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## The Effect of Exercise on Arterial Blood Gases in Chronic Obstructive Pulmonary Disease

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### ABSTRACT

It is important in the present day to ensure that the social activities of COPD patients are carried out without any problem as part of the goals of approach to and treatment of COPD patients for minimizing both labor loss and financial losses. The use of socioeconomic and demographic characteristics of COPD patients as a tool during their assessment is increasing in importance. Hence, the purpose of the present study was to examine the impact of exercise on blood gases in COPD patients. A total of 378 patients with ages ranging between 45 and 82 who have applied to the pulmonary diseases polyclinic and emergency of our hospital or who have been admitted to the clinic during March 2019 and December 2019 were included in this prospective study. All of the 160 patients with emphysema and 218 patients with chronic bronchitis were stable. Cases with accompanying diseases other than respiratory system disorders (cardiac, diabetes mellitus etc.) and patients in acute attack were excluded from the study. Of our cases, 180 (47.62 %) were female and 198 (52.38 %) were male with an age average of  $60.95 \pm 5.7$ . End of exercise respiratory rate increase, ( $p:0.003$ ), PaO<sub>2</sub> increase ( $p:0.008$ ), PaCO<sub>2</sub> increase ( $p:0.005$ ) and pH decrease ( $p:0.009$ ) were observed to be statistically significant in chronic bronchitis predominant patients. End of exercise respiratory rate increase ( $p:0.006$ ) along with decreases in pH ( $p:0.008$ ) and PaO<sub>2</sub> ( $p:0.009$ ) were observed to be statistically significant in emphysema predominant patients. Exercise training is important for the rehabilitation of COPD patients and increases their quality of life. Hence, we concluded that that it may be beneficial to determine the end of exercise blood gases of stable COPD patients for planning their residential treatment.

**Keywords:** Chronic Obstructive Pulmonary Disease, exercise, arterial blood gas

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## INTRODUCTION

Blood gas anomalies chronic obstructive pulmonary disease (COPD) may worsen during acute attacks, sleep and exercise (1). It is known that maximum exercise performance and exercise tolerance are lower for these patients compared to healthy individuals at the same age and gender. Physical exercise means increased metabolic rate. Oxygen generation and carbon dioxide consumption increases in all muscles involved in addition to an increased requirement for oxygen in these muscles as well as the requirement to remove the generated carbon dioxide (2). This may lead to clinical complaints in the patient under effort. Measuring the gas change is important for individuals with cardiopulmonary diseases since the symptoms that develop with exercise are at the forefront (3). However, the duration of the exercise, its intensity, type, age of the patient, body weight and physical form affect the evaluation of the response to the exercise.

Exercise in healthy individuals increases ventilation by increasing both tidal volume and respiratory rate. Tidal volume is stabilized at about 50-60 % of the vital capacity during activities that require greater effort and the increases in minute ventilation are only subject to the increased respiratory rate. Indeed, tidal volume may even decrease with increasing minute ventilation during periods of extreme effort. The same is true for COPD as well. However, tidal volume is much lower and respiratory frequency is much greater in comparison with healthy individuals at similar minute ventilation levels (4). It has been reported in various studies for emphysema predominant cases that partial oxygen pressure (PaO<sub>2</sub>) decreases with exercise, while PaO<sub>2</sub> has been reported to increase in cases without emphysema predominance (5). Lack of an improvement in diffusion capacity of emphysema patients with exercise is typical for emphysema and hypoxemia increases with exercise while it may recover for those with chronic bronchitis. However, the same case is not valid for every patient (6). While hypoxia may develop in emphysema subject to the increase in the dead space volume/tidal volume, PaO<sub>2</sub> may remain constant, may increase or decrease in chronic bronchitis subject to the change in the ventilation/perfusion (V/Q) ratio (7).

The use of exercise tests in assessing the patient has increased in recent years. Thus, the purpose of the study was to examine the impacts of exercise on blood gases in COPD patients.

## MATERIALS AND METHOD

A total of 378 patients with ages ranging between 45 and 82 who have applied to the pulmonary diseases polyclinic and emergency of our hospital or who have been admitted to the clinic during March 2019 and December 2019 were included in this study. Of the participants, 198 were male and 180 were female. In total, 160 had emphysema and 218 had chronic bronchitis and all were stable. All chronic bronchitis patients were stable. The patients were classified as

168 emphysema predominant patients and 210 chronic bronchitis predominant patients subject to the findings of anamnesis, physical examination, chest radiography, arterial blood gas and thoracic computerized tomography. The PaO<sub>2</sub> level was above 55 mmHg in all patients and cases with ischemic heart diseases or cor pulmonale symptoms were excluded from the study. Respiratory function test was applied on the patients at rest prior to the exercise. Blood was drawn from the brachial and radial arteries after which blood gas analyses were carried out via radiometer ABL 300 blood gas analyzer.

The patients were then asked to exercise for at most up to 5 minutes at the Monark 810 bicycle ergonomics until the onset of dyspnea and/or fatigue. The patients were monitored via ECG during this process. Blood gas analysis was repeated after the exercise was completed. The acquired data were recorded and statistical analyses were carried out.

### **Statistics**

NCSS (Number Cruncher Statistical System) 2017 (Kaysville, Utah, USA) was used for statistical analysis. Descriptive statistical methods (frequency, percentage) were used to evaluate the study data. Pearson chi-square test and Fisher-Freeman-Halton exact test were used to compare the qualitative data. The characteristics of the patients were determined by correlation and student-t test. Statistical significance was accepted as  $p < 0.05$ .

## **RESULTS AND DISCUSSION**

Of our cases, 180 (47.62 %) were female, 198 (52.38 %) were male with an age average of  $60.95 \pm 5.7$ . It was observed when both groups were compared together that end of exercise PaCO<sub>2</sub> and respiratory rate increase along with pH decrease were statistically significant ( $p < 0.01$ ) whereas the increase in PaO<sub>2</sub> was not statistically significant ( $p > 0.05$ ).

Of the patients with emphysema and chronic bronchitis included in the study, there were no statistically significant differences with regard to the numbers of female and males and their ages ( $p:0.1$  and  $p:0.2$  respectively).

It was observed when patients with chronic bronchitis and emphysema were compared with regard to vital capacities that the emphysema patients have vital capacities that are greater at a statistically significant level ( $p:0.004$ ).

End of exercise respiratory rate increase ( $p:0.003$ ) PaO<sub>2</sub> increase ( $p:0.008$ ) PaCO<sub>2</sub> increase ( $p:0.005$ ) and pH decrease ( $p:0.009$ ) were determined to be statistically significant in chronic bronchitis predominant patients with.

Whereas end of exercise respiratory rate increase ( $p:0.006$ ), pH ( $p:0.008$ ) and PaO<sub>2</sub> decrease ( $p:0.009$ ) were determined to be statistically significant in emphysema predominant patients.

**Table 1: Blood gas, Respiratory rate and Pulmonary function test values of patients**

	Total patient	Chronic bronchitis	p	emphysema	p
Number of patients(n)	378	210		168	
Age (median)	59.2±5.40	62.7±4.80		57.3±4.5	
FEV1	0.94±0.04	0.75±0.05		1.08±0.05	
Vital capacity	2.01±0.07	1.81±0.01		2.18±0.09	0.004
Respiratory rate					
Resting	25.6±0.07	27.8±1.10	0.003	24.0±0.80	0.006
End of exercise	34.7±0.07	32.4±0.80		37.5±1.30	
pH					
Resting	7.38±0.00	7.38±0.00	0.007	7.39±0.00	0.008
End of exercise	7.30±0.00	7.30±0.01		7.30±0.01	
PaO2 (mmHg)					
Resting	47.9±1.10	47.6±1.30	0.005	48.30±1.80	0.004
End of exercise	51.7±1.50	49.2±1.60		54.7±2.50	
PaO2 (mmHg)					
Resting	67.9±1.20	68.0±1.70	0.008	67.7±2.10	0.009
End of exercise	69.8±2.20	78.6±2.40		58.8±3.00	

## DISCUSSION

Measurement of blood gases during exercise aids in an objective assessment in those with suspicions related to the normality of respiratory and cardiac functions (8). It is more apparent that it will be more beneficial for determining the residential treatment of patients discharged with a PaO<sub>2</sub> value of above 55-60 mmHg following treatment of COPD related respiratory failure. However, it is also indicated that the assessment of clinical symptoms during exercise is more beneficial compared to arterial blood gases (9). Impacts of blood exercise on the blood gases and spirometric measurements of COPD patients attract the attention of researchers.

Ejiofor et al. carried out exercise studies on patients with moderate and severe airway obstruction as a result of which the PaO<sub>2</sub> level was determined to be low at a statistically significant level for the group with severe obstruction whereas a statistically insignificant increase was observed in PaCO<sub>2</sub> in both groups. More severe anomalies were determined in VD/VT an P(A-a) O<sub>2</sub> (alveolar- arterial O<sub>2</sub> gradient) in those with severe obstructive disorder (10).

Brightling et al. carried out an exercise on COPD patients classified into two groups based on emphysema and chronic bronchitis predominance as a result of which a decrease was reported in PaO<sub>2</sub> values of both groups and an increase was reported in the PaCO<sub>2</sub> values. The decrease in PaO<sub>2</sub> was more distinct in the emphysema group which was concluded to be closely related with diffusion capacity (11).

Whereas Wells et al. carried out an exercise on moderate and severe COPD patients as a result of which decrease in PaO<sub>2</sub> and increase in PaCO<sub>2</sub> were reported. However, they put forth that there are differences between the patients emphasizing that the difference in PaO<sub>2</sub> is greater

than 10 mmHg in 5 patients, whereas PaCO<sub>2</sub> changes in 8 patients are closely related with the response of CO<sub>2</sub> against metabolic generation, level of mechanical disorder, VD/VT ratio and the O<sub>2</sub> levels in arterial blood (12).

Arslan *et al.* reported a statistically significant increase in PaO<sub>2</sub> at the end of exercise. It was determined as a result of the assessment of COPD patients subject to disability that spirometric and arterial blood gas findings at the end of exercise do not have a statistically significant impact on the values acquired while at rest (13).

It is known that acidosis takes place in normal people and those with cardiovascular diseases during exercise. Metabolic acidosis developed in COPD patients which is more distinctive for patients with advanced limitations on exercise. This puts forth that acidosis in these patients is related mostly to extremity muscles rather than respiratory muscles (14).

PaO<sub>2</sub> increase, pH decrease, PaCO<sub>2</sub> increase in the chronic bronchitis predominant group along with PaO<sub>2</sub> decrease, pH decrease and PaCO<sub>2</sub> increase in the emphysema predominant group were determined to be statistically significant. In case there is an increase in the P(A-a)O<sub>2</sub> difference at rest, this may be improved or further regressed subject to whether a uniform V/Q distribution is obtained as a result of cardiac flow rate and ventilation. VD/VT ratio generally decreases despite the increase in physiologic dead space following the increase in respiratory volume. This is an indication that regions with greater ventilation-perfusion ratio receive greater amounts of blood flow. Hence, PaO<sub>2</sub> and P(A-a)O<sub>2</sub> difference may improve during exercise (15). PaO<sub>2</sub> may decrease when there is no increase in diffusion capacity in emphysema (16). Whereas hypercapnia is related with the respiratory response to metabolic acidosis in addition to the increase in VD/VT ratio and respiratory work (17).

Exercise training is important for the rehabilitation of COPD patients and increases their quality of life (18). . Hence, we are of the opinion that it may be beneficial to determine the end of exercise blood gases of stable COPD patients for planning their residential treatment.

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