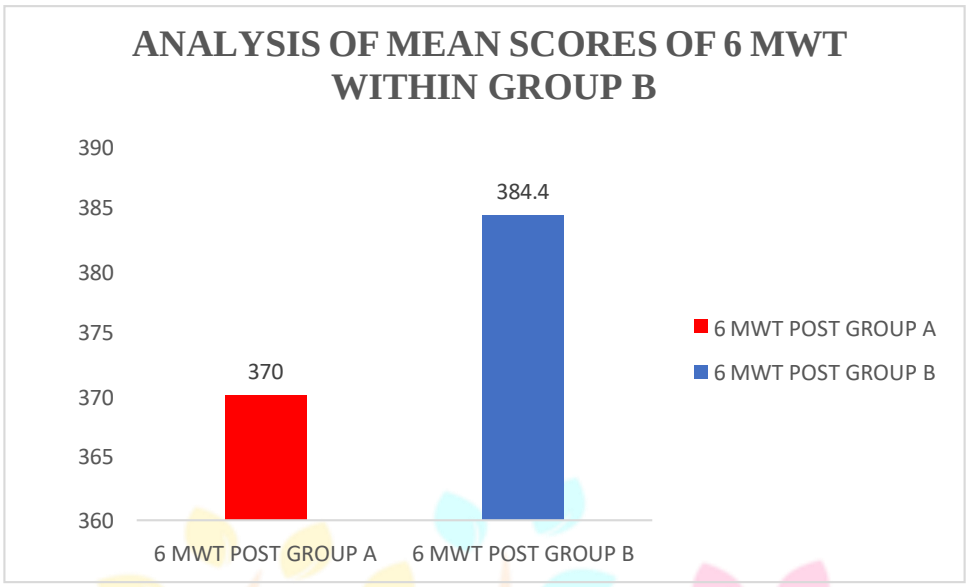
GRAPH 1

RESULTS: The above table and graphs shows the mean scores of Six minute walk test Changes from pre-test to post-test values within Group - A were found to be statistically highly significant (P <0.0005).

ANALYSIS OF MEAN SCORES OF 6 MWT WITHIN GROUP B

Group- B	Mean	Standard Deviation		P-Value	Inference
6MWT	Pre	370	21.02	0.001	Highly significant
	Post	384.40	26.45		

TABLE -2



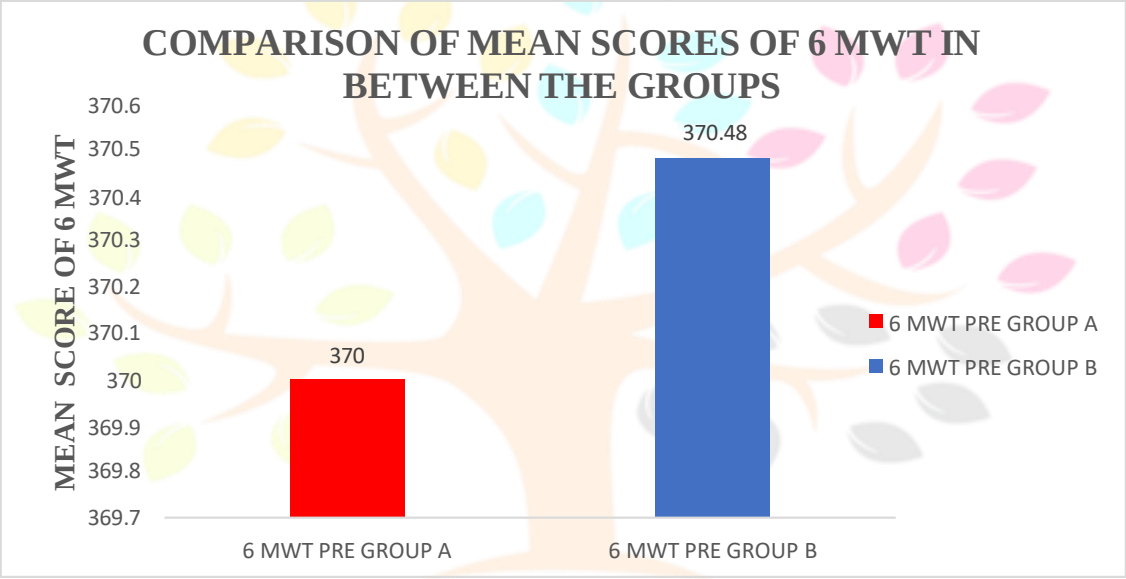
GRAPH 2

RESULTS:- The above table and graph shows that the mean score of Six minute walk test changes from pre-test to post-test values within Group-B were found to be statistically highly significant (P<0.0005).

COMPARISON OF MEAN SCORES OF 6MWT IN BETWEEN THE GROUPS (PRE-TEST)

6MWT		Mean	Standard Deviation	P-Value	Inference
Pre	Group A	370	20.93	0.9072	Insignificant
	Group B	370.48	21.02		

TABLE -3



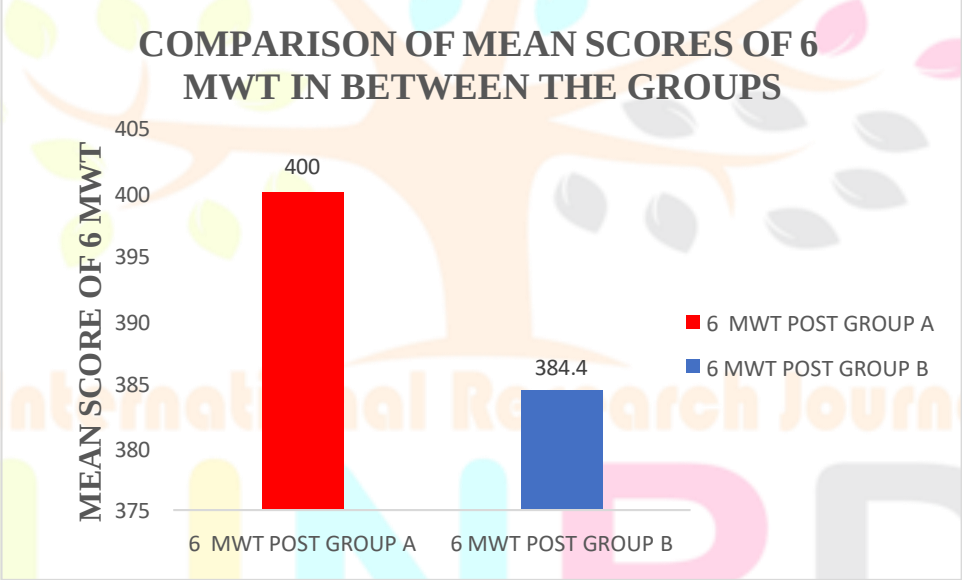
GRAPH 3

RESULTS :- The above table and graph shows that the baseline measurement of Six minute walk test mean scores in between the groups. Six minute walk test mean score in Group-A is 370 and Group-B is 370.48 which were found to be statistically insignificant**.**

COMPARISON OF MEAN SCORES OF 6MWT IN BETWEEN THE GROUPS (POST - TEST)

6MWT		Mean	Standard Deviation	P-Value	Inference
POST	Group A	400	28.86	0.001	Highly significant
	Group B	384.4	26.45		

TABLE -4



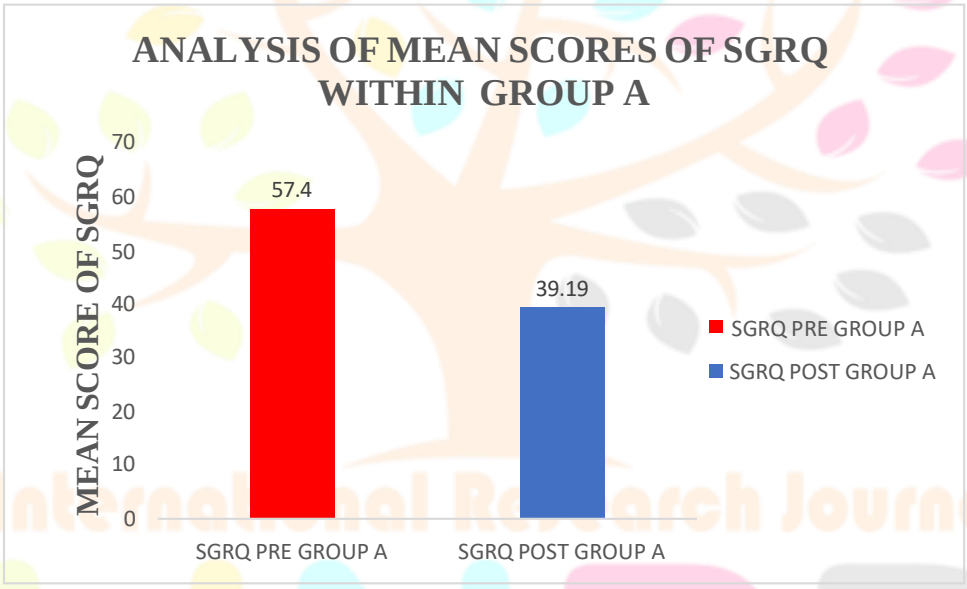
GRAPH 4

RESULTS :- The above table and graph shows that the Post-test measurement of Six minute walk test mean scores in between the groups. Six-minute walk test mean score in Group-A is 400 and Group-B is 384.4 which were found to be statistically highly significant**.**

ANALYSIS OF MEAN SCORES OF SGRQ WITHIN GROUP -A

Group-A		Mean	Standard Deviation	P-value	Inference
SGRQ	Pre	57.4	5.68	0.001	Highly significant
	Post	39.19	4.42		

TABLE -5



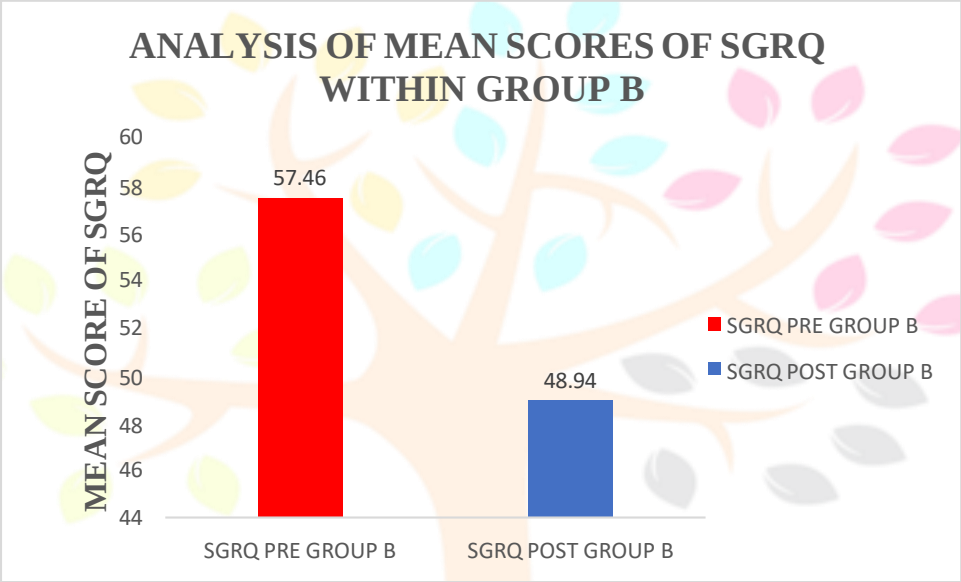
GRAPH-5

RESULTS: The above table and graphs shows that the mean scores of SGRQ Changes from pre-test to post-test values within Group - A were found to be statistically highly significant (P <0.05).

ANALYSIS OF MEAN SCORES OF SGRQ WITHIN GROUP B

Group-B		Mean	Standard Deviation	P-Value	Inference
SGRQ	Pre	57.4	5.66	0.001	Highly significant
	Post	48.94	7.83		

TABLE -6



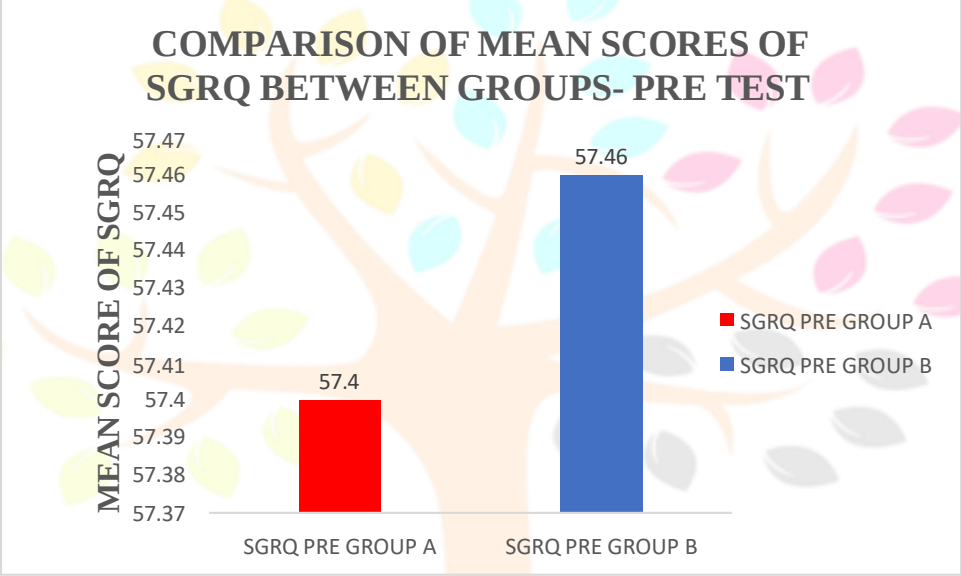
GRAPH-6

RESULTS: The above table and graphs shows that the mean scores of SGRQ Changes from pre-test to post-test values within Group – B were found to be statistically highly significant (P <0.05).

COMPARISON OF MEAN SCORES OF SGRQ IN BETWEEN THE GROUPS (PRE-TEST)

SGRQ		Mean	Standard Deviation	P-Value	Inference
Pre	Group A	57.4	5.68	0.9587	Insignificant
	Group B	57.46	5.66		

TABLE -7



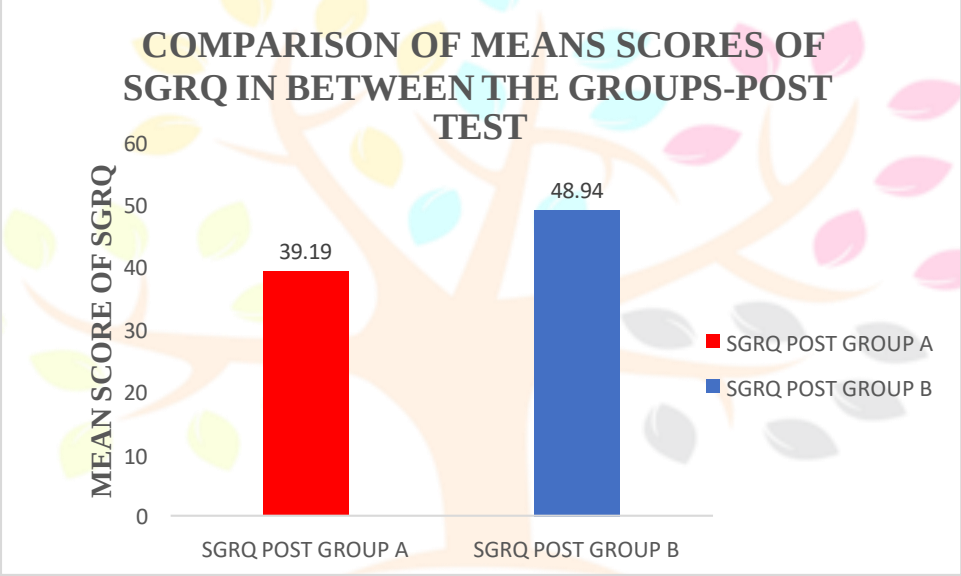
GRAPH -7

RESULTS :- The above table and graph shows that the baseline measurement of SGRQ mean scores in between the groups. SGRQ mean score in Group-A is 57.4 and Group-B is 57.46 which were found to be statistically insignificant**.**

COMPARISON OF MEAN SCORE OF SGRQ IN BETWEEN THE GROUPS (POST-TEST)

SGRQ		Mean	Standard Deviation	P-Value	Inference
Post	Group A	39.19	4.42	0.001	Highly significant
	Group B	48.94	7.83		

TABLE -8



GRAPH-8

RESULTS :- The above table and graph shows that the Post-test measurement of SGRQ mean scores in between the groups. SGRQ mean score in Group-A is 39.19 and Group-B is 48.94 which were found to be statistically highly significant.

DISCUSSION

The Aim of the study was to assess the effectiveness of Neuro Muscular Electrical Stimulation of the lower limbs combined with Pulmonary Rehabilitation verses Pulmonary Rehabilitation Alone for improving Exercise Tolerance and Quality of Life in Chronic Obstructive Pulmonary Disease subjects. Neuro Muscular Electrical Stimulation is one of the most used recent treatment techniques,

In this study, subjects were assessed for six-minute walk test and St. George Respiratory Questionnaire at base line and at end of intervention using Exercise Tolerance for six-minute walk test and St. George Respiratory Questionnaire for Quality of life. There were two drop outs in Group-A (Neuro Muscular Electrical Stimulation of lower limbs combined with Pulmonary Rehabilitation), for due to Chronic Obstructive Pulmonary Disease Exacerbations and two dropouts in Group-B (Pulmonary Rehabilitation alone) due to ill health.

In Group-A there is statistically more significant improvement in six-minute walk test (P=0.001) and also improvements seen in St. George Respiratory Questionnaire (P=0.001). Neuromuscular Electrical Stimulation uses conductive pads over the muscle and an intermittent electrical current to stimulate the muscle fibers, intramuscular nerve branches and action potentials to produce a powerful contraction, an already programmed stimulation device is connected to the conductive pads. A sequence of contractions that encourages strength or endurance improvements in the muscle can be favored by adjusting the stimulation parameters.

Because the ventilatory system is impaired in individuals with Chronic obstructive pulmonary disease, intense dyspnea frequently limits the amount of time that an effective training stimulus may be

sustained during aerobic exercise. Neuromuscular Electrical Stimulation on other hand isolates muscle regions that contract, reducing the ventilatory demand overall. Because of this, Neuromuscular Electrical Stimulation may be a suitable choice for Chronic obstructive pulmonary disease subjects whose dyspnea is so severe that it prevents them from engaging in aerobic exercise training at a level high enough to condition the peripheral muscles. Given that decreased Quadriceps function has been linked to impairments in exercise capacity, it is probable that strengthening these muscles using Neuromuscular Electrical Stimulation will boost Exercise Tolerance.

Amal Acheche et al 2020[25] conducted a study on Neuromuscular Electrical Stimulation with Endurance and Resistance Training on Exercise Capacity and Balance in Subjects with Chronic Obstructive Pulmonary Disease. The participants in one group were treated with Endurance and Resistance Training and Neuromuscular Electrical Stimulation and participants in another group treated with only Endurance and Resistance Training. Neuromuscular Electrical Stimulation improved better the static and dynamic balance and exercise tolerance, as well as the lower limb strength compared with training without Neuromuscular Electrical Stimulation in subjects with Chronic Obstructive Pulmonary Disease.

Roy Meys et al 2020[26] conducted a study on Impact of Mild - Moderate Exacerbations on outcomes of Neuromuscular Electrical Stimulation in patients with COPD. Mild - Moderate Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) does not impact clinical outcomes, adherence or intensity in patients with severe chronic obstructive pulmonary disease during a Pulmonary Rehabilitation program that is largely focused on Neuromuscular electrical stimulation. With High frequency- Neuromuscular Electrical Stimulation being the preferred muscle training technique, continuing Neuromuscular Electrical Stimulation appears to be a workable way to potentially reverse Exacerbation related Lower limb Muscle dysfunction and improve outcomes of Pulmonary Rehabilitation.

Mateo AC et al 2021[27] conducted a study on Neuromuscular electrical stimulation (NMES) program in exercise capacity of hospitalized severely hypoxemic Chronic Obstructive Pulmonary Rehabilitation (COPD) patients. Hospitalized patients were randomly assigned to one of three groups in this clinical trial, control group, Neuromuscular electrical stimulation group, exercise group. Every group was given the same medical care, a daily schedule of physical exercise and breathing was also given to the exercise group. Daily lower limb exercise

were given to the patients in the Neuromuscular electrical stimulation group in addition to an Neuromuscular electrical stimulation program. Concluded that an Neuromuscular electrical stimulation program can enhance lower limb strength and static balance in hospitalized patients with severely hypoxemic Chronic Obstructive Pulmonary Disease, hence enhancing their ability to exercise.

Current study Neuromuscular Electrical Stimulation of the lower limbs combined with Pulmonary Rehabilitation group is positive correlation with previous studies mechanism because Exercise tolerance measured on six-minute walk test and Quality of life measured on St. Geroge Respiratory Questionnaire.

Group-B (Pulmonary Rehabilitation) of current study had significant improvement in six-minute walk test (P=0.001) and also improvements seen in St. George Respiratory Questionnaire (P=0.001). pulmonary Rehabilitation programs to Chronic obstructive pulmonary disease in patients include reducing symptoms, improving exercise tolerance and health related quality of life and increasing physical activity and enhances emotional function, reduces fatigue and makes it easier to perform daily tasks. Clinically these advantages are both significant and comparatively wide ranging. Rehabilitation is a crucial part of managing Chronic Obstructive Pulmonary Disease and enhances training related to health and quality of life. In our current study participants were taken warm up as stretches, aerobic training, resistance training and cool down exercises.

Spielmanns M et al 2023[28] conducted a study on clinical effects of pulmonary rehabilitation in very old patients with COPD. Stated that all patients groups with COPD, even the oldest (>85 years), benefited from Pulmonary Rehabilitation regardless of their age and according to the assessments.

Arnold MT et al 2020[29] conducted a study on Pulmonary Rehabilitation for Chronic Obstructive Pulmonary Disease. Stated that Pulmonary Rehabilitation remains one of the most successful interventions to help COPD patients maintain an active and healthier lifestyle.

Higashimoto Y et al 2020 [30]conducted a study on Effect of pulmonary rehabilitation programs including lower limb endurance training on dyspnea in stable COPD. In this systematic review and meta-analysis demonstrated that a minimal essential Pulmonary Rehabilitation program including lower limb endurance training with an adequate intervention period (4-12 weeks) improves dyspnea as well as exercise capacity and Health related Quality of life in patients with stable COPD.

The study findings indicating that after 4 weeks of interventions neuromuscular electrical stimulation of the lower limbs combined with pulmonary rehabilitation was more effective than pulmonary rehabilitation alone in improving exercise tolerance and quality of life. Thus this study concludes that Neuromuscular electrical stimulation of the lower limbs combined with pulmonary rehabilitation is useful in subjects with Chronic Obstructive Pulmonary Disease.

LIMITATIONS

1. Small sample size.
2. Lack of control group in this present study.
3. Lack of long term follow up.
4. Lack of blinding of evaluators.

RECOMMENDATIONS FOR FURTHER RESEARCH

1. Sample size can be increased with inclusion of a greater number of subjects to generalized the effects of these 2 techniques in larger population.
2. Further studies are recommended for long term follow up.
3. Large sample size.

CONCULSION

The present study concludes Neuro Muscular Electrical Stimulation of lower limbs combined with Pulmonary Rehabilitation group and Pulmonary Rehabilitation alone group showed significant improvement in reduction of Exercise Tolerance and Quality of Life in subjects with Chronic Obstructive Pulmonary Disease. However, Neuro Muscular Electrical Stimulation of lower limbs combined with Pulmonary Rehabilitation group is more effective than Pulmonary Rehabilitation Alone group. Hence, we conclude that Neuro Muscular Electrical Stimulation of lower limbs combined with Pulmonary Rehabilitation is a suitable adjunct to Pulmonary Rehabilitation Alone in subjects with Chronic Obstructive Pulmonary Disease.

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