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Association between Emergency Visits with Acute Exacerbation and Exercise Performance in Chronic Obstructive Pulmonary Disease

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Abstract

Objective: The relationship between acute exacerbation and exercise performance in chronic obstructive pulmonary disease (COPD) is unclear. The aim of this study was to compare exercise performance between patients with COPD who visited and did not visit an emergency department in the last year; we also aimed to investigate the correlation between frequency of emergency visits and exercise performance.

Methods: We recorded the number of emergency department visits of 206 COPD patients. The six-minute walk test, the modified Medical Research Council Dyspnea Scale, body plethysmographs, carbon monoxide diffusion tests, and arterial blood gas analysis were practiced.

Results: We had one hundred twenty seven participants visited an emergency department at least once in the last year. Exercise performance, dyspnea, pulmonary functions, and oxygenation were significantly poorer in those patients ($p<0.05$). The number of emergency department visits was correlated with exercise performance, dyspnea, oxygenation, forced expiratory volume in one second forced expiratory volume in one second/forced vital capacity, and carbon monoxide diffusion capacity ($p<0.05$).

Conclusion: Exercise performance was poor and negatively related to the frequency of emergency department visits in COPD patients. We concluded that exercise performance-enhancing implementations may contribute to reduce the frequency of emergency department visits.

Keywords: Acute exacerbation, COPD, emergency visit, exercise performance, six-minute walk test

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the leading causes of mortality and morbidity worldwide; however, it is also a chronic disease with increasing prevalence despite medical treatment (1, 2). Acute exacerbation of COPD, which is the most common cause of hospital visits, may appear at any stage of the disease; its frequency and severity increases with disease severity (3, 4). Accelerated reduction in forced expiratory volume in one second (FEV_1), which is the primary determinant of pulmonary function and exacerbation, increases the severity of the disease, reduces the quality of life of patients, and increases health expenditures (5-7). Serious exacerbations requiring hospitalization are the leading causes of mortality and morbidity in COPD (8).

Physical decondition and pulmonary dysfunction are the primary causes of exercise intolerance, which is the main clinical feature of COPD (9). Assessment of exercise tolerance is necessary to evaluate the impact of COPD; however, measurement of pulmonary functions such as FEV_1 is not adequate to determine exercise tolerance (10). The six-minute walk test is a submaximal exercise test that assesses the functional status of COPD patients. It is easily applicable, inexpensive, and repeatable. In addition,

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this test allows simultaneous evaluation of the patient's pulmonary, cardiovascular, musculoskeletal, and neuromuscular systems (11, 12).

There is no study in the literature investigating the correlation between exercise performance and emergency visits with acute exacerbations in patients with COPD. In the present study, we investigated COPD patients in our clinic in two groups, those who visited and did not visit an emergency department in the last year; we aimed to compare exercise performance between these groups as well as to investigate the correlation between frequency of emergency department visits and exercise performance in cases who visited an emergency department.

METHODS

A total of 206 symptomatic COPD patients (189 males, 91.7%) who were referred to the University of Health Sciences Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital, Department of Chest Diseases between June 2013 and June 2015 were enrolled in our cross-sectional study. The demographic and clinical characteristics of the patients were recorded. They were asked about their emergency department visits due to dyspnea, as well as the increases in amount and purulence of their sputum in the last year. All study participants were informed about the study objectives and evaluation methods. Written consent was obtained from all patients. The physical and demographic data, disease duration, and history of smoking of the patients were recorded. All patients underwent pulmonary and cardiac system examination and pulmonary function testing (PFT). Lung radiographs and arterial blood gases (ABG) were evaluated. Each patient performed the six-minute walk test.

Pulmonary functions: The pulmonary functions of the patients were evaluated by body plethysmography (Zan 500, Germany) and carbon monoxide diffusion capacity (DLCO) (Zan 300, Germany).

Perception of dyspnea: The five-item Medical Research Council (mMRC) dyspnea scale was used to determine the severity of the patients' shortness of breath (13). "1" indicates the lowest severity, and "5" indicates the highest severity.

Exercise performance: Exercise performance was assessed by the six-minute walk test, which measures the longest distance patients can walk in six minutes (14). Heart rate, peripheral oxygen saturation, dyspnea, and leg fatigue, which was measured by the modified Borg scale pretest and post-test, were recorded.

The modified Borg scale, which is scored from 0 to 10, is used to assess exertional dyspnea; "0" indicates no dyspnea, and "10" indicates severe dyspnea (15).

The study participants were divided into in two groups: patients who had visited and who had not visited an emergency department in the last year.

Statistical Analysis

We performed statistical analyzes using SPSS 15.0 (Statistical Package for the Social Sciences Inc.; Chicago, IL, USA). Descriptive statistical tests were performed for all the recorded variables, and the data were expressed as median (interquartile range) or percentage (%). We used the Mann-Whitney U test to compare continuous data and the chi-square test for categorical data. We determined the relationships between continuous variables by calculating Spearman correlation coefficient. We considered $p<0.05$ to indicate significance.

RESULTS

Of the 206 study participants, 127 (61.6%) (116 males, 91.3%) had visited an emergency department at least once, whereas 79 (73 males, 92.4%) had not visited an emergency department in the last year. The median number of exacerbation was 3(1, 6) in patients who visited an emergency department. Of those 127 patients, 73 (57.5%) were hospitalized and 54 (42.5%) were prescribed drug treatment after exacerbation.

The median age and the number of patients with stage 4 COPD were significantly higher in patients who visited an emergency department ($p=0.032$ and $p<0.001$, respectively; Table 1). Both groups were similar in terms of body mass index (BMI) and cigarette consumption ($p=0.99$ and $p=0.91$, respectively; Table 1). Perception of dyspnea, pulmonary functions, and oxygenation were significantly poorer in patients who visited an emergency department compared to patients who did not visit an emergency department in the last year ($p<0.05$, Table 1).

When exercise performance was compared between the groups, the six-minute walk distance and changes in peripheral oxygen Saturation between pre and post-test were significantly lower and changes in dyspnea and leg fatigue were higher in patients who visited an emergency department ($p<0.05$, Table 2).

Table 1. Comparison of demographic and clinical characteristics between groups

Variable	Emergency department visit (+) (n=127)	Emergency department visit (-) (n=79)	p
Age (years)	64 (58, 70)	61 (55,67)	0.032*
BMI (kg/m^2)	26 (22, 30)	26 (23, 30)	0.99
Smoking (p-y)	50 (30, 80)	50 (35, 80)	0.91
STAGE n (%)			
Stage 1	0 (%0)	4 (%5.1)	0.021*
Stage 2	23 (%18.1)	29 (%36.7)	0.005*
Stage 3	56 (%44.1)	35 (%44.3)	0.545
Stage 4	48 (%37.8)	11 (%13.9)	<0.001*
FEV_1 (% predicted)	34 (26, 47)	44 (35, 63)	<0.001*
FEV_1/FVC	54 (44, 62)	60 (52, 70)	0.001*
DLCO (%)	34 (24, 44)	43 (30, 52)	0.008*
PaO_2 (mmHg)	67 (60, 76)	75 (69, 82)	<0.001*
$PaCO_2$ (mmHg)	41 (38, 47)	39 (36, 44)	0.014*
SaO_2 (%)	94 (91, 95)	95 (94, 96)	<0.001*
mMRC	4 (3, 5)	3 (2, 4)	<0.001*

Data are expressed as median (interquartile range) or percentage (%)

*$p<0.05$ for comparison of changes between groups based on Mann-Whitney U test or chi-square test

BMI: Body mass index; p-y: packs-year; FEV_1: forced expiratory volume in one second; FVC: forced vital capacity; DLCO: carbon monoxide diffusing capacity; PaO_2: partial arterial oxygen pressure; $PaCO_2$: partial arterial carbon dioxide pressure; SaO_2: arterial oxygen saturation; mMRC: Medical Research Council dyspnea scale

Correlation analysis performed for the patients who visited an emergency department revealed a weak negative correlation between the number of emergency department visits and exercise performance (r=−0.301; p=0.001), FEV_1 (%) (r=−0.254; p=0.004), FEV_1/forced vital capacity (FVC) (r=−0.300; p=0.001), and DLCO (%) (r=−0.264; p=0.012); weak positive correlation with perception of dyspnea (r=0.367; p<0.001); and very weak negative correlation with partial arterial oxygen pressure (PaO2) and arterial saturation (r=−0.179; p=0.046 and −0.178; p=0.047, respectively; Table 3).

DISCUSSION

In this study, we found that exercise performance was lower in COPD patients who visited an emergency department at least once in the last year. Moreover, high numbers of emergency visits were correlated with poor exercise performance.

In the present study, elderly males accounted for most of the COPD patients who were admitted to an emergency department with acute exacerbation (16). According to a study that evaluated the spirometric parameters of patients, FEV_1 was lower than 40% in COPD patients who visited a hospital with acute exacerbation (17). Decrease in FEV_1 (%) is a factor that leads to hospitalization of COPD patients for acute exacerbation (18). In another study, impaired oxygenation was a factor that led to emergency department visits (19). In the present study, FEV_1 (%) and partial oxygen pressure were also significantly lower in COPD patients who visited an emergency department for acute exacerbation compared to the other group. In another study, which investigated risk factors related to the mortality of COPD patients with exacerbation, it was found that a change in partial arterial carbon dioxide pressure ($PaCO_2$) between the first measurement on admission and during hospitalization was associated with mortality (20). Emerman et al. (21) showed that although FEV_1 was lower than 35% in patients who visited an emergency department with acute exacerbation and whose $PaCO_2$ levels were higher than 45 mmHg, no correlation was determined between FEV_1 and PaO_2. However, in the present study, $PaCO_2$ was significantly higher in patients who visited an emergency department.

In a study where COPD patients were followed for at least one year, increased dyspnea score was regarded to be an independent predictor of acute exacerbations (22). It was stated that COPD patients with low pulmonary functions and poor dyspnea scores returned to hospital within 30 days after hospital discharge (23). In another study, dyspnea was considered to be a significant risk factor for hospital revisits (24). In the present study, dyspnea scores were also significantly higher in patients who visited an emergency department compared to the other group.

Chronic obstructive pulmonary disease patients experience a loss of exercise capacity compared to healthy controls independent of the disease stage (25, 26). The simple and valuable six-minute walk test is the most frequently used method to assess exercise performance (27). Patient compliance with the six-minute walk test is higher than with the cardiopulmonary exercise test (28). Studies have revealed that the body-mass index, airflow obstruction, dyspnea, and exercise (BODE) index is the best indicator to determine not only the number and severity of exacerbations and hospital visits, but also revisits and mortality; however, no existing study focuses directly on the correlation between acute exacerbation of COPD and six-minute walk distance (29-31). In the present study, the six-minute walk distance was significantly shorter in COPD patients who visited an emergency department compared to the other group. In one study, the dominant symptoms at peak exercise were dyspnea and leg fatigue in COPD patients (32). Consistent with this study, we found changes in dyspnea perception were higher and changes in peripheral oxygen saturation were lower post-test in patients who visited an emergency department.

Table 2. Comparison of exercise capacity between groups

Variable	Emergency department visit (+) (n=127)	Emergency department visit (-) (n=79)	p
6 MWD (meters)	320 (217, 375)	395 (315, 440)	<0.001*
ΔHR (beats/minute)	19(12, 25)	14(9,22)	0.062
ΔSpO_2 (%)	-7(-10, -4)	-4(-6,-2)	0.029*
ΔDyspnea (MB)	2(1, 3)	1(1, 3)	0.003*
ΔLeg Fatigue (MB)	3(2, 4)	1(1, 2)	<0.001*

Data are expressed as median (interquartile range). Changes between post-test and baseline levels are shown as Δ values

*p<0.05 for comparison of changes between groups based on Mann-Whitney U test

6MWD: six-minute walk distance; HR: heart rate; SpO_2: peripheral oxygen saturation; MB: Modified Borg Scale

Table 3. Factors correlated with frequency of emergency department visits

	6MWD	mMRC	FEV_1 (%)	FEV_1/FVC	DLCO (%)	PaO_2	SaO_2
EV	-0.301**	0.367**	-0.254**	-0.300**	-0.264**	-0.179*	-0.178*
6MWD		-0.633**	0.368**	0.237**	0.320**	0.305**	0.261**
mMRC			-0.410**	-0.353**	-0.424**	-0.380**	-0.343**
FEV_1(%)				0.053**	0.557**	0.363**	0.373**
FEV_1/FVC					0.524**	0.123	0.127
DLCO(%)						0.148	0.221*
PaO_2							0.914**

Spearman Correlation Test. *p<0.05, **p<0.01

EV: number of emergency department visits; 6MWD: six minute walking distance; mMRC: modified Medical Research Council; FEV_1: forced expiratory volume in one second; FVC: forced vital capacity; DLCO: carbon monoxide diffusing capacity; PaO_2: partial arterial oxygen pressure; SaO_2: arterial oxygen saturation

Chronic obstructive pulmonary disease is characterized by restriction in progressive air flow, and pulmonary function tests are frequently used to evaluate COPD patients. FEV_1 is one of the best indicators of pulmonary emphysema and is traditionally used to grade the severity of COPD (33). However, exercise tolerance must be determined to assess the impact of COPD on the patient and to monitor alterations in exercise performance due to disease progression. The six-minute walk test is the most appropriate, simple, and reliable test for evaluation of exercise tolerance (29). A strong positive correlation has been determined between the six-minute walk test and FEV_1 (10, 11). Another study that determined the correlation between the six-minute walk test and spirometric parameters stated that the walk test can be used to monitor alterations in pulmonary function in patients with severe and very severe COPD (34). In another study, a correlation was found between the six-minute walk test and FEV_1, but not FEV_1/FVC, after bronchodilation. It was suggested that the six-minute walk test can be used instead of a spirometer to determine the severity of COPD (12). Studies investigating the correlation of the six-minute walk test with spirometric parameters demonstrated significant correlations with FEV_1 (31) and DLCO (35, 36). In the present study, the six-minute walk test showed a positive correlation with FEV_1 (%), FEV_1/FVC, and DLCO (%) values.

No study investigating the correlation between arterial blood gases values and the six-minute walk test is available. Most previous studies focused on the impact of the six-minute walk test on gas exchange (37, 38). It was demonstrated that six-minute walk distance is correlated with baseline O_2 saturation before and after testing (37). In a study suggesting that the six-minute walk test is a good determinant of prognosis in COPD patients, it was concluded that short walking distance and increased variability of O_2 saturation are independent and significant determinants of mortality (38). Similar to our study, changes in peripheral oxygen saturation, which reflect desaturation, were higher in patients who visited an emergency department.

In a study comparing hypercapnic and normocapnic COPD patients, the six-minute walk distance was found to be shorter in hypercapnic patients (39). In the present study, six-minute walk distance showed positive correlations with arterial saturation and PaO_2 but showed a negative correlation with $PaCO_2$. As in the present study, two other studies determined strong negative correlations between the mMRC scale and six-minute walk distance (40, 41).

This study has some limitations. Particularly, our study population has severe and very severe COPD; it does not include many patients with mild disease. Therefore, the results may not reflect all COPD patients. Investigating the correlation between emergency department visits and exercise performance in patients according to their disease stages may provide more accurate results and stronger correlations.

We could not record the last time of exacerbation because our patients visited other hospitals. Furthermore, some of our patients could not remember their last exacerbation event well. Therefore, we could not provide any information about the patients' most recent exacerbations, which may be important to determine final functional capacity.

Assessment of exacerbation severity is an important outcome to define the clinical features of patients. However, we could not use an effective tool to evaluate the severity of exacerbation and could only report the patients' number of hospitalizations, which indicated severe exacerbation.

The literature contains no study investigating the correlations between patient visits to an emergency department and acute exacerbation and exercise performance. However, some studies suggest strong correlations between regular physical activity and hospital visits (8) and revisits (42). It is stated that non-pharmacological interventions, such as education, smoking cessation, immunization, and pulmonary rehabilitation, in addition to pharmacological therapies, may prevent acute exacerbations in COPD patients (43).

CONCLUSION

Given the correlation between exercise performance and the number of emergency department visits determined in the present study, we conclude that non-pharmacological interventions such as regular daily physical activity and pulmonary rehabilitation may reduce the number of acute exacerbations in COPD patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of University of Health Sciences Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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