



Research Article

## EVALUATION OF LOWER LIMB MUSCLE STRENGTH AND FUNCTION IN INDIVIDUALS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE-AN OBSERVATIONAL STUDY

Aarti welling\* and Sanat kulkarni

Department of Orthopedic Physiotherapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India

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### ABSTRACT

**Aims and objectives:** To evaluate lower limb muscle strength and function in Chronic obstructive pulmonary disease patients.

**Methods:** Forty Subjects clinically diagnosed with COPD meeting the inclusion criteria were randomly assigned in the study. Lower limb muscle strength was assessed i.e. in quadriceps, hamstrings, calf and glutei muscles using pressure biofeedback unit and function was assessed by lower extremity functional scale questionnaire.

**Results:** Comparison of four muscles with respect to strength were done by one way ANOVA the mean sum of squares between groups at the right side was 1193.69 and within the groups was 103.67 and at the left side mean squares between groups was 1178.74 and within groups was 102.75, the results obtained were highly significant. ( $p=0.0001$ ) Pair wise comparison of four muscles were done at the right side and left side which showed that the results obtained were highly significant ( $p=0.0001$ ). Therefore we conclude that equal reduction in all the four muscles at left and right side was noted and the mean LEFS score was  $51.10 \pm 10.42$  years and LEFS showed no statistical significance.

**Conclusion:** The study concluded that equal reduction in all the four muscles at left and right side was noted with no statistical significance in LEFS value.

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### INTRODUCTION

Chronic Obstructive Pulmonary Disease is a major cause of chronic morbidity and mortality throughout the world. Many people suffer from this disease for years and die prematurely from it or its complications.<sup>1</sup> COPD is predicted to be the third leading cause of death and fifth leading cause of disability worldwide.<sup>2</sup> Chronic Obstructive Pulmonary Disease is an umbrella term used to describe progressive lung diseases including emphysema, chronic bronchitis, asthma, and bronchiectasis. COPD develops slowly and worsens over time.<sup>2</sup> Cigarette smoking is one of the most important risk factors for the development of COPD. Other risk factors include air pollution with dust, smoke and fumes, sulphur dioxide, passive smoking, previous tuberculosis, low socio-economic status and exposure to damp and foggy climate. Alpha 1- antitrypsin deficiency is an important genetic risk factor in development of COPD.<sup>3</sup>

COPD patients experience cough with sputum production for many years and in later stages of disease there is onset of breathlessness (Dyspnoea). Other symptoms such as tightness in chest, chest pain which can be pleuritic, haemoptysis,

recurrent pneumonias, weakness, anorexia, lethargy and weight loss which may be seen in advanced stages of the disease.<sup>3</sup>

Damage to respiratory mechanics and impaired pulmonary gas exchange lead to reduced functional capacity. Dyspnea is considered the principal symptom in limiting the exercise and activity of daily living.<sup>4</sup> several studies have shown progression of muscle weakness and preferential loss of muscle mass in patients with COPD, especially in the lower extremity. There is now abundant evidence from studies in incubated muscles and muscle extracts that ATP dependent ubiquitin- proteosome pathway is responsible for most of the increased proteolysis in various types of muscle atrophy. The functional consequence of these is reflected in significant changes in skeletal muscle energy metabolism in COPD patients. There is increase in the blood lactate levels during sub maximal exercise in patients with COPD. These factors play a major role in decreased strength of lower limb muscles.<sup>5</sup> In Chronic obstructive pulmonary disease patients, the degree of functional impairment appears to differ between the upper and lower limb. Upper limb muscle function and strength is relatively preserved because patients are able to continue to perform grip movements, including gripping, holding and carrying objects.<sup>4</sup>

Antigravity muscles of the body consist of gluteus Maximus, hip flexors, Quadriceps, hamstrings, gastrocnemius, soleus and tibialis anterior in which quadriceps is readily accessible and

\*Corresponding author: Aarti welling

Department of Orthopedic Physiotherapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India

primary muscle of locomotion, this muscle is most commonly studied in Chronic obstructive pulmonary disease patients with skeletal muscle dysfunction.<sup>4</sup>

Pressure Biofeedback is a simple device which registers changing pressure in an air filled pressure cell. This allows body movement, especially spinal movement, to be detected during exercise. The unit consists of gauge connected to a pressure cell.<sup>6</sup>

## MATERIALS AND METHODS

### Institutional review board approval

Ethical clearance was obtained from the Institute of Ethical Board and was conducted in conformity with ethical and human principles of research.

### Participants

Participants were included according to inclusion and exclusion criteria. Written informed consent was obtained from the study participants and was included in study group. 40 participants were included in the study from tertiary care hospital in Belgavi within three months. The inclusion criteria were 1. Diagnosed Chronic Obstructive Pulmonary Disease Subjects by pulmonologist 2. Male and female individuals 3. Age Group-(45-60 Yrs). The exclusion criteria were 1. Symptomatic Neurological Disease 2. Symptomatic lower limb orthopedic condition 3. Lower Limb Surgeries

### Procedure

Participants in tertiary care hospital were screened. 40 participants were included in the study. Demographic data was obtained that included age, gender, BMI and they were assessed for lower limb muscle strength and function by using pressure biofeedback and lower extremity functional scale questionnaire.

## RESULTS

The presented study titled as evaluation of lower limb muscle strength and function in individuals with chronic obstructive pulmonary disease-an observational study included 40 participants. They were assessed by pressure biofeedback unit for strength and lower extremity functional scale questionnaire for lower limb function.

Statistical analysis for the present study was done manually as well as using statistical package of social sciences ( SPSS) version 21 so as to verify the results obtained .For this purpose data was entered into an excel spread sheet, tabulated and subjected to statistical analysis. Various statistical measures such as mean, standard deviation, and test of significance such as one way ANOVA, Tukeys multiple Posthoc principal, paired t –test was used. Nominal data from patient’s demographic data i.e. the age, BMI, LEFS were analyzed using mean value. Comparison of four muscles at left and right side with respect to strength were done by one way-ANOVA. Pair wise comparison of four muscles were done at left and right side with respect to strength were done by Tukeys multiple posthoc procedure and comparison of strength of four muscles in right and left side were done by t- test. Total number of male participants was 30 and female participants were 10.

**Table 1** Comparison of four muscles (hamstrings, quadriceps, gluteal and calf) with respect strength at right side by one way ANOVA

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F-value	p-value
Between groups	3	3581.07	1193.69	11.5142	0.0001*
Within groups	156	16172.68	103.67		
Total	159	19753.74			

\*p<0.05

**Table 2** Pair wise comparison of four muscles (hamstrings, quadriceps, gluteal and calf) with respect strength at right side by Tukeys multiple posthoc procedures

Muscles	Hamstrings	Quadriceps	Gluteal	Calf
Mean	77.98	82.75	86.65	74.15
SD	9.86	10.18	10.32	10.35
Hamstrings	-			
Quadriceps	P=0.1539	-		
Gluteal	P=0.0008*	P=0.3168	-	
Calf	P=0.3342	P=0.0009*	0.0001*	-

\*p<0.05

**Table 3** Comparison of four muscles (hamstrings, quadriceps, gluteal and calf) with respect strength at right side by one way ANOVA

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F-value	p-value
Between groups	3	3536.23	1178.74	11.4714	0.0001*
Within groups	156	16029.75	102.75		
Total	159	19565.98			

\*p<0.05

**Table 4** Pair wise comparison of four muscles (hamstrings, quadriceps, gluteal and calf) with respect strength at right side by Tukeys multiple posthoc procedures

Muscles	Hamstrings	Quadriceps	Gluteal	Calf
Mean	77.95	82.75	86.63	74.23
SD	9.81	10.04	10.33	10.36
Hamstrings	-			
Quadriceps	0.1474	-		
Gluteal	0.0008*	0.3186	-	
Calf	0.3542	0.0010*	0.0001*	-

\*p<0.05

## DISCUSSION

The present study was conducted to evaluate the strength and function of lower extremity in individuals with chronic obstructive pulmonary disease. The Lower extremity muscles i.e. Glutei, Quadriceps, Hamstrings and Calf were assessed for strength using pressure biofeedback and the function of lower extremity was assessed using the lower extremity functional scale.

A study was carried out by Elkington *et al* with the aim to find out common symptoms in patients with COPD; the results concluded that breathlessness is the major symptom in all the subjects.<sup>7</sup> Other symptoms such as cough decreased exercise tolerance and lower limb fatigue, wheezing, discomfort in chest.<sup>8</sup>

Till date studies have been done where Quadriceps muscle strength was assessed in individuals with COPD. A study was done by Seymour *et al* in two cohorts consisting of 591 subjects was quadriceps strength was calculated by regression equation, the results concluded that one third of the subjects had quadriceps weakness.<sup>9</sup> As there is abundant evidence from studies in incubated muscles and muscle extracts that the ATP dependent ubiquitin-proteasome pathway is responsible for

most of the increased proteolysis in various types of muscle atrophy<sup>5</sup> but very few studies have been carried out in Indian scenario where correlation of lower limb muscle strength and function is been observed in individuals with COPD.

The age group included in this study was 30 to 60 years as various studies show that the prevalence of COPD was mainly found between the age of 30-60 years.<sup>11</sup> Literature suggests that decline in the muscle strength and endurance in the elderly is associated with many factors in addition to progressive disuse and inactivity. Factors such as decrease in muscle mass, decrease in the number of type 1 and type 2 muscle fibers with a corresponding increase in connective tissue in muscle, a decrease in the cross-sectional size of muscle, selective atrophy of type 2, and change in length- tension relationship of muscle associated with loss of flexibility. In addition to decrease in muscle strength, decline in speed of muscle contraction, muscle endurance, and the ability to recover from muscular fatigue occur with advanced age.<sup>10</sup>

In the present study we found that weight and BMI was not statistically significant. It was positively correlated with another study were 389 patients with moderate to severe COPD were low BMI was significantly more frequent in female than male COPD patients. In addition depletion of fat-free mass was associated with impaired peripheral muscle strength; independent of disease severity<sup>11</sup> on contrary the present study does not suggest any statistically significant value in chronic obstructive pulmonary disease

A study carried by Miranda *et al*, observed that in COPD patients the degree of functional impairment appears to differ between the upper and lower limb. Upper limb muscle function and strength is relatively preserved because patient can perform grip movements including gripping, holding and carrying objects<sup>4</sup> but there is preferential loss of muscle mass in patients with COPD, especially in the lower extremities.

Previous studies were done to assess strength in lower limb muscles using EMG biofeedback but in present study pressure biofeedback were used, as a Study was done to evaluate the reproducibility of the pressure biofeedback unit to measure the transverseabdominis muscle. the results of the study concluded that the reproducibility of PBU ranged from satisfactory to excellent.<sup>12</sup> Hence this gives us the proof that pressure biofeedback unit can be used to measure the muscle strength.

A study was conducted by Stasi *et al* in 101 individuals with musculoskeletal disorder for testing the reliability and validity of Lower extremity functional scale and the results concluded that the consistency was excellent with an overall Cronbach's  $\alpha$  at 0.974. Pearson's  $r$  and intraclass correlation coefficient revealed excellent correlations [0.986 and 0.986 respectively, ( $p < 0.001$ )] hence this gives us proof that lower extremity functional scale can be used to measure the lower extremity function.<sup>13</sup>

In the present study when four muscle hamstring, gluteal, quadriceps and calf was assessed for strength it showed that all four were equally affected. In other words the lower extremity strength was affected.

Lower extremity muscles which go into weakness in COPD are mainly glutei, hamstring, quadriceps and calf which are antigravity muscles. Studies have shown that Glutei mainly goes into weakness due to, decrease in the number of type 1 and type 2 muscle fibers with a corresponding increase in

connective tissue in muscle, a decrease in the cross-sectional size of muscle, selective atrophy of type 2, and change in length- tension relationship of muscle associated with loss of flexibility. In addition to decrease in muscle strength, decline in speed of muscle contraction, muscle endurance, and the ability to recover from muscular fatigue occur with advanced age.<sup>10</sup>

Various studies have stated that thigh muscles which include quadriceps goes into weakness due to reduced oxidative energy metabolism as result of the reduced cytochrom C oxidase and succinasedehydroginase activities have been reported in COPD.<sup>14</sup>

A study carried out by Mathur *et al* in 20 healthy and 20 COPD subjects to examine the relationship between CSA (cross-sectional area) and volume of adductors and hamstrings by MRI. The results of these concluded that the adductor and hamstring muscle were decreased in size and volume.<sup>15</sup> hence literature suggests that loss of muscle mass, intrinsic abnormalities in skeletal muscle metabolism are present in COPD patients.<sup>5</sup>

## CONCLUSION

The conclusion suggests that there is significant decrease in the strength of lower limb in chronic obstructive pulmonary disease individuals, but function in these individuals is not significantly affected.

### Future Scope

The present study can be conducted on a large sample size or with other age groups. Similar studies by employing a more direct objective outcome measures like EMG, dynamometer can be used.

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