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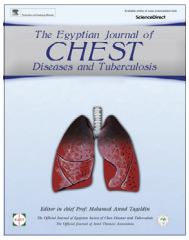

ORIGINAL ARTICLE

Is there a role for cough peak flow in assessment of patients with severe COPD?

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KEYWORDS

Cough peak flow;
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Abstract *Objective:* To assess cough peak flow in patients with frequent infective exacerbations of COPD.
Design: Cross-sectional controlled clinical study.
Settings: Pulmonary function laboratory of the Chest Department of Ain Shams University Hospitals, Cairo, Egypt.
Patients: Forty male patients with severe COPD; twenty with stable disease and twenty with more than two exacerbations in the last year were included in the study.
Interventions: Spirometry and cough peak flows were measured at least six weeks after recovery from their last exacerbation.
Results: Both groups were matched as regards demographics and lung functions. There was a statistically significant lower CPF in the frequent exacerbation group.
Conclusion: Cough peak flow can guide respiratory physicians in fine tuning the management of patients with severe COPD to their particular needs.

Introduction

COPD patients have generalized muscle weakness caused by deconditioning, malnutrition, electrolyte disturbances, cardiac failure, systemic inflammation and treatment with corticosteroids causing steroid-induced myopathy [1].

Inspiratory muscle weakness is more pronounced than the expiratory muscle weakness in patients with COPD [2]. This is thought to be caused by hyperinflation placing the inspiratory muscles at a mechanical disadvantage, while several studies reported that impaired expiratory muscle strength in most patients with significant COPD is thought to be part of the generalized muscle weakness in these patients [3–6].

In patients with neuromuscular diseases the inefficient cough secondary to affection of expiratory muscles is thought to be responsible for bronchial mucus retention, atelectasis and infection which have deleterious effects on their condition. Cough peak flow (CPF) is an acceptable alternative to measuring maximal expiratory flow (MEP) in assessing expiratory muscle weakness in these patients especially as performing the MEP can be quite cumbersome [7].

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There is a move toward phenotyping patients with COPD and hence optimizing and tailoring therapeutic interventions to their needs. A phenotype that we commonly see is the frequent exacerbators. With the strain on resources in Egypt there is always the need to find cheap easy to use instruments and measures that can help physicians provide good quality care to patients. Cough peak flow has this potential.

Aim of the work

To assess cough peak flows as a measure of respiratory muscle weakness in patients with severe COPD who have frequent exacerbations.

Subjects and methods

Forty male patients with severe COPD patients were enrolled in this study. The diagnosis and severity of the condition were established by history taking, thorough clinical examination and spirometry according to the American Thoracic Society criteria.

They were grouped into two subsets.

Group 1: Twenty patients with stable disease with less than 2 exacerbations in the last year.

Group 2: Twenty matched COPD patients with more than 2 exacerbations in the last year.

Routine blood tests, spirometry and cough peak flows were measured at least six weeks after recovery from their last exacerbation.

All patients were on optimal medications for their condition. None of the patients were on long term oxygen therapy or steroids. Some had co morbidities but they were all controlled and none had any other system failure.

Each subject was instructed by a single, non blinded technician, to reduce inter observer variability.

Patients performed standard spirometric tests using a Yaeger Viasys spirometer meeting the American Thoracic Society recommendations for accuracy and precision. Subjects were asked to blow as forcibly as they could into the mouthpiece from a full inspiration. Three measures were carried out and we considered the best of three to represent each individual.

CPF was measured using the Mini–Wright Peak Flow Meter from Clement Clarke International Ltd., portable, made of plastic material. It was used in order to assess the strength and speed exerted by the expiration in liters per minute (L/min). During the period in which we used our mechanical tool we did not realize any damage of the instrument. The testing was done in sitting position in a chair with no armrest. Subjects were seated and asked to perform a voluntary cough. The volunteers performed a maximal inspiration, followed by a quick, short and explosive expiration on the peak flow meter. The difference from the peak expiratory flow is the higher glottis pressure and the higher resistance induced by the closed glottis, which characterizes a forced cough. Three measures were carried out and we considered the average of three results for each individual.

The study obtained ethical approval from the Chest Department, Ain Shams University. The study and procedures were explained to the patients and appropriate consent was obtained.

Data were analyzed using graphpad prism 6 for windows version 6.04 (trial) – graphpad software Inc. – statistical package and compared with unpaired *t* test with the Welch correction and *P* of less than 0.05 was considered statistically significant.

Results

Forty male patients with severe COPD FEV1 $<30\%$ were enrolled in this study.

Group 1: Twenty patients with stable COPD having had less than 2 exacerbations in the last year.

Group 2: Twenty patients with more than 2 exacerbations in the last year.

The mean and standard deviation of demographic, arterial blood gases and CPF values are summarized in Table 1 and comparisons are illustrated in Figs. 1–3.

Discussion

The clinical relevance of the CPF has been defined primarily in patients with neuromuscular ventilatory impairment and those that need weaning from endotracheal to tracheostomy tubes. In the absence of bronchial obstruction, the peak flow (PF) evaluates the dynamic performance of the expiratory muscles and monitoring PF–CPF difference is useful to monitor expiratory muscle weakness and bulbar involvement and to assess its evolution in these patients [7].

The first publication that considered CPF in normal subjects was published by Leiner et al. [8]. In healthy individuals, the average CPF is higher than 300 L/min in Caucasian European subjects. Additionally, it must be higher than 160 L/min for an effective cough [9]. There is an increasing rate of change of cough flow during a cough sequence when children get older. Notably, the minimum CPF accepted as normal for the adult population (400 L/min) is shown to be reached in the pediatric subjects between ages 12 and 13 in both males and females [10]. More recently normal values for Brazilian healthy adults ranged between 240 and 500 L/min [11]. There are no normative values for Egyptians but this applies to all spirometric and lung function values.

The expiratory muscles have an important function in clearing the airways by producing 'effective' cough. The contraction of the expiratory muscles increases the intrathoracic

Table 1 The mean and standard deviation of demographic, arterial blood gas, and CPF values of groups A and B as well as *P* value on doing unpaired *t* test with Welch correction when *P* less than 0.05 were considered statistically significant.

	Group B		Group A		*P* value
	Mean	SD	Mean	SD	
Age	60.4	3.7	61.8	4.3	0.05
BMI	29.6	2.4	28.3	2.2	0.06
Sm.Index#	43.4	14.7	50.8	19.6	0.2
PH	7.39	0.04	7.4	0.04	0.16
PCO2	42.3	10.2	48	14	0.15
PO2	85	5.7	72	8.2	0.0001
Sat	87	8	88	7	0.6
CPF	179	19.7	164	24.8	0.04

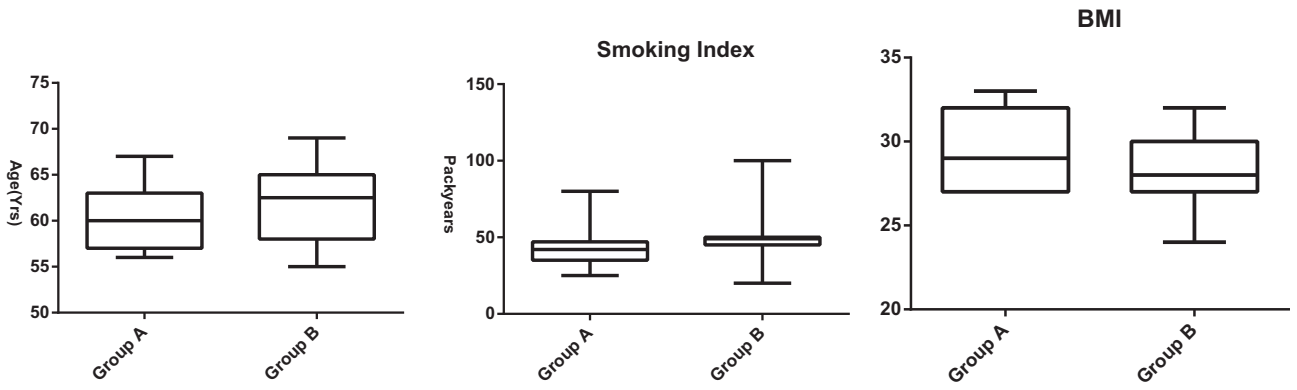

Figure 1 Comparison between groups A and B as regards age, smoking index and body mass index (BMI). There was no significant difference between the two groups as regards age, BMI and smoking index.

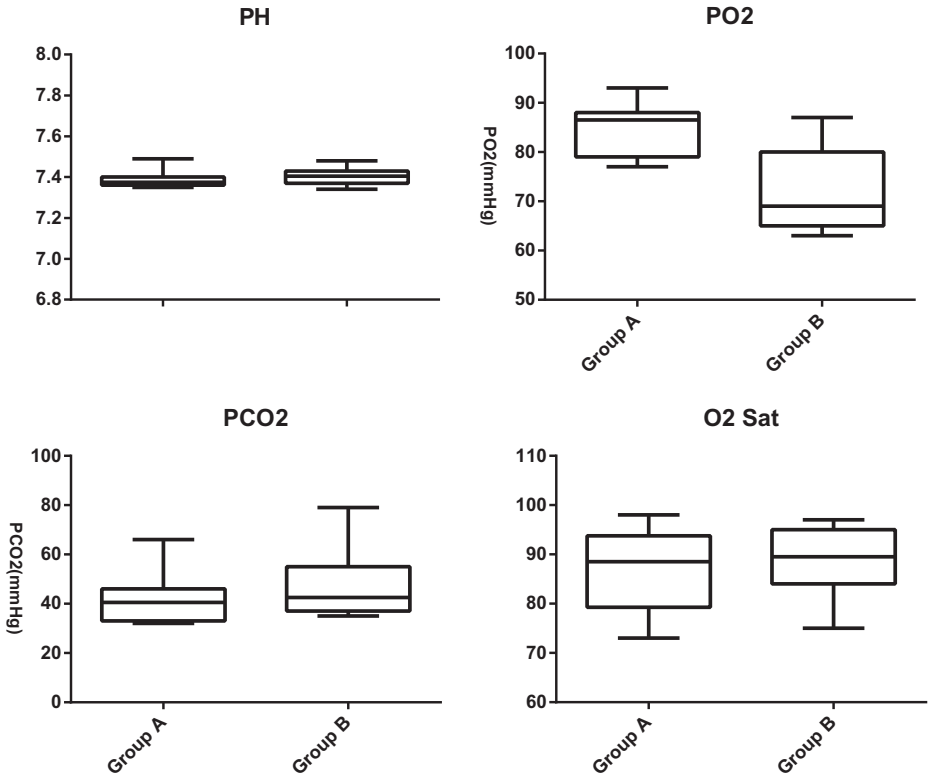

Figure 2 Comparison between groups A and B as regards PH, PO2, PCO2, and O2 saturations. Group B had significantly worse PO2 values compared to group A.

pressure, diminishes lung volume, and facilitates expiratory flow in the absence of flow limitation. For cough to be effective, the flow generated by the expiratory muscles should be high .This may be compromised by diseases of the lung parenchyma, weak respiratory muscles and laryngeal dysfunction [12].

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. As a consequence, CPF measurements directly assess bulbar-innervated muscle function. PEFR can be measurable in the absence of CPF, when the glottis cannot be closed [13].

The CPF correlates with respiratory muscle strength, especially with inspiratory muscle strength. In the inspiratory phase of cough, inhalation of high volumes promotes a relationship between time and tension of the muscles and increases the elastic recoil of the respiratory system, optimizing expiratory pressures. The muscle strength to inhale appropriate volumes leading to chest expansion and the muscle force to increase intrathoracic pressure are important to generate effective cough and high flows [14].

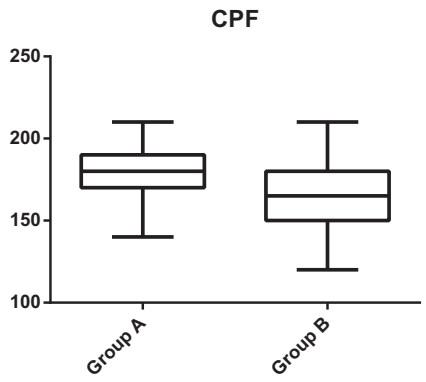

Figure 3 Comparison between groups A and B as regards cough peak flow (CPF). Group B had statistically significant lower CPF than group A.

In this study both groups comparably had severe COPD with no statistically significant difference as regards their demographics. The arterial blood gas value of group B was significantly worse which reflects the disease burden on this group and its impact on morbidity. The group which had more chest infections had a statistically significant lower cough peak flow.

Respiratory and peripheral muscle dysfunctions have significant consequences for COPD patients. They are associated with reduced exercise tolerance and reduced quality of life. Both are independent determinants of survival, in addition to the degree of airflow obstruction as measured by FEV1. Also the utilization of health care resources appeared to be related to respiratory and peripheral muscle weakness. Treatment of respiratory and peripheral muscle weakness in COPD patients is possible. Respiratory and peripheral muscle training has been shown to produce beneficial effects especially if they are used in combination with nutritional interventions and anabolic steroids [1].

There is a paucity of data related to the expiratory muscles (abdominal muscles and the internal intercostal muscles) in patients with COPD. These muscles have been found to be recruited in such patients both at rest and during loaded breathing. The significance of this activation has not been well defined; however, it is considered to be a mechanism that provides the system with functional reserve. Expiratory muscle strength and endurance can be impaired in patients with COPD and therefore decrease functional reserve [5,6]. The effectiveness of the cough generated by such muscles has not been studied to the authors' knowledge. This has generated some difficulties such as lack of reference to studies in relation to similar themes or methodologies on the CPF values.

The consequence of inspiratory muscle weakness is the loss of ability to perform a deep inspiration, which is necessary to maintain peripheral alveolar ventilation in addition to affecting the first phase of cough (deep breath). The weakness of the expiratory muscles may be seen in a reduction in maximal expiratory pressure and reduced ability to perform a deep expiration and cough [15].

The CPF as a functional marker in COPD would therefore appear to address both inspiratory and expiratory muscle strength with an advantage of giving us an idea about cough strength.

One of the limitations of the voluntary evaluation of CPF is the understanding and cooperation of the subjects. Also, the cough reflex mechanism would be triggered in a reasonable way to the method of evaluation. The differences in voluntary and reflex cough go beyond the way they are triggered. During the voluntary cough the expiratory and accessory muscle action only generates one CPF. On the other hand, during the reflex cough the muscle action is harmonious and simultaneous, generating two or more peak expiratory flows of lower amplitude [16].

Cough peak flow can therefore be used as a cheap assessment tool for patients with severe COPD to identify their risk of developing frequent exacerbation which increases the burden of the disease and impacts on morbidity and mortality.

Further clinical studies need to be designed to determine which threshold levels of CPF result in increased morbidity for COPD patients with respiratory muscle weakness. These could act as a reference against which measurements from patients with respiratory muscle weakness could be compared in order to identify early those at risk of problems with cough and secretion clearance. This information could be used in developing prevention programs by identifying and intervening in patients at risk. Expiratory muscles can be specifically trained and targeted in pulmonary rehabilitation programs with improvement of both strength and endurance in patients with COPD. This improvement is associated with an increase in exercise performance and no significant change in the sensation of dyspnea in daily activities [17].

Cough peak flow is a bedside cheap test that can guide respiratory physicians in tailoring their treatment of advanced COPD patients and fine tune their treatment to their particular needs.

Conflict of interest

None declared.

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