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Original Research Article

Comparison of muscle strength and endurance of the distal skeletal muscles of the upper limb in patients with COPD with age and gender matched healthy control

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory disease of the airways and lung parenchyma associated with airway narrowing, alveolar wall destruction and systemic hypoxaemia. There is dysfunction of peripheral skeletal muscles on exercise capacity in patients with COPD was first suggested by Killian & coworkers.
Objective: To compare strength and endurance using dynamometer in normal and COPD patients.
Method: Cross sectional, comparative, convenient sampling-50 COPD & 50 control. Inclusion: Age 40-70 years, both genders. Exclusion: any musculoskeletal, cardio-respiratory, and neurological diseases. Patient's referred from respiratory OPD, diagnosed and PFT done. Strength testing done with subject holding dynamometer in dominant hand in sitting position with arm by the side. Elbow flexed to 90^{O}. Handgrip muscle strength was recorded in kgs as indicated by the pointer on dynamometer i.e. maximum deflection. 3 recordings with gap of 2 min. taken and maximum value noted.
The endurance was measured by asking the subject to maintain their grip on the dynamometer at 1/3 rd of their max strength. The duration for which they maintained the grip strength was noted in seconds. 2 recordings with a gap of 5 min. taken maximum value were noted. Data collected and statistical analysis done.
Result: The strength and endurance was significantly reduced in COPD patients i.e. the strength was 14.88±4.448kg as compared to normal 22.0±4.354kg. Endurance was 22.56±10.94sec. in COPD as compared to 48.74±15.700 sec. in normals
Conclusion: The study concluded that there is significant reduction in handgrip strength and handgrip endurance in COPD patients as compared to age and gender matched normal subjects.
Keywords: COPD, hand dynamometer.

1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory disease of the airways and lung parenchyma associated with airway narrowing, alveolar wall destruction and systemic hypoxaemia.[1]

There is dysfunction of peripheral skeletal muscles on exercise capacity in patients with COPD was first suggested by Killian & coworkers.[16]

Then Hamilton and colleagues showed that approximately 70% of patients with chronic lung disease had poorer quadriceps strength when compared to age matched healthy subjects [17]. Thereafter, there have been many studies showing reduced skeletal muscle strength and

1.2 Aim

To compare the hand grip muscle strength and endurance of the distal skeletal muscles of the upper limb in patients with COPD with age and gender matched healthy controls.

2. Methods

- Design:- Cross-sectional comparative study

- Sampling technique:- Convenient
- Number of samples:- 50 COPD patients; 50 control group
- Duration of study:- 1 year and 6 months
- Data collection:- 6 months

2.1 Inclusion criteria

Age: 40-70 years; Gender: both; COPD patients

2.2 Exclusion criteria

Subjects with: Musculoskeletal disease and conditions; Cardiovascular disease; Neurological disease.

2.3 Outcome measure

Peripheral muscle strength and endurance in COPD patients

2.4 Procedure

Spirometry was performed using Helios 401 spirometer by trained person in a quiet room and the patients were graded according to GOLD standard as mentioned in annexure.

The parameters measured were Forced Vital Capacity (FVC) in liters, Forced Expiratory Volume in 1 sec (FEV1), Forced Expiratory Flow during 25-75% of FVC (FEF 25-75%) and Peak Expiratory Flow Rate (PEFR).

Patients referred from respiratory OPD, diagnosed and PFT done.

Strength testing:

Subjects held the dynamometer in the dominant hand in sitting position.

The arm was by the side of the patient, elbow flexed at 90°, forearm in mid prone and wrist in neutral position. Dysfunction of peripheral muscles contributes to exercise intolerance, which amplifies the patients inactivity and may result in isolation and depression.[22]

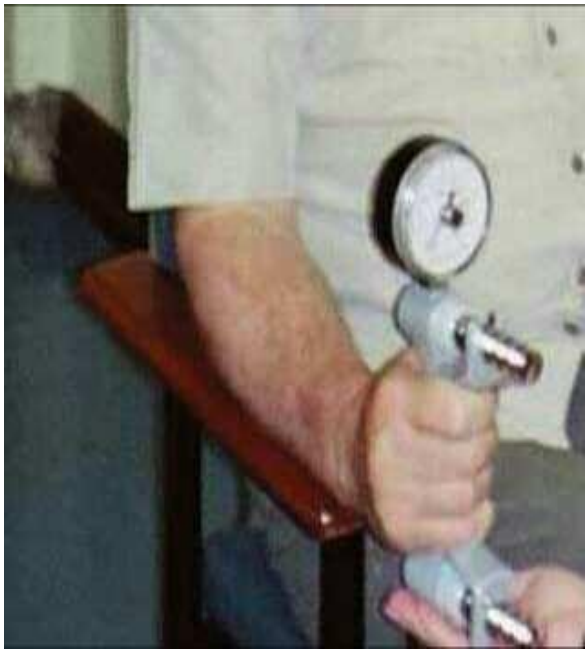

Figure 1: Hand dynamometer

- Subjects were asked to hold the dynamometer in such a way that the second phalanx will be against the inner stirrup and were then asked to grip the dynamometer handle with as much force as they possibly could apply.
- The handgrip muscle strength was recorded in kilograms as indicated by the pointer on the dynamometer i.e. maximum deflection.
- Three recordings were taken with a gap of two minutes between each effort and the maximum value was recorded for the analysis.
- The handgrip endurance was measured by asking the subjects to maintain their grip on the handgrip dynamometer at 1/3 rd of their maximum handgrip strength for as long as they could.
- The duration for which they could maintain the grip strength was noted in seconds.
- Two recordings were obtained with a gap of five minutes between each effort and the maximum value was recorded for analysis.
- Data was collected and statistically analysed.

2.5 Data Analysis

- Data was collected and master chart was prepared using Microsoft Office Excel 2007.
- Statistical analysis was done using the Software – Epi Info Software Version 6
- Student unpaired ‘t’ test and chi square test was used.
- P<0.001

3. Result

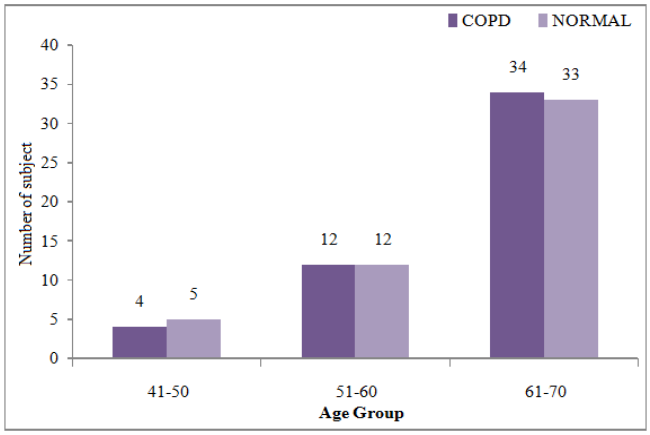

Figure 2: Age wise distributions

In the age group of 41-50 years - No. of COPD patients - 04
No. of normal subjects - 05
In the age group of 51-60 years - No. of COPD patients - 12
No. of normal subjects - 12
In the age group of 61-70 years - No. of COPD patients - 34
No of normal subjects - 33

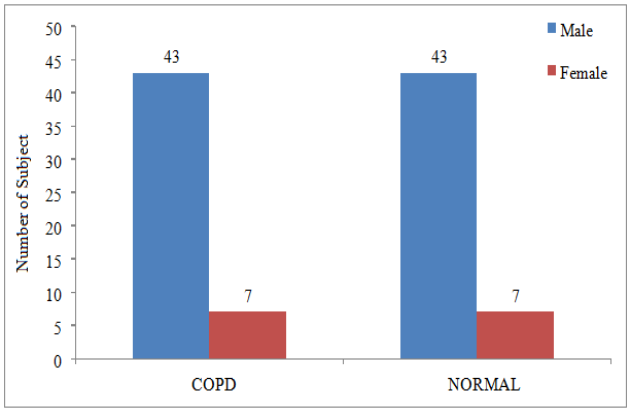

Figure 3: Gender wise distributions in COPD and Normal group

In COPD subjects – No. of males – 43 & No. of females - 07

In normal subjects – No. of males – 43 & No. of females - 07

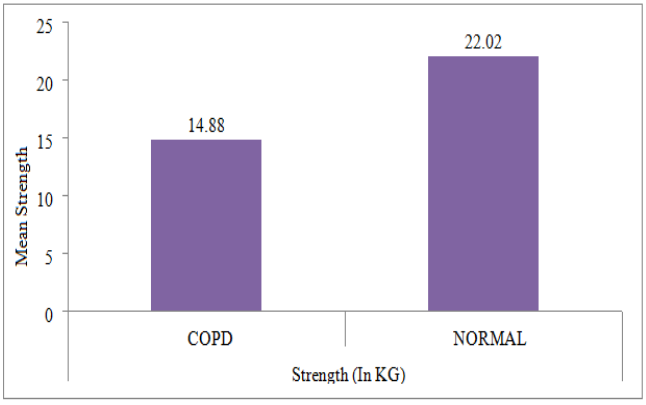

Figure 4: Mean strength in COPD and Normal group

- The mean strength in COPD patients was 14.88±4.448 kg
- The mean strength in normal subjects was 22.02±4.354 kg.
- p<0.001. Therefore, it shows significant reduction in strength.

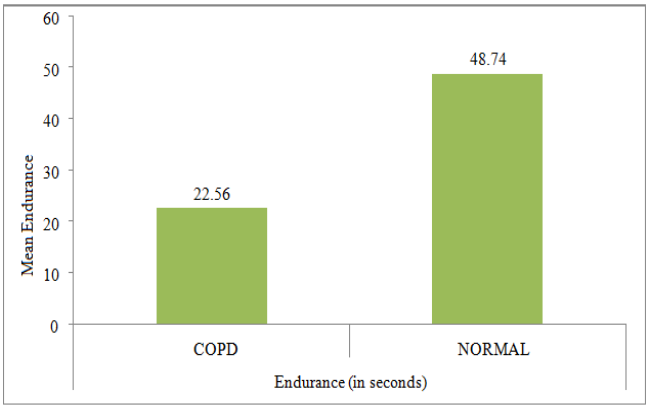

Figure 5: Mean endurance in COPD and Normal Group

- The mean endurance in COPD patients was 22.56±10.949 seconds.
- The mean endurance in normal subjects was 48.74±15.700 seconds.
- p<0.001.Therefore, it shows significant reduction in endurance.

4. Discussion

In our study, we found that the strength and endurance was significantly reduced in COPD patients i.e. the strength was 14.88 ± 4.448 kg as compared to normal subjects 22.02 ± 4.354 kg and endurance was 22.56 ± 10.949 seconds in COPD patients as compared to 48.74 ± 15.700 seconds in normal subjects.

Study done by Shah and co-workers in the year 2013 also found similar result i.e. the handgrip muscle strength decreases as the FVC and FEV1 decreased in patients with COPD.[14]

Study done by Almas Sirguroh *et al* in the year 2012 also found similar results i.e. the handgrip strength is reduced in patients with COPD but do not correlate with severity of obstruction as measured by PEFR or with BMI.[15]

Beate Rassler explained in 2013 that following could be the reason that contributes to this condition-

4.1 Inactivity and Deconditioning

Hypoventilation induced hypoxia and hypercapnia cause dyspnea and thereby reduces the patients exercise tolerance. Exercise intolerance is the most frequent complaint of COPD patients.[6] Patients keep down their muscular activity in order to reduce dyspnea. As a consequence, muscular deconditioning further decreases exercise capacity and may substantially compromise the patients daily life.[22]

4.2 Impaired Metabolic Situation

In chronic pulmonary disease, impaired pulmonary gas exchange causes hypoxaemia and hypercapnia. Consequently the oxygen supply to the muscles is reduced. The metabolic situation may be further compromised by fatigue of the respiratory muscles due to the increased work load of respiratory muscles including auxiliary respiratory musculature. In addition, cardiovascular dysfunction such as right ventricular overload (corpulmonale) and disturbances in microcirculation may aggravate tissue hypoxia and hypercapnia. As an adaptive response, muscle metabolism changes in favour to anaerobic metabolism and to increased lactic acid production. The altered muscle energy metabolism in COPD patients leads to premature muscle acidosis and consequently leads to increased muscle fatigability and reduced exercise capacity.[23]

4.3 Structural Alterations of Skeletal Muscle

Chronic ventilatory disease is often accompanied by weight loss and peripheral muscle atrophy. This occurs in about 40-50% of COPD patients but probably, this percentage is even underestimated.[24] It is characterized by enhanced protein degradation and associated with a change in fiber type composition.[6] One of the most typical abnormalities in COPD patients is a shift from fiber type I into type II. A meta-analysis of muscle fiber data showed that the type II to type I proportion was positively associated with the reduction in forced expiratory volume in 1 second (FEV1) and FEV1/forced vital capacity(FVC).[25] Muscle wasting and a reduced proportion of slow fibers result in muscle weakness and premature muscle fatigue.[22]

4.4 Inflammation and Oxidative Stress

Systemic inflammation may also impair muscle perfusion and metabolism. COPD patients present higher plasma levels of pro-inflammatory cytokines which are even more increased by exercise.[26] Moreover inflammation has been shown to trigger oxidative stress, which was associated with reduced skeletal muscle endurance.[27]

Resistive loading of inspiration and expiration reduced voluntary submaximal contraction force of upper and lower limb muscles in a differential way while maximal contraction force was only reduced in leg but not in arm muscles. Moreover upper limb muscles, especially muscles of hand and fingers, often have to perform precision movements with low demands on muscle strength and endurance which play an essential role in daily life. Therefore, early detection and treatment of impaired function of upper limb muscles have particular importance with respect to the patient's health-related quality of life.

5. Conclusion

The study concludes that there is significant reduction in hand grip strength and hand grip endurance in COPD patients as compared to age and gender matched normal subjects.

6. Limitation of Study

• Smaller sample size.

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