

The Six-Minute Walk Test – a Reliable Test for Detection of Exercise-Related Desaturation in Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Introduction: Exercise-induced desaturation is common in patients with moderate to severe chronic obstructive pulmonary disease (COPD). It provides additional information about physical capacity and disease evolution, and it is an important predictor of mortality.

Aim: To compare the six-minute walk test (6MWT) and the cardio-pulmonary exercise test (CPET) as methods for detection of desaturation in COPD patients. To explore the relationship between exercise-related desaturation, symptom questionnaires (mMRC, CAT, and SGRQ), pulmonary function testing (PFT), and blood-gas analysis.

Patients and methods: Forty adult male COPD patients, mean age 67.2±8.4 years (mean ± SD) underwent 6MWT, CPET, PFT, blood-gas analysis, and scored their symptoms (mMRC, CAT, and SGRQ). Oxygen desaturation was monitored during exercise. Desaturation was defined as a decrease in SpO₂ of ≥4% and values ≤88% held for ≥3 minutes.

Results: The studied patients had COPD stage 2A – 4D (GOLD 2011). The patients were categorized into two groups – with desaturation (A, n=19) and without desaturation (B, n=21). CPET elicited 21 individuals who experienced desaturation, 19 of them desaturated during 6MWT as well. In the whole group, the percentage of desaturation during CPET was 6.6±4.9% compared to 6.0±4.9% during 6MWT ($p<0.001$). There was a significant difference in the maximal oxygen consumption reached by the patients in group A – 16.2±4.5 and group B – 19.9±4.7 ($p=0.016$). Desaturation during 6MWT correlated significantly with that during CPET ($r=0.75$, $p<0.001$).

Conclusions: Exercise-related desaturation in patients with moderate to severe COPD could easily and reliably be detected by 6MWT.

Keywords

6MWT, COPD, CPET, desaturation, pulse oximetry

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major healthcare problem worldwide, closely related to tobacco smoking and environmental pollution. COPD is now one of the top three causes of death worldwide.^[1] It has been estimated that the condition affects 329 million people worldwide, or about 5% of the world's population.^[2] In 2013, the disease caused 2.9 million deaths as compared to 2.4 million in 1990.^[3] In the European Union, the total direct costs of respiratory diseases are estimated to be about 6% of the total annual healthcare budget, with COPD accounting for 56% (38.6 billion euros) of the cost of respiratory diseases.^[4]

Evaluation of the physical capacity of COPD patients is essential for defining the characteristic features of the disease, which is notorious for its complexity in terms of both pathophysiological mechanisms and clinical presentation. It facilitates the overall assessment of the severity and prognosis of the disease as well as the choice of therapeutic approach for the different groups.^[5] The physical capacity evaluated via exercise tests provides information about the joint response of the respiratory and cardiovascular systems, the blood, and the striated muscles under conditions of increased physical requirements. Wasserman et al. introduced the term cardio-pulmonary exercise test (CPET) to stress the importance of the evaluation of gas exchange.^[6,7] The most important metabolic parameter of CPET is the maximal oxygen consumption ($\text{VO}_2 \text{ max}$). It is defined as the maximal level at which the oxygen consumption remains stable despite the incrementing intensity of the exercise. Thus, it determines the functional aerobic capacity of the individual. This parameter is considered the 'gold standard' for assessment of the cardio-pulmonary system and is the most important measurement during CPET.^[8,9] According to the 2003 recommendations of the ATS/ACCP, cycle ergometry is the preferred modality to perform exercise, but, depending on the circumstances, a treadmill could be an acceptable alternative. It is known that the $\text{VO}_2 \text{ max}$ on a treadmill exceeds the values reached on a cycle ergometer due to the involvement of large muscular groups in walking and running.^[8] Performing a CPET requires a controlled laboratory environment, sophisticated and expensive equipment, and experienced personnel. For that reason, so-called *field tests* for the assessment of physical capacity have been developed. Their advantage is that they could be performed in the field without the need of special equipment and personal. In recent years, the most popular and widely used field test has been the six-minute walk test (6MWT). It is a well-standardized and validated tool allowing easy and inexpensive performance of submaximal exercise.^[9,10] These characteristics have made 6MWT the method of choice for evaluation of COPD patients as well as for ones with interstitial lung diseases, or with cardiac pathology, or with peripheral vascular diseases, etc. Saturation monitoring via pulse oximetry during exertion tests (6MWT and CPET) allows easy detection of the patients

with physical exercise desaturation.^[5] The phenomenon of desaturation is a common finding in the advanced stages of COPD and has a complex pathophysiology. It is related to the restricted airflow, reduced diffusion capacity, systemic inflammation, and oxidative stress, affecting multiple organs and systems and causing imbalance between requirement and supply of oxygen.^[11] Tojo et al. claim that repeated hypoxemic episodes during submaximal exercise, i.e. daily physical routine of patients, causes vasoconstriction in the pulmonary arteries basin, which is responsible for the development of irreversible pulmonary hypertension as well as for the worse prognosis for the patients.^[12] The level of desaturation on exertion in COPD patients is an important marker for the disturbed daily physical routine, faster deterioration of lung function (FEV_1 decrease), and increased mortality risk.^[11,13,14]

AIM

The study aimed to compare the six-minute walk test (6MWT) and the cardio-pulmonary exercise test (CPET) as methods of detecting desaturation in COPD patients, as well as their relationships with symptom scores (mMRC, CAT, and SGRQ), lung function, and blood-gas parameters.

PATIENTS AND METHODS

The study enrolled 40 male patients at different COPD stages according to GOLD 2011: one patient in stage 2A, eleven patients in stage 2B, one – in 3C, twenty – in 3D, and seven in stage 4D (**Table 1**). The current study was conducted in the Departments of Pulmonology, Cardiology, and Pathophysiology in the Medical University of Plovdiv in Bulgaria. The Ethics Committee of the Medical University of Plovdiv approved the design of the study. Each patient who met the selection criteria signed an informed consent form prior to undertaking any actions related to the study.

The following exclusion criteria were used:

- Left heart insufficiency ($\text{EF} \leq 50\%$, $\text{BNP} \geq 150 \text{ pg/mL}$), uncontrolled arrhythmias, unstable coronary artery disease (CAD), recent myocardial infarction (MI), and conditions following pulmonary thromboembolism (PTE). All the patients had baseline echocardiography and ECG in order to exclude systolic left ventricular dysfunction of myocardial or valvular origin.
- Bronchial asthma
- Lung cancer
- Musculoskeletal and other morbidity, precluding 6MWT and CPET
- Active lung tuberculosis (TB).

For each patient, a detailed history was taken of any current, concomitant, and previous diseases, smoking status, and number of exacerbations within the last year. The following diagnostic tests were performed:

- Bronchodilator spirometry. The test was performed at

Table 1. Characteristics of the studied COPD patients (n=40)

Parameters		mean±SD
Age	years	67.2±8.4
Smoking	pack/years	40.0±20.8
FEV ₁	% pred.	44.8±14.6
KCO	% pred.	74.8±30.3
PaO ₂	mm Hg	64.3±9.3
PaCO ₂	mm Hg	41.6±5.6
SpO ₂ bas.	%	94.8±1.0
6 MWT	m	505±81
mMRC		2.3±1.0
SGRQ		60.0±17.4
CAT		21.7±7.9
Exacerbations*	n	1.9±1.4
BODE index		3.3±1.9
DOREMIBOX		4.4±1.4
mPAP	mm Hg	39.3±6.3
EF	% pred.	58.7±69.2
BNP	pg/mL	59.7±4.8

FEV₁: forced expiratory volume in 1 second; KCO: diffusion capacity corrected for alveolar volume; PaO₂: partial O₂ pressure; PaCO₂: partial CO₂ pressure; SpO₂ bas.: baseline saturation; 6MWT: distance in meters covered during the test; mMRC: modified Medical Research Council dyspnea score; SGRQ: St George's Respiratory Questionnaire; CAT: COPD Assessment Test; BODE index – B - BMI (Body mass index); O – Obstruction, D – Dyspnea, E – Exercise, DOREMIBOX – the first index in which exacerbations are included as an important criterion for disease severity and progression^[15]; mPAP: mean pressure in the pulmonary artery; EF: ejection fraction; BNP: natriuretic peptide type B.

N exacerbations* – According to GOLD definition: moderate – the symptoms require application of corticosteroids and/or antibiotics, severe – the symptoms require evaluation in an emergency center or hospital admission.

a room temperature (22-24°C) by a computer-based spirometer Master Screen Diffusion™ (Jaeger, Würzburg, Germany) with real time curve display and automatic correction (BTPS – body temperature pressure saturated);

- Body plethysmography (Master Screen Diffusion/Body, E. Jaeger);
- Evaluation of diffusion capacity (Master Screen Diffusion/Body, E. Jaeger); the diffusion was measured by the single breath method; blood-gas analysis of arterialized capillary blood (Flex 830, Radiometer);
- Six-minute walk test (6MWT): conducted in a 35-meter-long closed corridor, in which patients had to walk for 6 minutes with the aim of covering as much distance as they could. Patients were instructed to walk from end to end as fast as they could for 6 minutes. Rest stops were allowed. During walking,

the patients were encouraged by standardized phrases. Covered distance was measured in meters. At the start and at the end of the test, the dyspnea was assessed via the Borg scale. Each patient performed the test minimum twice in 2 days.

- Cardio-pulmonary exercise test (CPET) was conducted on a treadmill TrackMaster™ and a CPET system MedGraphics CardioO₂™ (Medical Graphics, St Paul, Minnesota, USA) according to the Bruce protocol, characterized by a simultaneous increase in speed and slope. The tests were performed in the morning, 2 hours after a meal, at a standardized room temperature, humidity, and atmospheric pressure. Prior to each test, the gas analyzer and the pneumotach had been calibrated precisely.
- CPET and 6MWT were performed without O₂ supplementation.

Patients had been informed and instructed about the procedure and its parameters in advance and their consent was taken prior to conduction. Echocardiography was performed on a Hewlett Packard Sonos 2500 System. Left ventricular ejection fraction was assessed by Simpson's method. Mean arterial pressure of the pulmonary artery (mPAP) was measured via the built-in software of the device. Oxygen saturation was monitored during exercise (6MWT and CPET) by a Palm Sat 2500+ (Nonin Medical, Plymouth, MN, USA). A decrease in SpO₂ ≥4% and a drop ≤88% for at least 3 minutes was considered a desaturation. Desaturation was defined as a drop in SpO₂ of at least 4% and/or a level less than 88%. Questionnaires for symptoms and health status (mMRC, SGRQ, and CAT), standardized tests to assess patient's quality of life, feeling of dyspnea, and the reduction of the physical capacity related to it were used.^[16-21]

Statistical analysis

Statistical analyses were performed using SPSS software (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA & IBM Corp. Released 2013). The results are displayed as a mean value ± standard deviation (mean ± SD), unless otherwise stated. The non-parametric test of Kolmogorov-Smirnov was used to check normal distribution. The Student's *t*-test for independent variables (independent samples *t*-test) and for paired variables (paired samples *t*-test) was applied for comparison of mean values. Correlations between normally distributed quantitative variables were analyzed with the help of Pearson correlation; *p*<0.05 was a cut-off for significance.

RESULTS

Nineteen out of 40 patients (48%) desaturated during the 6MWT and 21 patients (53%) desaturated during CPET. For the whole group, the ΔSpO₂ (percent desaturation) observed during CPET was 6.6±4.9% and during 6MWT was 6.0±4.9% (*p*<0.001) (Fig. 1).

The patients were categorized into two groups – with desaturation (A) and without desaturation (B) based on the SpO₂ decrease during the test (Table 2).

The two groups differed significantly in terms of FEV₁%, IC%, KCO%, PaCO₂, baseline SpO₂, VO₂/kg (Fig. 2), and VO₂% pred. max., but not in mMRC, CAT, SGRQ, 6MWT, EF, mPAP and in the number of exacerbations throughout the last year.

The percentage of desaturation ΔSpO₂ correlates significantly with the diffusion capacity KCO% ($r=-0.55$; $p<0.001$) (Fig. 3), PaO₂ ($r=-0.40$; $p=0.009$), and VO₂% pred. max. ($r=0.36$; $p=0.02$), but not with the spirometric parameters, mMRC, CAT, SGRQ or the number of exacerbations within the last year.

The walking distance [m] covered during 6MWT was 498±82 vs. 510±81 ($p>0.05$) for the patients with and without desaturation, respectively – no significant difference was found for this parameter.

The desaturation on exertion during 6MWT correlates strongly with that during CPET ($r=0.77$, $p<0.001$) (Fig. 4).

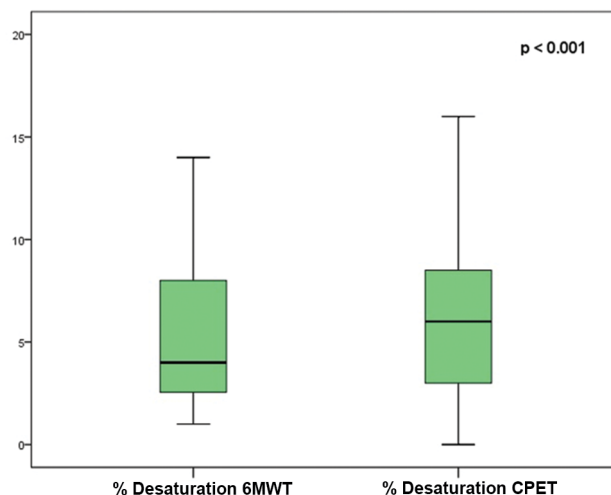


Figure 1. Mean percentage of desaturation for the whole group during CPET was 6.6±4.9% and during 6MWT – 6.0±4.9% ($p<0.05$).

Table 2. Comparison of functional and clinical parameters between patients with and without desaturation

Parameters	Without desaturation Group A n = 21	With desaturation Group B n = 19	P
Age years	64.9±7.9	63.6±9.2	NS
Smoking pack/years	42.2±21.2	37.6±20.8	NS
FEV ₁ % pred.	50.3±12.5	38.7±14.7	0.010
FVC % pred.	76.1±15.7	69.1±24.0	NS
IC % pred.	77.2±15.8	63.7±20.1	0.031
KCO % pred.	91.2±23.3	58.4±27.8	0.001
PaO ₂ mm Hg	66.3±7.8	62.1±10.6	NS
PaCO ₂ mm Hg	39.4±4.6	44.0±5.7	0.008
SpO ₂ bas. %	95.0±0.8	91.7±3.5	0.001
6MWT m	510±81	498±82	NS
VO ₂ kg	19.9±4.7	16.2±4.4	0.016
VO ₂ % pred. max.	70.3±18.3	56.4±16.7	0.017
mMRC	2.05±0.9	2.47±1.0	NS
SGRQ	57.5±18.1	62.8±16.7	NS
CAT	21.4±8.3	22.1±7.7	NS
Exacerbations* n	0.9±1.2	1.3±1.8	NS
EF % pred.	59.5±6.0	60.1±3.6	NS
mPAP mmHg	37.2±4.3	42.2±8.0	NS
BODE index	2.8±1.8	3.8±1.9	NS

FEV₁: forced expiratory volume in 1 second; FVC: forced vital capacity; IC: inspiratory capacity; KCO: diffusion capacity corrected for alveolar volume; PaO₂: partial pressure of O₂; PaCO₂: partial pressure of CO₂; SpO₂ bas.: baseline saturation; 6MWT: distance in meters covered during the test; VO₂: oxygen consumption; VO₂% pred. max.: maximal oxygen consumption; mMRC: modified Medical Research Council dyspnea score; SGRQ: St George’s Respiratory Questionnaire; CAT: COPD assessment test; EF: ejection fraction; mPAP: mean pressure in the pulmonary artery; BODE index – B - BMI (Body mass index); O – Obstruction; D – Dyspnoea; E – Exercise.

N exacerbations* – According to GOLD definitions: Moderate – symptoms require administration of corticosteroids and/or antibiotics; Severe – symptoms require evaluation in an emergency center and/or hospital admission.

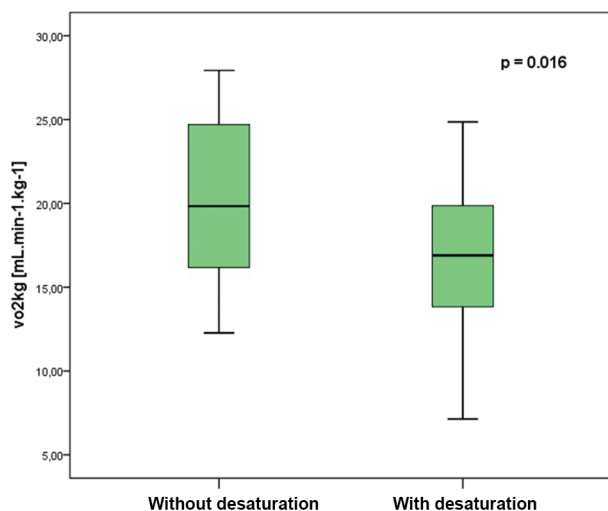


Figure 2. Relative oxygen consumption [$\text{mL}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$] reached by the patients from the two groups (16.2 ± 4.5 vs. 19.9 ± 4.7 , respectively; $p=0.016$).

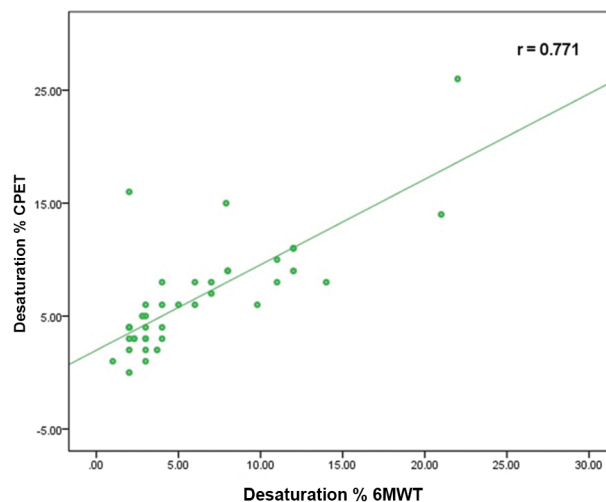


Figure 4. Correlation between desaturation percentage during the two exercise tests (CPET and 6MWT).

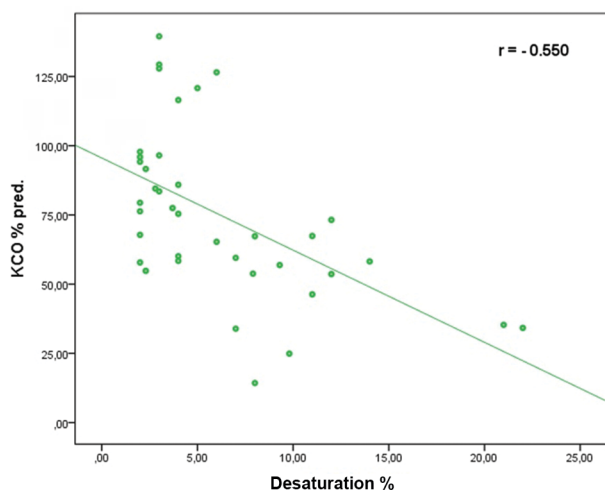


Figure 3. Correlation of the percentage of desaturation with $\text{KCO}\%$.

A significant correlation was also found between the maximal oxygen consumption $\text{VO}_2\%$ pred. max. reached during CPET and the distance covered during 6MWT ($r=0.55$, $p<0.001$).

DISCUSSION

The main finding of the present study is that exercise-related desaturation was established in 19 (48%) out of 40 patients during 6MWT desaturated compared to 21 (53%) during CPET.

Saturation monitoring during 6MWT via constant pulse oximetry is a reliable tool for detection of desaturation. It is comparable to the gold standard (CPET) test and does not require expensive equipment and special skills from the

personnel. The choice of criteria of desaturation on exertion is based on trials with professional athletes. These 4% are a combination of 2% decrease due to probable inaccuracies in pulse-oximetry and 2% to reflect the right shift of the saturation curve, taking into account the metabolic acidosis caused by the exercise.^[22] In order to avoid errors, the decrease in saturation by minimum 4% had to last for at least 3 minutes during exercise.

The comparison between CPET and 6MWT reveals close results in terms of peak VO_2 and heart rate. Along with that, 6MWT has considerably lower ventilatory requirements (peak CO_2 production, peak ventilation, and respiratory coefficient RER), which makes the test appropriate for elderly people with chronic respiratory pathology.^[13] The 6MWT distance is the most important test result – it has been shown to be associated with clinically significant consequences in patients with chronic lung disease. There is an inverse association between the length of the distance and mortality risk. For this reason, it is one of the four prognostic criteria of the renowned BODE index.^[23] According to ATS 2002 guidelines, pulse-oximetry during 6MWT is optional.^[10] Taking into consideration the recently accumulated evidence that desaturation upon exertion corresponds to a much worse prognosis (faster lung function deterioration – a decrease in FEV_1 , impaired daily physical activity, more frequent exacerbations – after some authors, higher mortality risk), the European Respiratory Society (ERS) and ATS published in 2014 technical standards for field test conduction in which continuous pulse-oximetry during 6MWT is recommended for detection of this important and not infrequent phenomenon with significant negative sequelae for the patients.^[24]

According to the analysis of the data obtained with 6MWT and CPET ($n=40$), the two tests show similar results in identifying desaturating patients. The advantage of 6MWT is that it is easier and cheaper to perform. The de-

saturation ΔSpO_2 during CPET was $6.6\pm 4.9\%$ and during 6MWT – $6.0\pm 4.9\%$ ($p<0.001$). Studying the potential impact of exercise tests in assessing the physical capacity of patients with COPD, many researchers come to the conclusion that CPET on a treadmill is more suitable and sensitive for detecting desaturation in COPD patients than the ergometer modality.^[25-27] Poulain et al.^[25] examined the previously established fact that patients with respiratory disorders desaturate during walking tests, but not during CPET, and compared 6MWT and CPET on an ergometer. Eighty patients had had a CPET on an ergometer as well as 6MWT twice with a constant SpO_2 record during all tests. Desaturation during 6MWT, which is not present in CPET, was detected in 23 (28%) patients (verified also by another CPET in those patients). Based on this data, the authors concluded that 6MWT was much more sensitive than CPET on an ergometer for detection of desaturation upon exertion. Valerio et al.^[27] measured the metabolic requirements during 6MWT and CPET of patients in different COPD stages, compared them to the results of healthy volunteers and found out that VO_2 reached during 6MWT remains constant after the third minute both in COPD patients (3-4 stage) and the control group. The 6-minute walk distance is significantly related to VO_2 max from CPET. VO_2 at the end of 6MWT is very similar to the one measured at the anaerobic threshold (AT) and at the threshold of decompensated metabolic acidosis (TDMA) both in COPD patients (1-3 stage) and healthy controls. In stage 4 COPD patients, the difference between VO_2 max during CPET and during 6MWT is reduced. 6MWT is found to be more appropriate for detection of desaturation upon exertion. The team concludes that from a physiological point of view 6MWT and CPET are, to a large extent, similar but not altogether replaceable. CPET allows detection of the underlying cause of the decreased physical tolerance, while the informative value of 6MWT result is improved by the multiparametric O_2 indexes, desaturation data, degree of dyspnea, exacerbations, etc. A similar conclusion was drawn by Troosters et al.^[28] and other authors based on earlier experiments and a comparison of 6MWT and CPET on a treadmill and an ergometer.^[29]

Bearing in mind the above evidence and the main objective of our study – to find out an easy and affordable daily practice test that is able to detect reliably desaturation upon exertion, we have compared 6MWT to CPET and have found that 6MWT is a trustworthy alternative to the gold standard CPET with an excellent potential for everyday practice.

Desaturation upon exertion is not an uncommon phenomenon. Jenkins and Cecins^[30] studied a large group of patients ($n=741$) with chronic respiratory diseases, 572 of whom had COPD, and reported 47% ($n=345$) desaturators during 6MWT.

Van Gestel et al.^[31] also found a considerable frequency of desaturation upon exertion (6MWT) in COPD patients – 61.7% out of a group of 154 tested patients and reckoned

that $\text{FEV}_1\% < 50\%$ could be a reliable predictor for this phenomenon.

We divided the tested patients into two groups – with desaturation (A) and without desaturation (B), and found that the desaturators with COPD differed significantly from the non-desaturators during 6MWT with regard to the spirometry results ($\text{FEV}_1\%$; IC%), blood-gas analysis (PaCO_2), baseline SpO_2 , diffusion parameters (KCO%), and VO_2/kg , but there were no significant differences in the symptom score scales (mMRC, CAT, and SGRQ), EF, mPAP, 6MWT and the number of exacerbations in the last year.

Dogra et al. examined 60 COPD patients divided into desaturators and non-desaturators and compared their functional and clinical characteristics and found that the desaturators had significantly lower spirometric parameters $\text{FEV}_1\%$, FVC%, baseline SpO_2 , as well as a higher degree of dyspnea rated on the Borg scale and covered shorter distance during 6MWT. The authors determined an inverse relationship between desaturation on the one hand and baseline SpO_2 , distance covered in 6MWT, and $\text{FEV}_1\%$ on the other, and concluded that lower baseline SpO_2 is a good predictor of desaturation during 6MWT.^[32]

In our study group as well, a significant correlation with $\text{FEV}_1\%$ was found, but also with the diffusion parameters – KCO% ($r=-0.55$; $p<0.001$), with the blood-gas analysis values: PaO_2 ($r=0.400$; $p=0.009$) and $\text{VO}_2\%$ pred. max. ($r=0.36$; $p=0.02$). In the group, no remarkable difference was found in the distance [m] covered during 6MWT 498 ± 82 vs. 510 ± 81 ($p>0.05$) between the desaturators and non-desaturators, respectively. It is consistent with previous studies^[13,25] that report no correlation between 6MWT and desaturation, but a significant association between $\text{VO}_2\%$ pred. max in CPET and the covered distance in 6MWT ($r=0.55$, $p<0.001$). The lower $\text{VO}_2\%$ and the shorter 6MWT of patients in more advanced stages of COPD are important markers for poorer survival prognosis.^[14,33-36]

As long as our objective was to compare 6MWT and CPET as methods for detection of desaturation among COPD patients, a possible limitation of our study could be the relatively small number of subjects, wherefore the trends in the statistical differences and correlations between the parameters of the two groups, desaturators and non-desaturators, could be further enriched and specified by increasing the sample size.

CONCLUSIONS

In patients with moderate and severe COPD, desaturation upon exertion is a common finding with important negative predictive value and could be easily and reliably detected via 6MWT. In this respect, the 6MWT is a credible alternative to the gold standard CPET and has a high potential for wide application in daily practice.

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Тест шестиминутной ходьбы – надёжный тест для выявления связанной с физической нагрузкой десатурации у пациентов с хронической обструктивной болезнью лёгких

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Резюме

Введение: Десатурация, вызванная физической нагрузкой, часто встречается у пациентов с хронической обструктивной болезнью лёгких (ХОБЛ) средней и тяжёлой степени. Она предоставляет дополнительную информацию о физических возможностях и развитии заболевания, а также является важным предиктором смертности.

Цель: Сравнить тест с шестиминутной ходьбой (6MWT) и сердечно-лёгочный нагрузочный тест (СПЕТ) как методы выявления десатурации у больных ХОБЛ. Изучить взаимосвязь между десатурацией, связанной с физической нагрузкой, опросниками симптомов (mMRC, CAT и SGRQ), тестированием функции лёгких (PFT) и анализом газов крови.

Пациенты и методы: Сорок пожилых пациентов мужского пола с ХОБЛ, средний возраст 67.2 ± 8.4 года (средний \pm стандартное отклонение), прошли 6MWT, СПЕТ, PFT, анализ газов крови и оценили свои симптомы (mMRC, CAT и SGRQ). Во время физической нагрузки контролировали десатурацию кислорода. Десатурация определялась как снижение SpO_2 на $\geq 4\%$ и значения $\leq 88\%$ удерживались в течение ≥ 3 минут.

Результаты: Обследуемые пациенты имели ХОБЛ 2А–4D стадии (GOLD 2011). Пациенты были разделены на две группы – с десатурацией (А, n=19) и без десатурации (В, n=21). СПЕТ выявил 21 человека, которые испытали десатурацию, 19 из них также потеряли насыщенность во время 6MWT. В целом по группе процент десатурации при СПЕТ составил $6.6 \pm 4.9\%$ по сравнению с $6.0 \pm 4.9\%$ при 6MWT ($p < 0.001$). Выявлена достоверная разница в достигнутом максимальном потреблении кислорода у пациентов группы А - 16.2 ± 4.5 и группы В - 19.9 ± 4.7 ($p = 0.016$). Десатурация во время 6MWT достоверно коррелировала с таковой во время СПЕТ ($r = 0.75$, $p < 0.001$).

Заключение: Десатурация, связанная с физической нагрузкой, у пациентов с ХОБЛ средней и тяжёлой степени может быть легко и надёжно установлена с помощью 6MWT.

Ключевые слова

6MWT, COPD, СПЕТ, десатурация, пульсоксиметрия