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Original Research Article

Effect of Lower Limb Strengthening Exercises on Stair Climb Power Test and 6 Minute Walk Test in COPD Patients

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death in the world. 6MWT gives the patient's walking ability whereas SCPT gives the patient's ability to climb steps, which is dependent on lower limb muscle power. The Aim of this study was to determine the effect of lower limb strengthening on 6 Minute Walk Test & Stair Climb Power Test by incorporating progressive resistive exercises.

Method: 60 patients were enrolled for the study. The patients were recruited into control group and experimental group by simple random method. There were 33 patients in control group and 27 in experimental group. Both the groups were treated separately thrice in a week for 6 weeks. Experimental group received conventional physiotherapy and progressive resistive training of quadriceps and hamstring muscles by using 1RM .Control group received only conventional physiotherapy. 6MWT and SCPT were taken pre and post training in both the groups.

Result: In the Experimental group, the pre post comparisons of 6MWT, SCPT, 1RM Quadriceps and Hamstrings were done using the paired t test, there was a statistically significant increase in 6MWD, SCPT, 1RM ($p=0.000$, $p<0.05$). In control group paired t test were used and there was no significant increase in 6MWD, SCPT, 1RM for Quadriceps and Hamstring (p=.096, .152, .161, .161) respectively ($p>0.05$). The comparison of differences in 6MWT, SCPT, 1RM Quadriceps and Hamstrings between the experimental and Control groups were done using Mann Whitney U test. The experimental group showed increase in 6MWD, SCPT, 1RM for Quadriceps and Hamstrings compared to control group, which was statistically significant ($p=0.000$, $p<0.05$).

Keywords: SCPT (stair climb power test), 6MWD (6 minute walk distance), RM (repetition maximum)

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death in the world. It is a major cause of morbidity and mortality throughout the world. Many people suffer from this disease for years and die prematurely from its complication.[1]

It has been estimated that by the year 2030, COPD will become the third biggest cause of death. According to the World Health Organization, COPD kills more people than HIV-AIDS, Malaria and Tuberculosis all put together in the South East Asian region. Mortality rates due to COPD are anticipated to increase by over 160% over the next 2 Decades. Half a million people die every year due to COPD in India, which is over 4 Times the number of people who die due to COPD in USA and Europe. COPD has emerged as the major cause of morbidity and mortality expected to become the 3rd most leading cause of death and the 5th leading cause of loss of 'Disability Adjusted Life Years' (DALYs) as per projection of the Global Burden of

Disease Study (GBDS)[2]. COPD being a chronic, progressive disease poses a huge economic burden on the patient as well as the health-care systems. There is a direct relationship between the severity and the cost of care, and the distribution of cost changes as the disease progresses.[3]

Exercise intolerance is a characteristic and incapacitating outcome of COPD. The Physiologic mechanisms underlying exercise intolerance are increasing airways resistance, ineffective ventilation, hyperinflation and increased elastic load to breathing, gas exchange abnormalities, and mechanical disadvantage of the respiratory muscles. Skeletal muscle dysfunction is another important factor that contributes to exercise intolerance and is a common systemic co-morbidity of COPD. It is a better predictor of disease mortality than lung function[4,5,]. Muscle abnormalities observed in patients with COPD include muscle atrophy, reduced oxidative metabolism, reduced muscle capillarization and change in muscle fiber type (reduced proportion of type I fibers and increased proportion of type II b which contribute to leg and arm fatigue.)[6,7]. Deconditioning has been traditionally suggested as the main reason for the presence of these peripheral muscle abnormalities in patients with COPD[8]. Other important factors contributing to skeletal muscle changes include malnutrition, exposure to corticosteroids, tissue hypoxia, coexisting heart disease, systemic inflammation (elevated levels of cytokines)[9], skeletal muscle apoptosis, oxidative stress, tobacco use, individual susceptibility and hormone alterations [10,11].

Studies have shown that physical training enhanced the muscle function in these patients, suggesting that inactivity is an important contributor to skeletal muscle dysfunction [12, - 14].

Studies have shown that individuals with COPD have impaired muscle force of both lower and upper limb. There might be a preferential involvement of lower limb muscle over upper limb muscle. The quantification of physical activities in daily life in COPD patients reported that these patients reduces the use of lower limbs while the use of upper limbs remain unchanged[15,16]. Bernard et al have found that quadriceps strength was more affected than pectoralis major and latissimus dorsi.[7,17-19]. In COPD patients, shoulder girdle muscles such as pectoralis major, pectoralis minor, latissimus dorsi, serratus are regularly active during quite breathing. Whereas these muscles are generally not used by healthy individuals. As a result, the arm muscles are used for breathing hence relatively less deconditioned than leg muscles[16]. In COPD patients, the muscle strength and muscle fiber profile of upper extremities are better preserved than lower extremities. There are reduced proportions of type I fibers and the increase in type II fibers. Muscle atrophy occurs with a reduction in fiber cross-sectional area, reduced Oxidative enzyme activity, reduced muscle capillarization and reduced aerobic capacity during exercise[6,20-22].

Pulmonary rehabilitation is defined as a multidisciplinary program of care for patients with chronic respiratory impairment that is individually tailored and designed to optimize the individual's Physical and social performance[23]. It helps to optimize the function and independence by increasing exercise capacity, reducing symptoms and improving health related quality of life (HRQL)[7,24].Comprehensive pulmonary rehabilitation includes exercise training, education, psychosocial and behavioral intervention, nutritional therapy and outcome assessment.[25] The Royal Dutch Society of Physiotherapy or Koninklijk Nederland's Genootschap voor Fysiotherapie [KNGF] guidelines describe three aspects of the Physiotherapy treatment in patients with COPD. The first two are based on two major symptom domains in COPD, viz.Dyspnea, reduced exercise performance, and physical activity and impaired airway secretions clearance. The third treatment aspect is that of patient education and self–management.[26]

Recent evidence suggest that long term programs (6 months) translate into better daily function and increased activity levels for patients with COPD[27]. Lower limb resistance training has been included into PR programs in order to address the musculoskeletal dysfunction present in COPD patients. The resistance-training program is a safe type of exercise for COPD patients except when serious contraindications are present ie severe osteoporosis [7].

An exercise program for improving the skeletal muscle dysfunction in COPD, Especially muscle training will be helpful in the mechanism of deconditioning from disuse that is believed to be a major contributing factor of the skeletal Muscle dysfunction[6,10,20]. Strength training improves muscle growth and produces less Dyspnea as compared to aerobic exercises hence it is well tolerated by COPD Patient. This suggests that strengthening exercises should not be used alone. Studies have shown that greater improvement in muscle strength and muscle mass were obtained by combining both training modalities[28].

Functional exercise such as stair climbing and walking required integrated Strength of the quadriceps, hamstrings, hip flexors, extensors and plantar Flexors. In daily life, it is common to utilize large muscle groups of lower extremity In any activity such as walking, stairs climbing.[6,,29].

When compared with muscle strength, muscle powers have a preferential Influence on functional performance.[30] Climbing stairs is a functional activity of day to day life. Stair climb power test is cardiorespiratory fitness test used to assess the power of lower limb.

The 6MWT is often used to assess exercise capacity in patients with respiratory diseases[31, 32,33]. A recent study also suggested that the 6-min walking distance (6MWD) is a good predictor of mortality in COPD patients.[34].

Patients with COPD show poor exercise performance, and exercise intolerance is one of the main factors limiting participation in activities of daily life (Nici, Donner et al.2006)[35]. Peripheral muscle dysfunction is a well recognized disabling feature of COPD. Several studies have shown that physical exercise reverses COPD induced skeletal muscle dysfunctions and improve exercise tolerance, reduce dyspnea and substantially improve quality of life (Nici, Donner et al. 2006)[35].

The 6 Minute Walk Test (6MWT) Stair Climb Power walk tests (SCPT) are standardized validated tests for assessing the functional capacity of an individual. 6MWT gives the patient’s walking ability whereas Stair Climb Power test gives the patient’s ability to climb steps, which is dependent on lower limb muscle power. Use of free weights in progressive resistance training allows full ROM and the transfer to real world movements is greater than that for machines.[36] In COPD patients, muscle strengthening program with progressive resistive strengthening by using 1RM as an objective measure is not commonly incorporated in pulmonary rehabilitation. Hence, the Aim of this study is to determine the effect of lower limb strengthening on 6 Minute Walk Test & Stair Climb Power Test by incorporating progressive resistive exercises.

MATERIALS USED

Sphygmomanometer, Stopwatch, Measuring tape, 2 sets of Weight cuffs ranging from 0.5 to 5 kgs, Plinth, Stethoscope, Staircase, pulse-oximeter, weighing machine.

Fig: Stair case

METHODOLOGY

The approval for the study was taken from the local institution Ethics Committee and university research board. Physical randomization method using a coin (toss of coin – heads for control and tails for experimental group) was used for random allocation of subjects to experimental (PRE + convention therapy) and control groups (convention therapy). It was done prior to the commencement of the study by an independent person and sealed in separate, opaque, numbered envelops.

200 patients attending the chest OPD were screened of which 80 were recruited. 15 patients did not meet the inclusion criteria and 5 patients refused to give their consent to participate in the study. The remaining 60 patients were enrolled for the study. As the patients were recruited, the corresponding numbered envelops were opened by the investigator and the patients were allocated to the experimental and control groups accordingly. After random allocation, the number of subjects in the control group was 33 and in the experimental group were 27. The treatment was given thrice a week for both groups – the experimental group received treatment on Mondays, Wednesdays and Fridays whereas the control group received intervention on Tuesdays, Thursdays and Saturdays to ensure no interaction of subjects between the groups. The pre post measurements of outcome measures were done by an independent assessor. A trial practice on the Stair Climb Power Test and 6 Minute Walk Test (as per ATS guidelines) was given prior to baseline measurements in both groups. The baseline muscle strength of the knee extensor and flexor muscles was found by using weighted cuffs of various weights for measuring the 1RM (Repetition Maximum) of dominant lower limb. Dominance was decided by asking the subject to kick the ball[37]. 1RM is the greatest amount of weight (load) a subject can lift through the available range of motion just once[38]. Initial warm up of 5 minutes was given prior to testing of 1 RM. The 1RM of knee extensors was measured in the sitting position while that of knee flexors in the standing position. The starting weight for measuring 1 RM was calculated as 20% and 10% to15% of body weight for Quadriceps and Hamstrings respectively[38,39] If the subject could lift this weight easily, the weight was gradually increased by 0.5 kgs till 1 RM was achieved with adequate rest intervals in between each attempt. Similarly, if the subject found it difficult to lift the starting weight, it was gradually decreased by 0.5 kgs till 1 RM was achieved. Else the starting weight was considered as 1 RM.

The subjects were advised not to reveal their treatment days to the assessor.

The control group received conventional physiotherapy i.e. breathing control thoracic expansion exercise, forced expiratory technique, general body exercises like SLR in supine, dynamic quadriceps in sitting, forward and sideward lunges, mini squats in standing and exercise to improve endurance like cycling for 10 minutes against no resistance.

The experimental group received lower limb strengthening exercises along with conventional physiotherapy. The 10 RM was calculated as approximately 75% of 1RM[38,,40].

The knee muscles were strengthened using DeLorme regimen.1st, 2nd, 3rdsets comprises to form one cycle. Total 3 sets of such cycle were given[38,41, 42].

1st set -10 repetitions 50% of 10 RM
2nd set-10 repetitions 75% of 10 RM
3rd set-10 repetitions 100% of 10 RM

Every week 1 RM was re-evaluated and 10 RM recalculated for progression of the Strengthening program in the experimental group.

Both groups received closed chain weight bearing exercises like mini squats, forward lunges, sideway lunges in three sets of 10 repetitions each with adequate rest interval in between each set.

The treatments in both the groups were given 3 times/ week for 6 weeks[40, 43,44]. In Experimental group and Control group 5and 8 subjects respectively were lost follow up and hence they are not included in the study. At the end of 6 weeks duration, the performance on Stair climb power test and 6 Minute walk Test were noted and the data were collected.

Stair climb power test

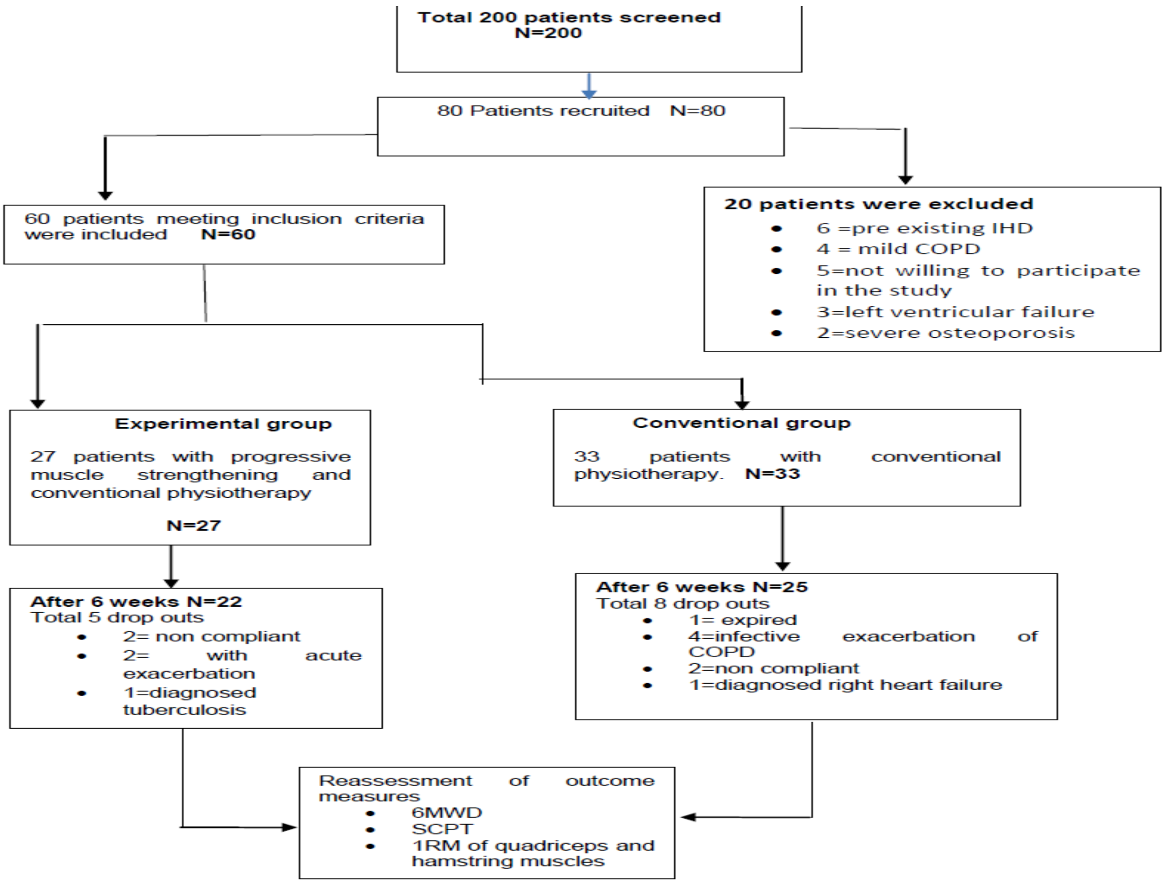

Fig: Flow chart of the study.

RESULTS

The SPSS 16 software was used for data analysis. The data was tested for normality using the Shapiro Wilk test. Parametric tests, paired and unpaired t tests, were used to analyze data passing the normality test whereas non parametric tests, Wilcoxon Signed Rank test and Mann Whitney U test were used to analyze data not passing the normality test. The level of significance was set as 5%

In the Experimental group, the pre post comparisons of 6MWD, 1RM Quadriceps and 1RM Hamstrings were done using the paired t test. The pre post comparison of SCPT was done using the Wilcoxon Signed Ranks test.

In the Control Group, the pre post comparisons of 6MWD, 1RM Quadriceps, 1RM hamstrings and SCPT were done using the paired t test.

The comparison of differences in 6MWD, SCPT, 1RM Quadriceps and 1RM Hamstrings between the experimental and Control groups were done using Mann Whitney U test.

TABLES AND GRAPHS

DEMOGRAPHIC DATA

Table 1: gender distribution in Experimental and Control Groups

	Experimental Group	Control Group
Male	11 [50%]	17 [68%]
Female	11 [50%]	8 [32%]
Total	22	25

The above table shows the gender distribution in the study groups. In the experimental group, the number of subjects was 22, of which 50% of the subjects were males and 50% were females. In the Control Group, the number of subjects was 25, of which 68% of the subjects were males and 32% were females.

Table 2: Age and FEV1% of the Experimental and Control groups

	Experimental Group	Control Group
	Mean + SD [95% CI]	Mean + SD[CI]
AGE	51.45 +13.3 [45.53 - 57.37]	49.55 + 15.6 [42.64 - 56.44]
FEV1%	48.86 +9.23 [44.77 – 52.96]	49.59 +9.47[45.39 – 53.79]

The above table shows the Age and FEV1% of the experimental and Control groups. The Mean Age and FEV1% of the Experimental group was 51.45 yrs + 13.3 [95% CI, 45.53 - 57.37] and 48.86% + 9.23 [95% CI, 44.77 – 52.96] respectively. The Mean Age and FEV1% of the Control group was 49.55 yrs + 15.6 [95% CI, 42.64 - 56.44] and 49.59% + 9.47 [95% CI, 45.39 – 53.79] respectively.

Table 3: Test for Normality for Age and FEV1 in both Experimental and Control Groups

	EXPERIMENTAL GROUP				CONTROL GROUP			
	Statistic	Df	Sig	Passing Normality?	Statistic	Df	Sig	Passing Normality?
AGE	.983	22	.955	YES	.945	22	.252	YES
FEV1	.972	22	.765	YES	.934	22	.149	YES

The above table shows that in both experimental and Control Groups, Age and FEV1 are passing the test of normality and hence parametric unpaired t tests is used to compare the differences in means of the two groups

Table 4: Comparison of Age and FEV1 in both Groups

	Mean difference	SE difference	95% Confidence interval of Difference		T statistic	Df	Sig [2 tailed]	Sig?
			Lower	Upper				
AGE	1.3745	4.20274	-7.09022	9.83931	.327	45	.745	NO
FEV1	-1.336	2.742	-6.860	4.187	-.487	45	.628	NO

The unpaired t test was used to analyze differences in Age and FEV1 in both groups. The above table shows that there is no significant difference in Age and FEV1 in both groups. This suggests that both the groups are homogenous with respect to age and FEV1.

Table 5 Baseline measures of 6MWD and SCPT in Experimental and Control groups

	Experimental Group	Control Group
	Mean + SD [95% CI]	Mean + SD[CI]
6MWD	307.73 + 58.30 m [95% CI, 281.8-333.58]	290 + 88.69 [95% CI, 253.39 - 326.61]
SCPT	133.24 + 47.49 [95% CI, 112.2 – 154.30]	128.83 + 44.81[95% CI, 110.3 -147.3]

Table 6 Test for Normality of Baseline measures of 6MWD and SCPT

	EXPERIMENTAL GROUP				CONTROL GROUP			
	Statistic	Df	Sig	Passing Normality?	Statistic	Df	Sig	Passing Normality?
6MWD	0.949	22	0.304	YES	0.942	25	0.167	YES
SCPT	0.910	22	0.047	NO	0.961	25	0.445	YES

Table 7 Comparison of baseline measures of 6MWD in both groups

	Mean diff	SE diff	95% Confidence interval of Difference		T statistic	Df	Sig [2 tailed]	Sig?
			Lower	Upper				
6MWD	17.73.	22.23	-27.042	62.49709	.798	45	.429	NO

The unpaired t test was used to analyze differences in 6MWD in both groups. The above table shows that there is no significant difference in 6MWD in both groups. This suggests that both the groups are homogenous with respect to 6MWD.

Table 8 : Comparison of baseline measures of Power on SCPT in both groups

	Group	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Asymp Sig (2 tailed)	Sig
SCPT	Experimental	22	23.93	526.50	273.500	-.032	.974	NO
	Control	25	24.06	601.50				
	Total	47						

The Mann Whitney U test was used to analyze differences in SCPT in both groups. The above table shows that there is no significant difference in SCPT in both groups. This suggests that both the groups are homogenous with respect to SCPT.

CONTROL GROUP ANALYSIS

Table 9: Descriptive statistics of Control group

	6MWD		SCPT		1RM Quadriceps		1RM Hamstring	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	290	294	128.8	122.08	8.34	8.38	6.44	6.48
SE	17.73	17.75	8.96	9.30	.353	.360	.276	.275
SD	88.6	88.7	44.81	46.50	1.76	1.8	1.38	1.38
Median	320	320	131.7	130.6	8	8.5	7	7
95% CI	253.3-326.6	257.3-330.6	110.3-147.3	102.8-141.2	7.6-9	7.6-9.1	5.8-7	5.9-7
IQR	130.00	145.00	48.31	62.20	2.50	2.50	2.25	2.25

The above table shows the Mean and Standard deviation of the 6MWT, SCPT, 1RM for Quadriceps and Hamstrings, both pre and post training in the control group.

Table 10: Test for Normality in Control group.

	PRE TRAINING				POST TRAINING			
	Statistic	Df	Sig	Passing Normality?	Statistic	Df	Sig	Passing Normality ?
6MWD	.942	25	.167	YES	.946	25	.200	YES
1RM for Quadriceps	.966	25	.546	YES	.960	25	.406	YES
1RM for Hamstrings	.946	25	.200	YES	,949	25	.235	YES
SCPT	.961	25	.445	YES	.936	25	.117	YES

The above table shows that In Control Group, 6 MWD, SCPT, 1RM quadriceps and 1RM hamstrings are passing the test of normality and hence parametric paired t tests is used to compare the differences in means.

Table: 11 Pre and post training difference in control group

	Mean diff	SE Diff	SD	95% Confidence interval of Difference		t value	Df	Sig [2 tailed]	Sig?
				Lower	Upper				
6MWD	4.00	11.5	2.31	-.766	8.76	1.73	24	.096	NS
1RM Quadriceps	.040	.138	.027	-.017	.097	1.45	24	.161	NS
1RM Hamstrings	.040	.138	.027	-.017	.097	1.45	24	.161	NS
SCPT	-6.74	22.8	4.56	-16.15	2.66	-1.48	24	.152	NS

The paired t test was used to analyze differences for 6MWD, 1RM for Quadriceps, 1RM for Hamstrings and SCPT in Control groups. The above table shows that the increase in 6 MWD, 1RM Quadriceps, 1RM Hamstrings, SCPT post training in Control group are statistically not significant. ($p>0.05$)

EXPERIMENTAL GROUP ANALYSIS

Table 12: Descriptive statistics of experimental Group

	6MWD		SCPT		1RM Quadriceps		1RM Hamstring	
Mean	307.73	353.18	133.24	181.85	8.86	11.70	7.14	10
SE	12.43	13.46	10.13	14.23	.41	.42	.41	.45
SD	5.830	6.31	4.75	6.67	1.91	1.97	1.93	2.11
Median	310	360	124.30	164.60	9.0	12.0	7.50	10
95% CI	281.8-333.6	325.2-381.2	112.2-154.3	152.3-211.5	8.02-9.71	10.83-12.56	6.28-7.99	9.06-10.94
IQR	52.50	55.00	59.60	108.15	3.25	2.25	4.00	3.25

The above table shows the Mean and Standard deviation of the 6MWT, SCPT, 1RM for Quadriceps and Hamstrings, both pre and post training in the experimental group

Table 13: Test for Normality in Experimental group.

	PRE TRAINING				POST TRAINING			
	Statistic	df	Sig	Passing Normality?	Statistic	Df	Sig	Passing Normality?
6MWD	.949	22	.304	YES	.956	22	.421	YES
1RM Quadriceps	.917	22	.066	YES	.927	22	.104	YES
1RM Hamstrings	.918	22	.069	YES	.967	22	.634	YES
SCPT	.910	22	.047	NO	.935	22	.157	YES

The above table shows that In experimental Group, 6 MWD, 1RM quadriceps, 1RM hamstrings are passing the test of normality and hence parametric paired t tests is used to compare the differences in means. As SCPT pre training is not passing the test for normality, Wilcoxon Signed rank test is used for pre post comparison

Table14: Pre and post training difference in Experimental group.

	Mean Diff	SE diff	SD	95% Confidence interval of Difference		t value	Df	Sig [2 tailed]	Sig?
				Lower	Upper				
6MWD	45.45	16.2	3.46	38.25	52.66	13.12	21	.000	YES
1RM Quadriceps	2.84	1.17	.25	2.32	3.36	11.40	21	.000	YES
1RM Hamstrings	2.86	1.33	.28	2.27	3.45	10.11	21	.000	YES

The paired t test was used to analyze differences for 6MWD, 1RM for Quadriceps, 1RM for Hamstrings in Experimental groups. The above table shows that there is an increase in 6MWD, 1RM for Quadriceps, 1RM for Hamstrings in Experimental group which is statistically significant ($p=0.000$)

Table 15: Pre and post training difference in Experimental group.

SCPT pre- SCPT post	N	Mean Rank	Sum of Ranks	Z	Asymp. Sig(2- tailed)	Sig
Negative Ranks Positive Ranks Ties	22[a] 0[b]	11.50 .00	253.0 .00	-4.107[a]	.000	YES

a. SCPT pre < SCPT post,
b. SCPT pre > SCPT post
c. SCPT pre = SCPT post

The Wilcoxon Signed Ranks test was used to analyze the pre and post difference in power (SCPT) in Experimental groups. The above table shows that there is statistically significant increase in power in SCPT ($p =0.000$).

EXPERIMENTAL Vs CONTROL GROUP ANALYSIS

Table 16: Descriptive statistics of pre-post training Difference in Experimental and Control groups.

	EXPERIMENTAL GROUP (Pre and Post training difference)				CONTROL GROUP (Pre and Post training difference)			
	6MWD	SCPT	1RM Quadriceps	1RM Hamstrings	6MWD	SCPT	1RM Quadriceps	1RM Hamstrings
Mean	45.45	48.61	2.84	2.86	3.18	-7.34	.046	.045
SE	3.46	5.76	.249	.283	2.32	5.16	.031	.031
SD	16.25	27.02	1.17	1.33	10.86	24.19	.147	.147
Median	40	45.30	3	2.75	.000	.000	.000	.000
95% CI	38.25-52.66	36.63-60.59	2.32-3.36	2.27-3.45	-1.63 - 7.99	-18.1-3.4	-.019-.110	-.019-.111
IQR	22.50	42.90	2	1.5	10	15.26	.00	.00

The above table shows the Mean and Standard deviation for pre and post training differences in the 6MWT, SCPT, 1RM for Quadriceps and Hamstrings in both experimental and control groups.

Table 17: Test for normality of pre-post training difference in Experimental and Control groups.

Pre and Post training difference	EXPERIMENTAL GROUP				CONTROL GROUP			
	Statistic	Df	Sig	Passing Normality?	Statistic	Df	Sig	Passing Normality?
6MWD	.916	22	.064	YES	.898	22	.027	NO
1RM Quadriceps	.909	22	.045	NO	.332	22	.000	NO
1RM Hamstrings	.850	22	.003	NO	.332	22	.000	NO
SCPT	.959	22	.477	YES	.869	22	.007	NO

The above table shows that In Experimental and Control group, the pre and post training difference in 6 MWD, SCPT, 1RM quadriceps and 1RM hamstrings are not passing the test of normality and hence non parametric Mann Whitney U test is used for comparison between Experimental and Control groups.

Table 18: Increase in 6MWD in Experimental Vs Control groups

Group	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Asymp Sig (2 tailed)
Experimental	22	36.36	800.00	3.000	-5.853	.000
Control	25	13.12	328.00			
Total	47					

The above table shows the increase in the 6MWD post training was more in the experimental group than in the control group which was statistically significant (p=0.000).

Table 19: Increase in SCPT in Experimental Vs Control groups

N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Asymp Sig (2 tailed)
22	35.77	787.00	16.000	-5.557	.000
25	13.64	341.00			
47					

The above table shows the increase in Power of the lower limbs (SCPT) was more in the experimental group than in the control group which was statistically significant (p=0.000).

Table 20: Increase in 1RM Quadriceps in Experimental Vs Control groups

N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Asymp Sig (2 tailed)
22	36.50	803.00	.000	-6.263	.000
25	13.00	325.00			
47					

The above table shows the increase in 1RM Quadriceps was more in the experimental group than in the control group which was statistically highly significant (p=0.000).

Table 21: Increase in 1RM Hamstrings in Experimental Vs Control groups

Group	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Asymp Sig (2 tailed)
Experimental	22	36.50	803.00	.000	-6.263	.000
Control	25	13.00	325.00			
Total	47					

The above table shows the increase in 1RM Hamstrings was more in the experimental group than in the control group which was statistically highly significant (p=0.000).

Summary of Results

1) Number of subjects in experimental group was 22 and 27 in control group.
2) Percentage of females was 50% and 32% in experimental and control groups respectively. Percentage of males was 50% and 68% in experimental and control groups respectively.
3) Both experimental and Control groups were homogenous with respect to age and FEV1%.
4) Following 6 weeks of strength training in experimental group, there was a statistically significant increase in 6MWD, SCPT, 1RM for Quadriceps and Hamstrings (p=0.000, p<0.05)
5) Following 6 weeks of conventional therapy in control group, there was no significant increase in 6MWD, SCPT, 1RM for Quadriceps and Hamstring (p=.096, .152, .161, .161) respectively (p>0.05)
6) The increase in 6MWD, SCPT, 1RM for Quadriceps and Hamstrings in the experimental group was more as compared to that in the control group which was statistically significant (p=0.000, p<0.05)

DISCUSSION

The Objectives of this study was three fold. The first was to study the effects of conventional physiotherapy on Stair Climb Power Test and 6 Minute Walk Test (Control group). The second was to study the effect of lower limb strengthening exercises along with conventional physiotherapy on Stair Climb Power Test and 6 Minute Walk Test (Experimental group). The third was to compare the effects of conventional physiotherapy with lower limb strengthening exercises (Experimental Group) over Conventional Physiotherapy alone (Control Group) on Stair Climb Power Test and 6 Minute Walk Test in patients with COPD .

Physical randomization method using a coin (toss of coin – heads for control and tails for experimental group) was used for random allocation of subjects to experimental (PRE + convention therapy) and control groups (convention therapy). It was done prior to the commencement of the study by an independent person and sealed in separate, opaque, numbered envelops.

In the present study 60 patients with moderate to severe COPD, as per recent GOLD standard based on FEV1, were recruited. As the patients were recruited, the corresponding numbered envelops were opened by the investigator and the patients were allocated to the experimental and control groups accordingly. After random allocation, the number of subjects in the control group was 33 and in the experimental group were 27. The treatment was given thrice a week for both groups – the experimental group received treatment on Mondays, Wednesdays and Fridays whereas the control group received intervention on Tuesdays, Thursdays and Saturdays to ensure no interaction of subjects between the groups. The pre post measurements of outcome measures were done by an independent assessor. The subjects were advised not to reveal their treatment days to the assessor.

Both groups received an exercise program of 6 weeks duration. The Control group was given conventional physiotherapy which included breathing control exercise, thoracic expansion exercise, forced expiratory technique, general body exercises like SLR in supine, dynamic quadriceps in sitting, forward and sideward lunges, mini squats in standing and exercise to improve endurance like cycling for 10 minutes against no resistance.

The Experimental Group received DeLorme regimen for strengthening in addition to conventional physiotherapy. 6MWT, SCPT, 1RM for Quadriceps and Hamstrings were recorded at baseline and after 6 weeks of exercise program. In the Experimental group, 1RM of both Quadriceps and Hamstrings were measured after every week and 10 RM for each was calculated accordingly.

In the Experimental group 5 subjects were lost to follow up whereas in control group 8 subjects were lost to follow up. The data of 22 subjects in experimental and 25 in Control group were collected and analyzed using SPSS 16 software.

The present study showed that the added effect of progressive resistive exercise on conventional therapy resulted in a significant improvement in muscle strength (1RM for Quadriceps and Hamstrings), Power of the lower limbs (SCPT) and functional capacity (6MWD) after progressive resistive exercises (PRE) as compared to conventional therapy alone. Thus, there is evidence that the Null Hypothesis can be rejected.

Dourado et al. (2009), in his study showed a 58% improvement in muscle strength after 12 weeks of strengthening program. They also found that there is significant increase in muscle strength without significant increase in 6MWD while Spruit, Gosselink et al. (2002) found significant improvement in 6MWD after strength training.

According to American College of Chest Physicians and the AACVPR guidelines (1997), exercise training should be included routinely in the rehabilitation of COPD patients[45]. The ATS and BTS Statements on Pulmonary Rehabilitation and the Global Obstructive Lung Disease (GOLD'S) Guidelines on management of patients with COPD also stated that any patient with moderate to severe COPD and exercise or activity limitation who lacks contraindications for exercise should undergo exercise training, particularly of the lower limbs[45].

Available data suggest that systemic inflammation, low anabolic hormone levels, reactive oxygen species, deconditioning, nutritional impairment, aging, and hypoxia likely play a role in skeletal muscle dysfunction[6,45,46]. In COPD patients, there is an increase in pro inflammatory cytokines which further increases activity of the ubiquitin- proteasome pathway, a proteolytic pathway that causes muscle wasting [45].

In COPD patients there is a shift from type I to type II skeletal muscle fibers, reduced mitochondrial density per fiber bundle, and decrease in capillary density.[47-49]. Quadriceps strength is decreased on average by 30 per cent in patients with moderate to severe COPD[28, 50.]

Thus, Strength training with Progressive resistance exercises, by promoting muscle growth and strength, is a useful adjunct in rehabilitation of patients with COPD. Furthermore, strength exercise may induce less dyspnea than aerobic exercises and, as a result, are usually well tolerated.

CONCLUSION

There was no statistically significant improvement in power of the lower limbs, functional capacity and muscle strength following 6 weeks of conventional physiotherapy in Control group ($p>0.05$).

There was statistically significant improvement in power of the lower limbs, functional capacity and muscle strength following 6 weeks of PRE in addition to conventional physiotherapy in Experimental group ($p<0.05$).

The improvement in Power of the lower limbs, functional capacity and muscle strength was more in the experimental group receiving PRE in addition to conventional group as compared to control group receiving only conventional therapy which was statistically significant ($p<0.05$).

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