Correlation of Peak Cough Flow Rate with Peak Expiratory Flow Rate In Patients With Chronic Respiratory Diseases

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Abstract: Background & Objective: Chronic cough is a most common symptom of chronic respiratory disease. Peak expiratory flow rate (PEFR) is routinely used as a bed- side tool to evaluate the degree of airway obstruction in these patients. Whereas Peak cough flow rate (PCFR) a measure of cough strength is rarely used. There is no established data regarding any association between PEFR and PCFR. Hence the objective was to study the association between the two variables and compare PCFR and PEFR of respiratory patients with that of age matched controls. Method: 113 patients diagnosed with stable chronic respiratory diseases and presentation of cough/sputum production as a symptom were included. Patients with exacerbation, or any other recent surgery were excluded. 113 age and BMI matched healthy controls were recruited to obtain normative data. The evaluation of PEFR and PCFR was done by the Mini wright Peak flow meter. Result: A statistically significant positive correlation was found between PEFR and PCFR (r-0.718). Conclusion: The study concluded that there is a significant positive correlation between PEFR and PCFR and a significant reduction in PEFR and PCFR in patients than the matched controls. [N Shahane, Natl J Integr Res Med, 2018; 9(3):21-25]

Key Words: Chronic Respiratory disease, Peak Expiratory Flow Rate, Peak Cough Flow Rate.

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Introduction Chronic respiratory diseases are group of chronic diseases of the airways and other structures of the lungs[1]. The top five respiratory diseases account for 17.4% of all deaths and 13.3% of all Disability-Adjusted Life Years (dalys)[2].Chronic cough, i.e. Cough lasting longer than 8 weeks, is a common clinical presentation in these patients[3].Patients with chronic cough suffer considerable physical and psychological morbidity[3]. Peak expiratory flow rate (PEFR) which is defined as "the maximum rate at which the air can be expired after a deep inspiration"[4] cannot be used as a surrogate measure of cough efficiency. PEFR can be measurable in the absence of peak cough flow, when the glottis cannot be closed and the risk of laryngeal penetration and pulmonary morbidity is high[5].The peak cough flow rate (PCFR) is a measure of the maximum air flow generated during a normal cough[6]. The PCFR is especially used to assess cough efficacy in patients with respiratory muscle weakness, particularly in patients with neuromuscular disease[7,8,9]. PCFR gives an important measure of the cough strength which determines the effectiveness of cough.

There are various correlational studies between PEFR and obesity indices[11], nutritional status[12] and height[13]There is paucity of literature related to the use of PCFR in patients with chronic respiratory diseases. In order to clear airways, these patients exert and cough extensively to expectorate mucus. Though enough flow rates may be generated, it is still difficult to clear the airway. PEFR has been used as measure of huff strength[14] however PCFR is measure of cough strength [15,16]. Hence the aim was to study the correlation between PEFR and PCFR.

Methods: Institutional ethics committee permission was obtained and 113 patients within age group of 20-65 years with chronic respiratory diseases, FEV1 < 80% or FVC<80% and presentation of cough/sputum production as a primary symptom were included. Patients in acute exacerbation, having any recent history of surgery and any other conditions affecting the pulmonary function were excluded. Simillarly,113 Age and BMI matched healthy controls with no known respiratory and Cardiovascular system involvement, having no addictions or history of passive smoking or wood challah exposure , no history of tuberculosis contact were included to evaluate normative values of PEFR and PCFR .

After seeking written informed consent from included patients their demographic data was noted. Duration of the disease, presentation and severity of symptoms like cough and dyspnoea, history of addictions, exacerbations, daily medications were inquired. Chest X-ray was also noted. Anthropometric measurements (Height, weight) were taken. PEFR and PCFR was measured with a Mini- Wright Peak flow meter[17,18,19] using standardized instruction. The readings was noted with help of the displaced marker. The best of three reading was recorded. Patients were given a rest

period of ten minutes between the measurement of PCFR and PEFR.

Data was then computed and analyzed using SPSS for windows version 16 software. Spearman rank test of correlation was used to study the correlation between PEFR and PCFR. Mann Whitney U test was used to compare the continuous variables(PEFR and PCFR)between the patient and control groups. P value of ≤ 0.05 was considered as statistically significant.

Result: Total 226 subjects participated in the study. The subjects were divided in two groups (patients and controls). Each group had 113 participants. Out of 113 patients, 20%(n=23) were diagnosed with bronchial asthma, 35% (n=38) had bronchiectasis (this also includes Post tuberculosis bronchiectasis), 42%(n=45) had obstructive airway disease(this also includes Chronic obstructive pulmonary disease, post tuberculosis obstructive airway disease and also wood smoke related lung disease) and 2% (n=2) had interstitial lung disease.83%(n=109) patients were on bronchodilators and 17%(n=23) were taking steroids.

Patient's dyspnea was assessed on Modified Medical Research Council Scale(MMRC). 6% (n=7) patients had grade 0 dyspnea, 10.6% (n=12) had grade 1 dyspnea, 46.9% (n=53) had grade 2 dyspnea and 36.28% (n=41) had grade 3 dyspnea. Patients cough quality was assessed on Miller's scale wherein 67.3 % (n=76) had grade M1 (mucoid with pus), 29.2% (n=33) had grade M2 (mucoid with suspicion of pus), 3.5 %(n=4) had grade P1 (1/3 purulent and 2/3 mucoid). Average quantity of mucus expectorated by the patients with chronic respiratory diseases was 29.03 cc per day.

A moderate positive correlation(r= 0.718) along with a statistical significant association as P value was <0.0001(graph 1) was found between PCFR and PEFR. Further, regression analysis was done to determine the relationship between the two variables. In patient group the equation obtained was PCFR= 8.46 + 0.638 (PEFR).In control group the equation obtained is as follows: PCFR= 46.30 + 0.78 (PEFR).

In order to compare the two variables in both the groups, non parametric test (Mann-Whitney U test) was applied (Table-3) The mean rank of PEFR in patients group (63.37) was lower than that of controls (163.63).The Mann Whitney U value was found to be statistically significant (U=719.5 ,p=.000). The mean rank of PCFR in patients group (60.54) was lower than that of controls (166.46).The Mann Whitney U value was found to be statistically significant (U=399.5 ,p=.000).Thus, the mean rank in patients group was lower than that of controls in both the variables.

Table: 1 Baseline Characteristics of Patients and Controls

	Patients(n=113)		Controls(n=113)	
Variable	**Mean ± SD**	**Range**	**Mean ± SD**	**Range**
Age (yrs)	46.28 ±12.63	20-65	45.42±13.13	20-65
BMI (Kg/m2)	22.16 ±4.974	12.28-33.33	22.94± 4.268	15.74-34.47
PEFR (L/min)	204.1 ± 89.78	60-500	405 ± 85.37	200-650
PCFR (L/min)	138.7 ± 73.15	60-450	363.3± 87.2	200-600

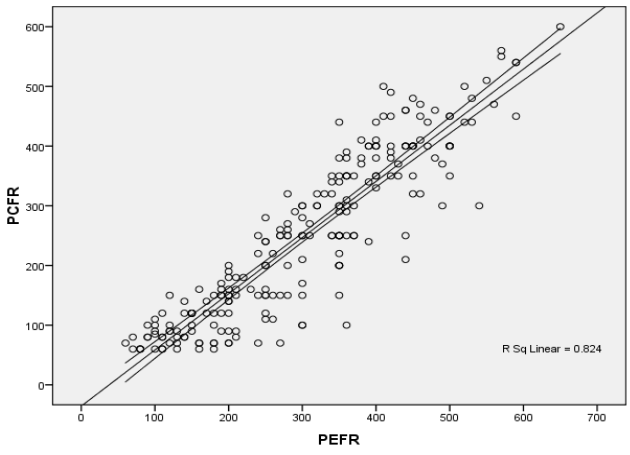
Table 2: Mean rank of PEFR and PCFR in the two groups

Variable	Groups	Mean Rank
PEFR	Patients	63.37
	Controls	163.63
PCFR	Patients	60.54
	controls	166.46

Table 3: Mann-Whitney U test applied for the intergroup comparison

	PEFR	PCFR
Mann-Whitney U	719.500	399.500
Wilcoxon W	7160.500	6840.500
Significance	.000	.000

Graph 1: Correlation between PCFR and PEFR in both the groups



Discussion: This correlational study was conducted on 113 subjects with chronic respiratory disease and 113 controls. The aim of the study was to correlate peak cough flow rate (PCFR) with peak expiratory flow rate (PEFR) in patients with chronic respiratory diseases. The secondary objective of the study was to compare PEFR and PCFR between the normal and patient population.

We found a statistically significant moderate positive correlation (P <0.0001, r=0.718) between the two objective measurements. Regression analysis has given the equation to estimate the value of PCFR with PEFR as dependent variable in patients and controls separately. The equations can be used to estimate PCFR where it cannot be measured and it can also be used to identify the candidates likely to develop pulmonary complications.

PEFR is the greatest flow velocity that can be obtained during a forced expiration starting from fully inflated lungs. Hadorn introduced PEFR in 1942 and it was accepted as a parameter of pulmonary function test in 1949[21] and is very useful in the assessment of severity of airway obstruction as a bedside tool.[19,22,23] It is influenced by various intrinsic factors, environmental and ethnic differences[12]. PEFR has been used as a measure of huff strength[14]. In literature there are various correlational studies finding the association of PEFR with various variables. There are significant association between PEFR and obesity indices, thickness of external oblique thickness and skin fold thickness[10,11,12]

Cough flow testing is useful as a monitoring or diagnostic tool in clinical practice and research[24]. Peak cough flow (PCF) is commonly used as an indicator of the strength or effectiveness of cough, particularly in clinical populations with neuromuscular impairment[25]. however it is not applied to chronic respiratory diseases. For an effective cough , the flow generated by the expiratory muscles should be high which may be compromised by diseases of the lung parenchyma, weak respiratory muscles and laryngeal dysfunction[26]. PEFR cannot be considered as a surrogate measure of cough efficiency. PEFR measures expiratory flow through an open glottis, whereas the forceful expiratory flow of a normal cough follows a glottic closure of about 0.2 s[7]. The PCFR correlates with respiratory muscle strength, especially with inspiratory muscle strength. Coughing follows a deep inspiration and involves the generation of high intra-thoracic pressure against a closed glottis, which is then suddenly opened to allow rapid expiration[27]. Huffing follows an inspiration and is a sharp forced expiratory manoeuvre where the glottis remains open. Performance of coughs and huffs by patients is influenced by lung volumes, sensitivity of airway reflexes, muscle biomechanics, medications, pain, and the patient's state of mind [28,29]. Higher lung volumes have been linked with better expiratory muscle length-tension relationships[30] and improved expiratory pressures and flow rates. We found a significant correlation between the PEFR and PCFR. If PCFR cannot be evaluated, it can be estimated by the equation derived in the results of the study which can give the therapist an estimate about cough efficiency.

The secondary objective of the study was to compare the variables PEFR and PCFR of the patient with that of the matched controls. Table 3 shows a statistically significant difference between the mean rank of PEFR and PCFR on the intergroup comparison between patients and control groups. From the table 2 the mean rank of PEFR and PCFR in patients with chronic respiratory diseases is 63.37 and 60.54 respectively, while in the control population it is 163.63 and 166.46 respectively. This shows that the variables were significantly lower in patients than controls .In this study, the mean PEFR in patients was 204 L/min and in controls it was 405 L/min, while the mean PCFR was 138 L/min in patients and in controls it was 363 L/min between the age group of 20-65 years. The range of PEFR in patients was 60-500 L/min and in controls it was 200-650 L/min. The range of PCFR in patients was 60-450 L/min and in controls it was 200-600 L/min.

The average PEFR of healthy young Indian males and females are around 500 and 350 litres/minute respectively[18] .The PEFR reaches a peak at about 18-20 years, maintains this level up to about 30 years in males, and about 40 years in females, and then declines with age[32,33].The first publication that considered Peak Cough Flow rate in normal subjects was published by Leiner et al[34]. In healthy individuals,the average PCFR is higher than 300 L/min in Caucasian European subjects[31].In our study we found the range between 200-600L/min Additionally, it must be higher than 160 L/min for an effective cough[26] . More recently normal values for Brazilian healthy adults ranged between 240 and 500 L/min[35].

In patients with chronic respiratory disease there is airway ostruction, ineffective airway clearance, compromised cough mechanism due to decrease respiratory muscle strength. PEFR is associated with huff strength and airway obstruction. While, PCFR is associated with cough efficiency and respiratory muscle strength. Therefore, We conclude that the PEFR and PCFR were significantly reduced in the patient group as compared to control group.

The study. This will help identify the subjects likely to have pulmonary complications and hence early intervention can be initiated by the health care provider

Conclusion: We conclude that there is significant association between PEFR and PCFR. We also conclude that there is significant reduction in PEFR and PCFR in patients than the matched controls.

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