Study of exercise-induced desaturation in chronic obstructive pulmonary disease patients visiting tertiary care center in Bangalore

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) patients often have a lower ability to exercise and muscle weakness, both decreasing their quality of life. The 6 min walk test (6MWT) offers insightful data on the functional capacity of respiratory variables on exercise performance. A significant reduction in oxygen saturation (SpO_2) throughout the test signifies a lower tolerance for exercise or additional oxygen requirement. **Aims and Objectives:** This study focuses to investigate desaturation in COPD patients with normal resting oxygen levels (normoxemic) employing the 6MWT. The objective of the study defines to analyze different clinical parameters such as smoking behavior, 6MWT, and clinical parameters of COPD patients to diagnose respiratory performance. **Materials and Methods:** Between June 2019 and May 2020 study was conducted on patients presenting to our OPD, who were above 40 years and diagnosed with COPD, with baseline $SpO_2 \geq 90\%$. 6MWT was performed on them as per American Thoracic Society guidelines. Noting their distance covered and desaturation if present. **Results:** The study group included 60 patients; the group was divided into 35 desaturators (DS) and 25 Non-DS (NDS) based on fall in SpO_2 during 6MWT, all current smokers were in the DS group and had low body mass index values, DS group covered less distance when compared to NDS, DS had low mean forced vital capacity and forced expiratory volume 1 second values. **Conclusion:** This study established the relationship between COPD risk variables and 6MWT. The 6MWT was identified as a useful method to examine respiratory performance by noting exercise-induced desaturation and in turn the respiratory capacity among COPD patients.

Key words: Chronic obstructive pulmonary disease; 6-min walk test; Respiratory desaturation; Oxygen saturation; Desaturators; Non-desaturators; Forced vital capacity; Forced expiratory volume 1 second

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common preventable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases.[1] The most important symptoms of COPD are breathlessness on exertion and chronic cough with or without sputum.[2]

Exercise-induced desaturation (EID) is an important clinical parameter in COPD patients and it is associated with poor prognosis. Intolerance to exercise in COPD patients has important implications on the health-related quality of life and survival. Baseline oxygen saturation

(SpO_2) is an individual's normal or average SpO_2 level when they are fit and at rest. It gives a point of reference for SpO_2 readings taken at different diagnoses and testing.[3] Patients with COPD are evaluated for their capacity for functional activity using a test called the 6-min walk test (6MWT) and 6-min walk distance (6MWD) is a primary outcome of this test since it is a major independent risk factor for mortality. Desaturation is another result that is connected with greater mortality, including the loss in lung function, and an increased number of exacerbations.[4]

Considering the feasibility of 6MWT, the effectiveness of the test is required to be analyzed along with the risk factors of COPD, which could endorse it as a reliable diagnostic aid. The study focuses to assess the correlation of EID and identifying various possible predictors of EID in stable normoxemic patients of COPD. The 6MWT has been observed to be more sensitive to identifying EID in patients with COPD compared to cardiopulmonary exercise testing. In order to analyze the EID, 6MWT has been employed and the saturation levels were analyzed for the COPD patients.

Aims and objectives

The aim of the study was to assess exercise-induced desaturation (EID) in stable normoxemic patients diagnosed with COPD. Objective of this study was to analyse possible predictors of EID in these stable normoxemic patients of COPD.

MATERIALS AND METHODS

The present study was conducted in the Department of Respiratory Medicine, Kempe Gowda Institute of Medical Sciences, which is a tertiary care center in Bangalore, Karnataka, India, from September 2019 to October 2020 after obtaining approval from the institutional ethics committee.

The research utilized an observational study approach with a sample population size of 60 COPD patients above 40 years of age, diagnosed with moderate-to-severe COPD. It was also ensured that COPD patients considered with baseline $SpO_2 \geq 90\%$, which denotes their normoxemic state. Normoxemic COPD affects people who have normal resting oxygen levels but yet experience oxygen desaturation after activity or under specific circumstances (exacerbations). The clinical data were analyzed using statistical mean and standard deviation calculations and interpreted further. 6MWT is one of the performance assessments undertaken by patients who were attending the COPD clinic. This was conducted according to a standardized protocol by the American Thoracic Society

guidelines. It was performed along a 30-m long walkway. Patients were told that the purpose of the test was to see how far they could walk at their normal pace for 6 min. They were instructed to walk back and forth along the walkway, and they could stop if they wished. Total distance covered during the test (i.e., 6MWD) was calculated and recorded. Saturation was recorded using a pulse oximeter, pre- and post-test.

Inclusion criteria

The study included 60 patients, who were above 40 years of age, either sex, with moderate-to-severe COPD categorized according to GOLD guidelines 2020, with baseline SpO_2 more than 90% checked on room air and were able to walk (with or without support) and gave informed consent.

Exclusion criteria

It was as follows: patients refused to provide informed consent, COPD patients who were in exacerbation, had an episode of myocardial infarction within a month, patients with ongoing angina, who were not able to walk, patients with overlap syndrome (COPD WITH OSA), COPD with baseline $SpO_2 <90\%$.

Statistical analysis

Statistical analysis was performed using the SPSS version 16 statistical software (SPSS, Inc., Chicago, IL, USA). The desaturator and non-desaturator groups were compared by the independent Studenttest, Chi-square test. To assess the correlation of EID with demographic and clinical parameters, Pearson correlation (parametric data) and the Spearman rho test (non-parametric data) were used. The binary logistic regression analysis was done for the desaturation and independent variables. The most significant variable of this analysis was subjected to the receiver operating characteristic (ROC) curve from which the area under the curve, sensitivity, specificity, and positive and negative predictive values were determined. *P*-value was considered statistically significant if it is *P*<0.05.

RESULTS

The study considered significant key diagnostic parameters, including sociodemographic details such as gender, patient habits such as smoking, biomass exposure, 6MWT, and parameters such as forced vital capacity (FVC) and forced expiratory volume 1 second (FEV1).

The study group included 60 patients, males numbering 39 and females count 21. Further, the group was divided into desaturators (DS) and non-DS (NDS) based on fall in SpO_2 during 6MWT. DS group included 35 patients with 22 (56.4%) male and 13(61.9%) female. The NDS group included 25
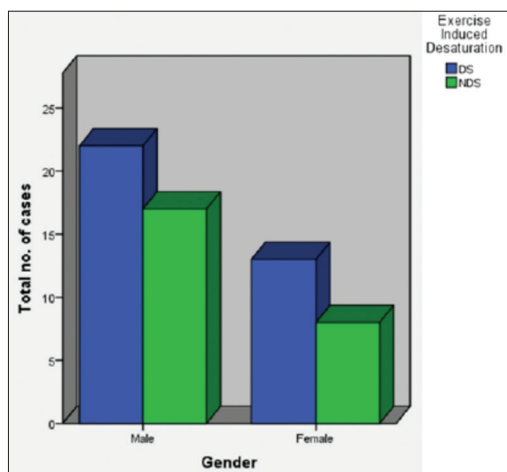
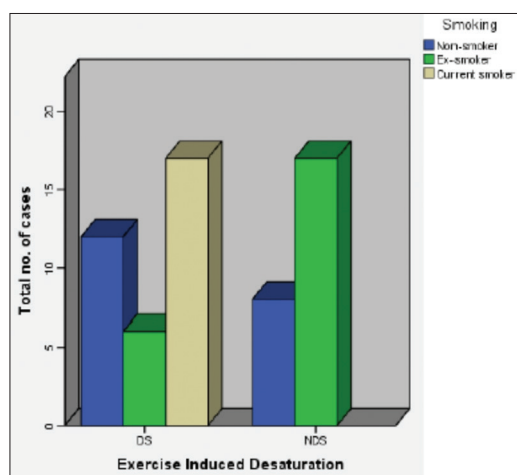**Figure 1:** Data observed based on gender & Desaturation level

Figure 2: Distribution of smokers & non-smokers

members including a male count of 17 (43.6%) and a female count of 8 (38.1%), as per the data depicted in Figure 1.

Among the smokers shown in Figure 2, the current smoker count was identified as 17 and ex-smokers with a count of 23. Although cigarette smoking is generally regarded as the dominant risk factor, it is not considered a prerequisite among COPD patients, since COPD can occur also among non-smokers. All current smokers fell into the DS group indicating that continuation of smoking will cause a rapid fall in saturation on exertion.

All the above-discussed sociodemographic details and smoking data of the considered COPD patients are enlisted in Table 1. The average body mass index (BMI) of the patients was observed ranging to 21.4 kg/m². DS showed low BMI values, which indicated low strength of muscles, especially the respiratory muscles, which can lead to muscle weakness and breathing difficulties. On the other side, obesity can also make COPD patients respiratory symptoms worse, reduce their capacity for exercise, and

raise their chance of developing concomitant conditions. While tobacco use is acknowledged as the major risk factor for COPD, exposure to biomass has also been found to be a significant role in the development of COPD, especially in non-smokers.[5] Smoke from biomass burning and tobacco use together may worsen the condition of the lungs. Chronic exposure to biomass smoke results in high levels of particulate matter, carbon monoxide, and other harmful substances being breathed in, which can harm the lungs and induce respiratory symptoms as well as chronic airway inflammation. Non-smokers with COPD brought on by biomass exposure frequently exhibit symptoms of emphysema and chronic bronchitis.

A count of 35 COPD patients with 66.6% of the considered population exhibited desaturation in 6MWT, as shown in Figure 3. The DS group covered less distance (mean=396 m) when compared to NDS (mean=482 m) and a significant p-value was determined as <0.001. Further, the FEV and FVC values were analyzed and enlisted in Table 2.

When compared to NDS detailed in Table 2, DS have low mean FVC and FEV1 values. The baseline SpO_2 value is 92.8% only in NDS, whereas, in DS, it is 94.8%. DS have covered less distance (mean=396 m) when compared to NDS (mean=482 m) because of exercise intolerance exhibited for 6MWT. DS have more fall in SpO_2 (mean=5.6%), whereas it is only (mean=2.8%) in NDS. Desaturation caused by exercise can happen to both smokers and non-smokers, although it's possible that smokers will experience it more strongly than non-smokers.[6] Patients with more advanced COPD typically experience greater EID, reflecting the extent of lung impairment and reduced overall respiratory reserve. According to the data analyzed above, DS had a significant negative correlation with FEV in 1 s (FEV1), SpO_2, 6MWD, and breathlessness score (Borg), indicating a greater degree of airflow obstruction, and a lower resting SpO_2 limited exercise tolerance as demonstrated by a smaller 6MWT distance.

DISCUSSION

Our study reported a very high frequency of EID. Out of 60 patients in our study, 35 patients (n=35/60), that is, 58.3% of patients desaturated on 6MWT. Similar results are recorded by Van Gestel et al., in 2012,[7] who did a study on 154 patients with COPD (87 females). The mean FEV1 was 43.0% (19.2) predicted and the prevalence of EID was 61.7%. However, the prevalence of EID differs widely in previously established studies. Andrianopoulos et al.,[8] in 2014, studied the prevalence and characteristics of patients who exhibited EID to SpO_2 ≤88%. Four hundred and two non-hypoxemic COPD patients performed 6MWT.

Table 1: Sociodemographic and risk factors observed in 60 COPD patients

	Total (n=60)	DS (n=0	NDS (n=25)	p-valve
Age in years (mean+SD)	53.2+9.6	54.5+10.3	51.4+8.4	0.23
Males, number (percent)	39	22 (56.4%)	17 (43.6%)	0.62%
Females, number (percent)	21	13 (61.9%)	8 (38.1%)	
BMI (mean±SD)	21.4+4.8	20.9+3.7	22.1+6.1	0.41
Current smokers, number (percent)	17	17 (100%)	0 (0%)	0.39
Ex-smokers, number (percent)	23	6 (26.1%)	17 (73.9%)	
Non-smokers, number (percent)	20	12 (60%)	8 (40%)	
Severe COPD, number (percent)	26	21 (80.7%)	5 (19.3%)	<0.01
Moderate COPD, number (percent)	34	14 (41.1%)	20 (58.9%)	
Packs/year (mean+SD)	10.2+10.2	12.2+11.8	7.5+6.8	0.07
Duration of smoking, years	15.5+12.2	14+10.9	14+10.9	0.42
Biomass exposure	28	8 (28.6%)	8 (28.6%)	0.54

Table 2: Clinical parameters observed among 60 COPD patients

Pulmonary function tests	Total (n=60) Mean±SD	DS (n=35) Mean±SD	NDS (n=25) Mean±SD	P-value
FVC (in liters)	2.3±0.5	2.2±0.5	2.5±0.5	<0.05
FEV1 (in liters)	1.3±0.4	1.2±0.4	1,5±0.4	<0.01
FEV1/FVC (% predicted)	57.1±9.3	53.6±9.5	61.9±6.6	<0.001
Baseline SpO_2 (%)	93.7±1.9	92.8±1.7	94.8±1.5	<0.001
Post walk SpO_2 (%)	89.2±3.3	87.1±2.6	92.1±1.7	<0.001
Change in SpO_2 (%)	4.4±1.8	5.6±1.3	2.7±0.4	<0.001
6MW distance (m)	432.4±77.6	396.4±65.4	482.8±64.7	<0.001
Change in heart rate (beats per min)	21.1±9.8	21.06±12.6	21.08±3.6	NS
Change in dyspnea (Borg Scale)	2.4±0.7	2.8±0.6	2±0.5	<0.001

FVCL: Forced vital capacity, FEV1: forced expiratory volume 1 second, 6MW: 6 min walk, SpO_2: Oxygen saturation
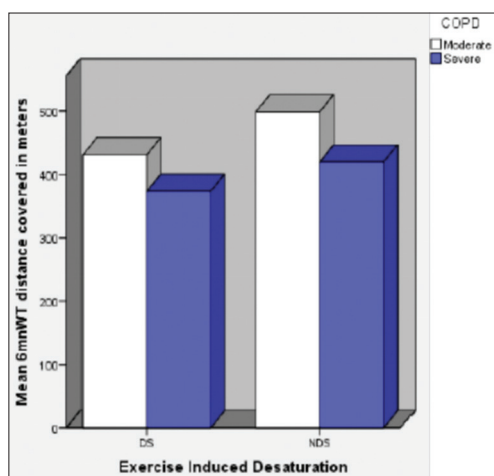
Figure 3: Mean distance data observed in 6MWT among the COPD patients

Sensitivity and specificity of baseline SpO_2 ≤95% as a cutoff to predict EID and determinants of EID were investigated. Only 158 (39%) patients exhibited EID. (our study shows 58.3% EID) This difference is due to lack of a standardized exercise protocol to elicit decreases in oxygen levels in individual with COPD or a lack of a uniform definition of EID in patients with COPD.

Our study revealed that DS had a significant inverse correlation with FEV1, baseline SpO_2, 6MWD, and breathlessness score (BORG scale), signifying a higher degree of airflow obstruction and a lower resting SpO_2 limited exercise tolerance evidenced by lesser distance covered during 6MWT. Similar observation was seen in a study done by Van Gestel et al.,[7] They included 154 patients with COPD (87 females). The mean FEV1 was 43.0% (19.2) predicted and the prevalence of EID was 61.7%. FEV1 was found to be significantly and independently associated with EID. They found that the only independent predictor of EID was FEV1 and the optimal cut-off value of FEV1 was at 50% predicted (area under ROC curve, 0.85; P<0.001).

In our study, the dyspnea score was significantly higher in the DS group compared to the Non-DS (NDS) and it correlated inversely to EID. A similar observation was made by De Torres et al., in 2007,[9] they stated that mMRC dyspnea score negatively correlated with PaO2, (r=−0.59, P<0.001), and $PaCO_2$ (r=0.27, P=0.05) in patients with COPD, suggesting that a higher dyspnea score leads to a greater possibility of exercise desaturation. In our study, the variables that remained significant were baseline SpO_2, FEV1, 6MWT distance, and breathlessness score. The model with the most baseline SpO_2 was sensitive and its performance was quantified by calculating the area under the ROC curve of 0.79 (*P*<0.001).

Limitations of the study

This study had a small sample size, limited only to one hospital and hence requires a larger sample-sized study for external validity. This study also failed to collect other important data like associated comorbidities as these factors might influence 6MWD and hence affect the results.

CONCLUSION

Based on the findings of our research, it is evident that the 6MWT is a simple, reliable, and readily accessible screening tool for identifying COPD patients. The sociodemographic factors analyzed indicate that smoking and biomass exposure worsens lung functioning and causes low respiration capacity. The empirical data results obtained from the 6MWT can be correlated and it is comprehended that the DS shows difficulty in continuous walking, whereas resulting in low distance coverage (396.4±65.4 m), which typically represents low resistance to exercise or physical activity due to COPD ailment.

Screening patients with COPD who have undetected cases of EID could potentially result in the planning treatment, thereby prevention of advanced and harmful effects associated with it. The findings contribute vital new knowledge on the progression of COPD disease, and it is recommended that assessing desaturation status be considered as part of the standard evaluation of individuals who have the COPD.

ACKNOWLEDGMENT

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