ORIGINAL ARTICLE

Correlation of Peak Expiratory Flow Rate and Hand Dynamometry in Chronic Obstructive Pulmonary Disease Patients--A Case Control Study

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ABSTRACT

Objectives: To determine the correlation of peak expiratory flow rate and hand dynamometry in patients with chronic obstructive pulmonary disease and to find out the differences between hand grip in cases and control group

Methodology: This study was carried out in the Department of Physiology and Department of Chest Medicine, Liaquat National Hospital and Medical College between July 1st 2019 and June 30th 2020 after the approval of the research and ethical committee of the same hospital. We used purposive sampling technique. Total 100 consenting individuals were recruited that were equally divided into control group and chronic obstructive pulmonary disease group. Anthropometric measurements alongwith peak expiratory flow rate and hand dynamometry values were measured.

Results: We found significant difference in hand grip strength and peak expiratory flow rate between the case and control groups, chronic obstructive pulmonary disease patients have decreased peak expiratory flow rate and handgrip strength. Weak correlation exists between peak expiratory flow rate and hand grip strength with significant p value. No relationship was found between waist hip ratio and hand grip. Also, body mass index showed a weak negative but statistically significant correlation with hand grip strength.

Conclusion: In chronic obstructive pulmonary disease patients, hand grip strength is decreased and determining hand grip strength may ensures quick assessment of quality of life.

Keywords: chronic obstructive pulmonary disease, Air way Obstruction, Hand grip, Grip strength, hand dynamometry, peak expiratory flow rate, skeletal muscle dysfunction

How to cite: Afaq E, Nisar MK, Shoaib N, Irfan M, Hassan SH, Ahmed T. Correlation of peak expiratory flow rate and hand dynamometry in chronic obstructive pulmonary disease patients—a case control study. Ann Jinnah Sindh Med Uni. 2022;8(2):69-73

DOI 10.46663/ajsmu.v8i2.69-73

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is one of the major health problems faced globally. It is considered as the 4th leading cause of death worldwide[1]. COPD is an obstructive lung disease in which air is trapped in the lungs increasing lung compliance, the Residual Volume (RV), Functional Residual Capacity (FRC) and Total Lung Capacity (TLC)[2]. Some risk factors for COPD include smoking, alpha1 antitrypsin deficiency, occupational exposure to toxins, and cannabis smoking[3]. COPD can be suspected on history and physical examination. Dyspnea, chronic productive cough, frequent lower respiratory tract infections, family history, smoking, and exposure to industrial dust are key indicators for COPD diagnosis[4]. Spirometry is a prerequisite to make the diagnosis and a post-bronchodilator FEV1/FVC less than 0.70 confirms the presence of persistent airflow obstruction[3]. Peak expiratory flow rate (PEFR) between 450 to 550 l/min is consider normal in males. The value is lower in females[5]. It is used as an alternative way of measuring airway obstruction when FEV1 value is unavailable[6].

Poor exercise capacity is a major complaint among persons with COPD[7]. In cardiopulmonary disorders, many factors contribute to muscular impairment. These include hypoxia, oxidative stress and atrophy due to

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disuse, medication, nutritional depletion, and systemic inflammation[8,9]. Peripheral muscles fatigue is suggested to be a exercise limitation contributor in patients with COPD[10].

In COPD, a hand dynamometer can be used to measure hand grip strength[11]. It is a device that is used to study muscle fitness and over all the general well-being of a person[12] and it can be used unaccompanied or in arrangement with other sensors like electromyogram (EMG)[13].

It is valuable to note grip strength because in many illnesses, muscle strength decreases. Kevin J Solverson and others using dynamometric studies, observed the physical functioning of critically ill survivors with diminished muscle strength in various muscle groups[14]. Pierrette Baschung P fister and companions studied hand held dynamometry in patients suffering from inflammatory myopathy[15]. J M Brismee, S Yang and colleagues used hand dynamometry as a tool in their study to observe the musculoskeletal differences between males and females[16].

Patients suffering from COPD are likely to suffer from skeletal muscle dysfunction. Many articles have been published that mention lower limb muscle groups especially quadriceps being affected the most in COPD patients[17]. On the contrary, fewer studies have been done about involvement of muscles of the upper limb extremities.

METHODOLOGY

This study was conducted in the Department of Physiology and Department of Chest Medicine, Liaquat National Hospital and Medical College (LNH&MC) after the approval of the research committee and ethical review committee by certifying it with IRB certificate No. Ref:App # 0388-2017- LNH –ERC at LNH. The total duration of the study was one year, from July 1st 2019 and June 30th 2020. This was a case control study. Purposive sampling technique was used.

Sample size was calculated using Open Epi online software. For sample size estimation mean and standard deviation of handgrip strength in COPD patients (17.4±4.40) and in control group (28.43±8.35) was used from previous study[18]. Two independent sample t-test was applied with 80% power and 95% confidence interval; the calculated sample size was 14 in each group (total 28). However, we recruited total 100 subjects (50 cases and 50 controls). After taking proper written consent, patients diagnosed with COPD within one year were selected in this study. Age and gender of the cases corresponded to that of the healthy control group.

Cases and controls that had known medical illness of osteoarthritis, osteoporosis, any deformity of upper limb, neurological disorders effecting the upper limbs, history of fracture of the dominant upper limb, pain in the dominant upper extremity and history of inflammatory joint disease were excluded from this study. None of the cases were found to be asthmatic.

Detailed history of already diagnosed COPD cases regarding their illness and past medical records were observed. Anthropometric measurements like weight (kg), height (ft.), BMI (kg/m2), waist circumference (cm), hip circumference (cm) and WHR were taken for record. PEFR (L/min) was noted as a measure of lung function by using Wright's Peak flow meter[19]. Hand grip strength was measured (kg) using Camry digital hand dynamometer (grip strength measurement meter auto capturing electronic hand grip power 198 lbs / 90 kgs). This device is centered on isometric force sensing that is strain gauge based. The instrument augments the force applied and converts it into a voltage that can be monitored by the lab interface. It is the gold standard for measuring hand grip strength in adults. Both the cases and healthy controls were explained about the procedure of measuring hand grip strength. All the subjects were asked to sit on a chair, with a straight back and both feet resting flat on the floor. Subjects were asked to hold the hand dynamometer in their dominant hand, placing their arm on their sides, with flexed elbow at 90 degrees, forearm in proned position and wrist at neutral position. Subjects were asked to squeeze their hand with maximum strength and three readings of grip strength were measured with one minute interval between the readings[18]. Three readings were taken for both the variables and the best one was chosen from them. SPSS 21 was used to analyze the collected data. The socio-demographic details were executed using descriptive statistics. Mean and standard deviation was used for continuous variables like age and gender, and frequencies and percentages were used for categorical variables like diabetes mellitus, coronary heart disease, hypertension, and smoking. Comparison of anthropometric measures was done by Independent t-test. Pearson correlation coefficient was used to find out the linear correlation between quantitative variables. p-value=0.05 was indicated as significant difference.

RESULTS

Study included 50 COPD cases and 50 healthy controls. Mean ages in cases and controls were 44.4611.15 and 45.769.79 years old, respectively. In case group, 16 percent of people had diabetes, while 14 percent of people in controls had diabetes. Out of 50 cases, nine were current smokers and 32 had left smoking five to

eight years ago. Table 1 lists the baseline descriptive characteristics of COPD patients and controls.

Table 1: Baseline Descriptive Characteristics of Study Subjects

Quantitative Variable		Cases (n=50)	Controls (n=50)
Age (years), mean± standard deviation		45.769.79	11.15
Qualitative Variables			
Gender	Male	32 (64)	32 (64)
	Female	18 (36)	18 (36)
Diabetes	Diabetics	8 (16)	7 (14)
	Non diabetics	42 (84)	43 (86)
Coronary Heart Disease	Present	3 (6)	2 (4)
	Absent	47 (94)	48 (96)
Hypertension	Yes	15 (30)	12 (24)
	No	35 (70)	38 (76)
Smokers	Smokers	9 (18)	5 (10)
	Non smokers	41 (82)	45 (90)

We found significant mean difference of peak expiratory flow rate ($p<0.001$) and hand grip/dynametry ($p<0.001$) as presented in Table-2.

Table 2: Comparison of Anthropometric Measures Between Two Groups

	Mean±Standard Deviation		P-value
	Cases (n=50)	Controls (n=50)	
Body Mass Index (kg/m^2)	23.924.44	22.633.67	0.119
Waist Hip Ratio	.83.091	.84.10	0.594
Peak Expiratory Flow Rate (L/min)	251.08 90.33	353.95130.64	<0.001
Hand Grip/ Dynamometry (kg)	23.25±6.43	29.27±10.28	<0.001

n. =number, kg/m^2 = kilogram/meter square, L/min=Liters/ min, Kg=kilogram, * p-value is significant at 0.05

There was a weak positive correlation of hand grip with peak expiratory flow rate (r=0.270) while negative weak correlation of hand grip was found with BMI (r=-0.246) among cases. We found significant and positive moderate correlation of hand grip with peak expiratory flow rate (r=0.574) while significant positive weak correlation of hand grip was found with BMI (r=0.312) among controls as shown in Table-3.

Table 3: Correlation Between PEFR and Grip Strength: Comparison of Grip Strength, WHR and BMI Between COPD Patients and Controls

Study Variable	Cases		Controls	
	Correlation (r)	P-value	Correlation (r)	P-value
Peak Expiratory Flow Rate	0.270	0.058	0.574	<0.001
Waist Hip Ratio	0.075	0.606	-0.236	0.100
Body Mass Index	-0.246	0.085	0.312	0.028

* p-value is significant at 0.05

DISCUSSION

COPD is a type of lung illness which may have extra pulmonary manifestations of fat, bone, and muscle wasting[20]. Muscle strength refers to a muscle's ability to generate maximum force, whereas muscle endurance refers to a muscle's ability to withstand a submaximal force over time. Muscle dysfunction in patients of COPD is regarded as a decrease in either endurance of the affected muscle or strength of that muscle[21]. A reliable tool to measure the strength of the muscle in clinical settings is hand held dynamometer[22]. We observed the values of PEFR and handgrip strength in both control and COPD group, and found that both hand grip strength and PEFR values were lower in the COPD group than in the control group.

In this research, we discovered a weak positive correlation between PEFR and hand grip strength using hand held dynamometer in patients with COPD with a statistically significant p value. Our result is supported by the fact that upper extremity muscles are impaired in patients suffering from COPD as supported by previous research[23]. COPD is a progressive disease, and reduced muscle mass and hand grip strength may be associated with the disease severity. Although the association between low hand grip strength and chronic lung disease is multifactorial[24].

We found significant and positive moderate correlation of hand grip with peak expiratory flow rate(r=0.574) while significant positive weak correlation of hand grip was found with body mass index (r=0.312) among controls as shown in Table-3.

We discovered a weak negative but statistically significant relationship between BMI and hand grip strength in cases of our research. Though body weight is low in ten to twenty percent cases of COPD as explained by various researchers[25]. It is independent to the degree of the airflow obstruction and is related to increased gas trapping and decreased diffusion capability.

When compared to COPD patients of normal weight, a low BMI is associated with decreased exercise capacity and a higher risk of mortality[26]. Weight loss is commonly thought to be a sign of illness progression, but according to findings from a population-based study, the prevalence and course of weight loss in COPD patients is similar to that of older people with normal lung function[27]. Low bodyweight can be reversed in individuals with COPD, regardless of the cause, and weight increase is linked to a lower mortality risk in individuals with severe disease[28]. Low body

weight may be attributed to apoptosis of skeletal muscle. COPD patients often have a low fat-free mass, this is linked to a poor quality of life, decreased muscle strength, and a higher chance of mortality. Our study opens doors for carrying out further research on extra pulmonary effects of COPD[29]. We used hand held dynamometer as a tool, more studies should be done using other pressure augmenting instruments for better understanding. We had a small sample size, so more studies with greater sample sizes will help us better understand the effects of COPD for improvement in therapeutic regimes.

CONCLUSION

Although we found weak positive correlation between PEFR and hand grip strength in COPD patients. This study concludes that patients with COPD have reduced hand grip strength. In clinical settings, frequent monitoring of hand grip strength may appear to be useful in predicting COPD disease progression, determining hand grip strength ensures quick assessment of quality of life.

Acknowledgement: We acknowledge the immense help received from the articles that are cited and counted in the references of this manuscript. We would like to thank the faculty of Department of Physiology and Department of Chest Medicine LNH&MC for granting permission to conduct this study in their premises and allowing us access to the instruments needed for our study.

Conflict of Interest: The authors declare that they have no conflict of interest.

Authors' Contribution: EA conceived the idea and concept of research, worked on study design, interpretation of results, manuscript writeup, and review. MKN and MI worked on data entry and statistical analysis, and manuscript writeup, NS and TA worked on sample collection and manuscript writeup. SHH critical review of the article and all the authors review and approve the final manuscript.

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