Original paper
Chronic Obstructive Pulmonary Disease: Impact Of Hypoxia

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Abstract

Background: Chronic obstructive lung disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. Many people suffer from this disease for years and die prematurely from it or its complications.

Objective: This study was aimed to:1.Study and compare some demographic and physiological changes in hypoxic and non-hypoxic groups of patients with COPD. 2. Assessment of effect of smoking in both groups. 3. Correlate these findings with severity of the COPD.

Patients and method: The study was performed in Merjan Teaching Hospital in Babylon Province in the period from November 2012 to October 2013, the study included one hundred eighty two (182) patients with history of COPD who were studied clinically and each patient was submitted for spirometry, pulse oximetry, chest x-ray and electrocardiography. According to the results of oximeter, patients were divided into two groups, hypoxic and non-hypoxic group, hypoxic group included 96 patients (mean age was 57.14±11.24, 66% were males) while the non-hypoxic group included 86 patients (mean age was 54.42±12.75, 62% were males).

Results & Discussion: Study showed that the mean pack years of tobacco use in hypoxic group was 42.83±47.95 pack years while in non-hypoxic group the mean duration was 24.91±32.84 and there was significant differences between groups (P=0.000),it also revealed that pack year was significantly correlated with the severity of obstruction in hypoxic group (P value= 0.000) in contrast to non-hypoxic group (P value= 0.2).

The study also showed significant negative linear relation between degree of dyspnea (functional state) and oxygen saturation (SpO2) (r=-0.2, p=0.04) in reverse to non-hypoxic group (r=-0.11, p=0.3). Furthermore, the study clarified that most patients in both groups had normal ECG changes (73% in hypoxic group and 90% in non-hypoxic group) and the most common ECG finding in both groups was P pulmonale (11% in hypoxic group and 6% in non-hypoxic group)**.**

When linear regression analysis of the results of this study was considered, there was significant positive linear correlation between oxygen saturation (SpO2) and severity of obstruction in hypoxic group while non-significant linear correlation between SpO2 and severity of obstruction in non-hypoxic group.

Conclusion: From the results of this study, we conclude that lung hypoxia has a relation with severity of obstruction, pack years, functional state and ECG changes. Females were more sensitive to the effects of smoking than males.

Key points: COPD, hypoxia, pack year, obstruction.

Introduction

Chronic obstructive pulmonary disease (COPD) is a disease state characterized by airflow limitation that is not fully reversible. The airflow limitation is usually both progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases [1].

It is one of the most common chronic diseases worldwide, and its morbidity and mortality are still increasing. Thus, it is expected that,

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globally, COPD will be the third most common cause of death by 2020 [2]. Moreover, COPD leads to enormous health-economic costs (i. e., outpatient and inpatient treatment, inability to work). Nevertheless, the prevalence of COPD is underestimated ,this is partly because often, the disease is symptomatic only in its advanced stages and as a result it is not diagnosed until late [3].

Pack years: A way to measure the amount a person has smoked over a long period of time. It is calculated by multiplying the number of packs of cigarettes smoked per day by the number of years the person has smoked. [4].

This study aimed to illustrate some physiological parameters related to COPD and correlate them with hypoxemia as measured by oximeter.

Patients and Methods

The study was conducted in Merjan Teaching Hospital in Babylon Province during the period from November-2012 to October-2013. The study consisted of 182 patients with COPD who were classified into two groups according to oxygen saturation (SpO2). The study was carried out on patients with COPD with abnormal pulmonary function tests and history of the symptoms more than six months.

The patients involved in this study were either admitted in the wards or coming to the hospital as outpatients. Patients with a history of systemic hypertension, ischemic or valvular heart disease or episodes of right-sided and/or left-sided cardiac failure, congenital heart disease were excluded from the study, in addition to patients with anemia, chronic liver disease, peripheral vascular disease, and patient with pigment in the skin or nail.

All patients were subjected to: verbal agreement, full history, complete clinical examination, some needed investigations, packed cell volume (PCV), chest x-ray, electrocardiography(ECG), oxygen saturation (SpO2) as measured by pulse oximeter, and pulmonary function tests (PFT) as measured by spirometer.

According to the results of spirometry and oximetry, patients were classified into two groups. **1) Hypoxic group** (COPD+ hypoxemia): which involved patients with abnormal PFT along with arterial hypoxemia (SpO2 equal or less than 95%). **2) Non-hypoxic group** (COPD + normoxemia): which consisted of patients with abnormal PFT and oxygen saturation more than 95%. This group acted as the control group in many comparisons.

Assessment of dyspnea (breathlessness):

Dyspnea was assessed according to the scale of Medical Research Council (MRC) (5) which reflects the functional state of the patients. It is divided into 5 grades as follows:

Table 1. Medical Research Council (MRC) dyspnea scale

Grade	Degree of breathlessness related to activities
1	Not troubled by breathlessness except on strenuous exercise
2	Short of breath when hurrying or walking up a slight hill
3	Walks slower than most people on the level because of breathlessness, stops for a mile or so or stops after 15 minutes when walking at own pace
4	Stops for breath after about 100 m or after a few minutes on the level
5	Too breathless to leave the house, or breathless when dressing or undressing

Pulse oximetry:

Oximetry was performed with a pulse oximeter which records arterial haemoglobin saturation and heart rate. Oximetry measures light absorption over a number of pulses, usually five. This causes the short delay before readings are obtained. An SpO2 of greater than 95% is generally considered to be normal [6].

Pulmonary function tests:

The basic test of lung function can be done with a spirometer. To do the test, a person inhales fully and then blows out the air in his or her lungs through a tube as hard, fast, and completely as possible. The test is repeated until at least three of the exhaled breaths are as good as possible.

In this study, pulmonary function tests were carried out on all subjects (patients and control) with the help of Mir spirometer connected to computer using Spirobank software. This apparatus also records oxygen saturation (SpO2) and pulse rate. Before doing the test, weight and height of each patient were measured and the spirometer automatically calculates the PFT parameters that appear as percent predicted values according to the age, gender and race, weight and height. Three trials of the test were done for each patient until we get the result that is acceptable and reproducible. severity of COPD was also determined by the apparatus.

Statistical analysis:

All calculations and analysis was performed using the Statistical Package for the Social Sciences (SPSS version18). Clinical data were expressed as mean ± standard deviation (SD) for continuous variables or as number and percentage for categorical variables.

Student's 't' test was used to compare mean of continuous variables between two groups. For all tests $p < 0.05$ was considered statistically significant.

Regression analysis was chosen as a statistical tool to investigate the measured parameters and to find the correlation. Simple linear regression was used and the correlation coefficient (r) was calculated.

Results

The study involved 182 patients (96 in hypoxic group and 86 in non-hypoxic group). The ages of patients ranged from 31-70 years. There was no significant difference in ages between the studied groups (P=0.152). There was also no significant difference in gender between groups (P=0.5), most of patients were male (66% in hypoxic group and 62% non-hypoxic group).

Pack years:

The mean pack years of tobacco use in hypoxic group was 42.83±15.34 pack years with a range of 4 to 160 pack years, patients with less than 10 pack years of exposure was only 2% while in non-hypoxic group the mean duration was 24.91±10.24 and the range was from 1 to 150 pack years and patients with less than 10 pack years of exposure was only 7%, most patients in both groups

Table 2. Mean of pack years

Pack years	Hypoxic group (No.96)	Non-hypoxic group (No.86)	P value
mean± SD*	42.83±15.34	24.91±10.24	0.003

*SD= standard deviation

Correlations between severity of obstruction and pack years

Figures (1) and (2) shows the correlation between pack year and severity of obstruction as assessed by FEV1% predicted in hypoxic and non-hypoxic groups. The figures revealed that pack year was significantly correlated with the severity of obstruction in both groups.

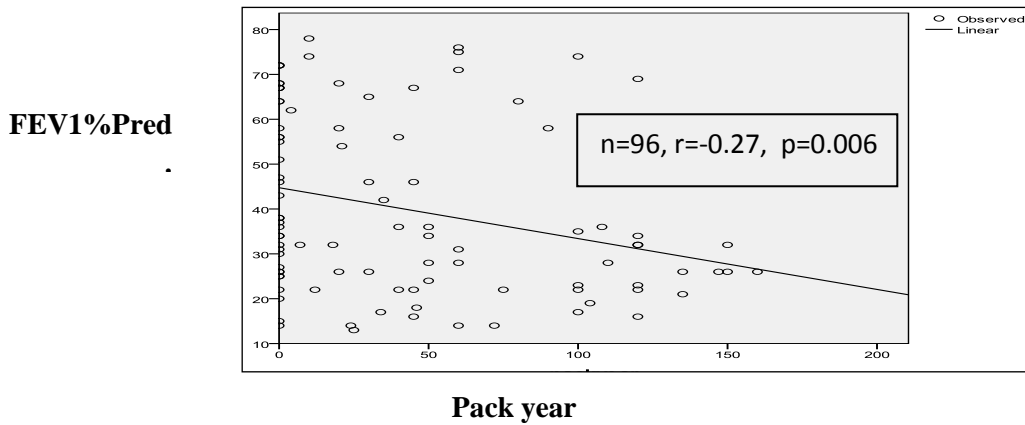**FEV1%Pred**

n=96, r=-0.27, p=0.006

Pack year

Figure 1. Relation between pack years and severity of obstruction in hypoxic group FEV1% Pred.: forced expiratory volume in one second as per cent predicted
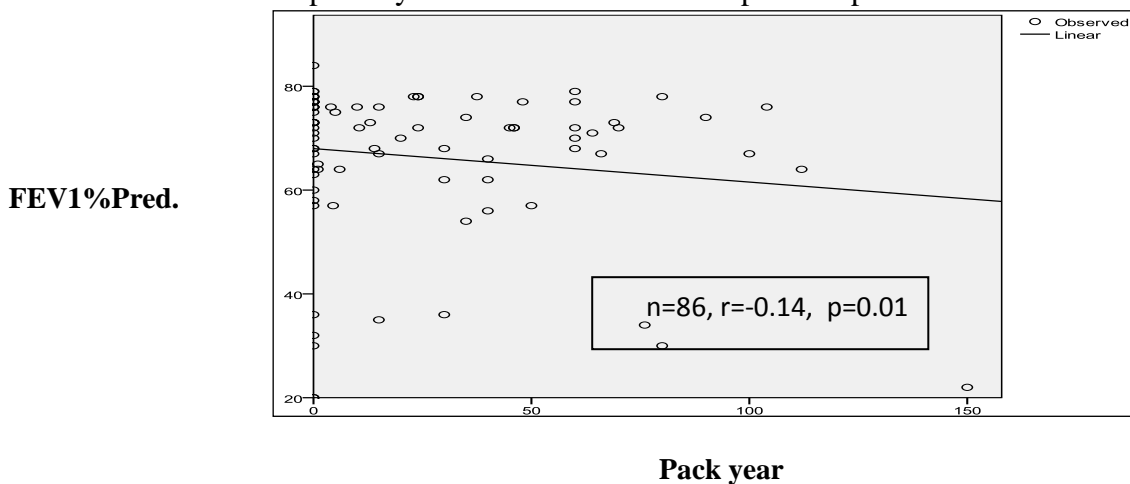

FEV1%Pred.

n=86, r=-0.14, p=0.01

Pack year

Figure 2. Relation between pack year and severity of obstruction in non-hypoxic group FEV1% Pred.: forced expiratory volume in one second as per cent predicted

Correlations between severity of obstruction and functional state:

Regarding the relation between degree of dyspnea (functional state) and severity of diseases, the study revealed that in both hypoxic and non-hypoxic groups there was significant negative linear correlation between functional state and severity of obstruction as shown in figures (3 and 4).
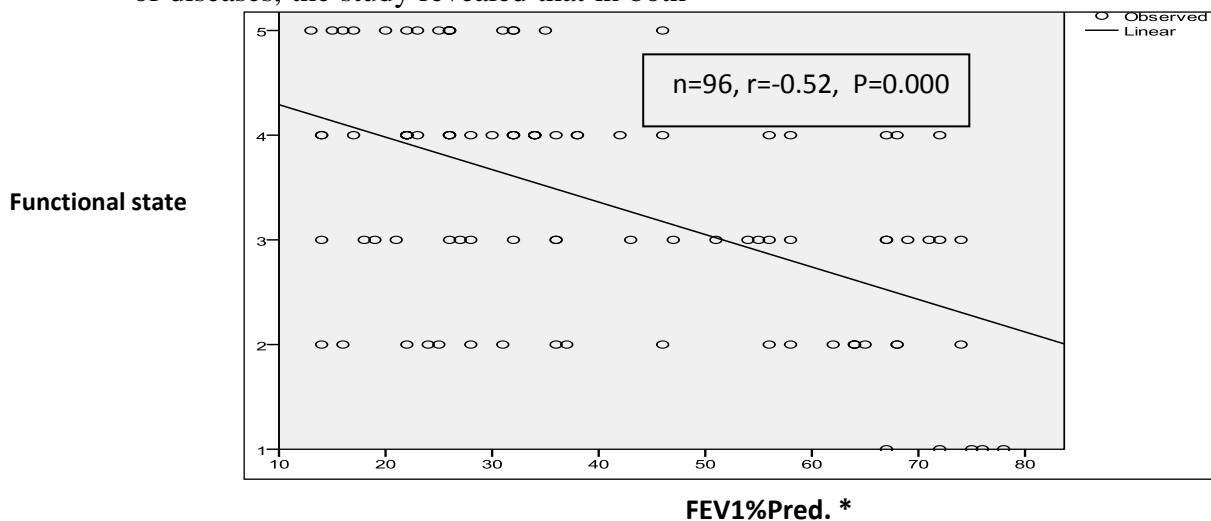

Functional state

n=96, r=-0.52, P=0.000

FEV1%Pred. *

Figure 3. Correlation between severity of obstruction and functional state in hypoxic group

FEV1% Pred. *: forced expiratory volume in one second as per cent predicted
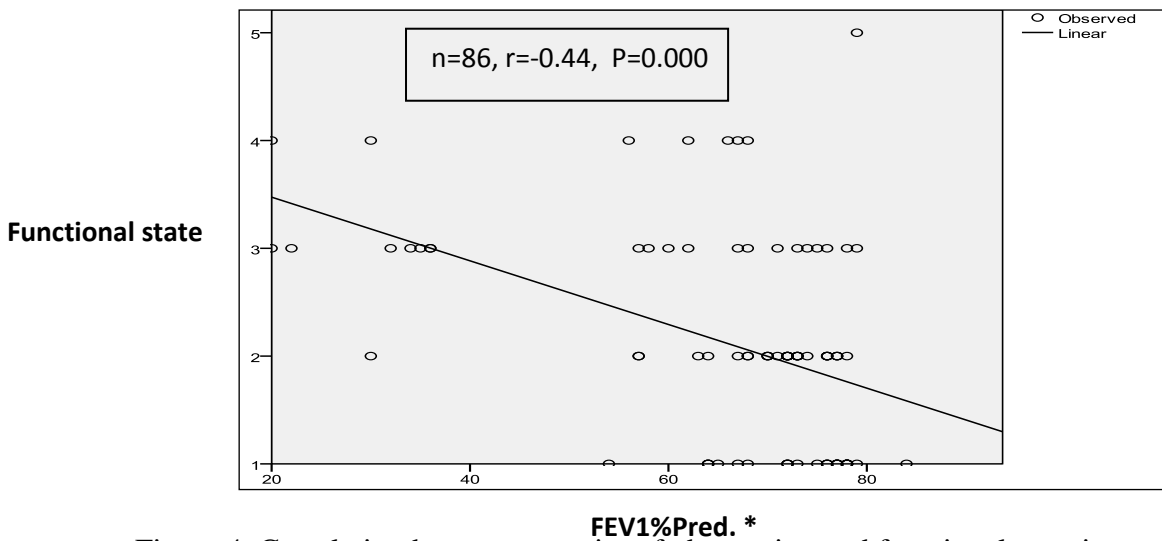

FEV1%Pred. *

Figure 4. Correlation between severity of obstruction and functional state in non-hypoxic group

FEV1% Pred. *: forced expiratory volume in one second as per cent predicted

Correlations between severity of obstruction and duration of symptoms

There was no significant correlation between duration of symptoms and severity of obstruction in hypoxic and non-hypoxic group as clarified in figures (5) and (6)
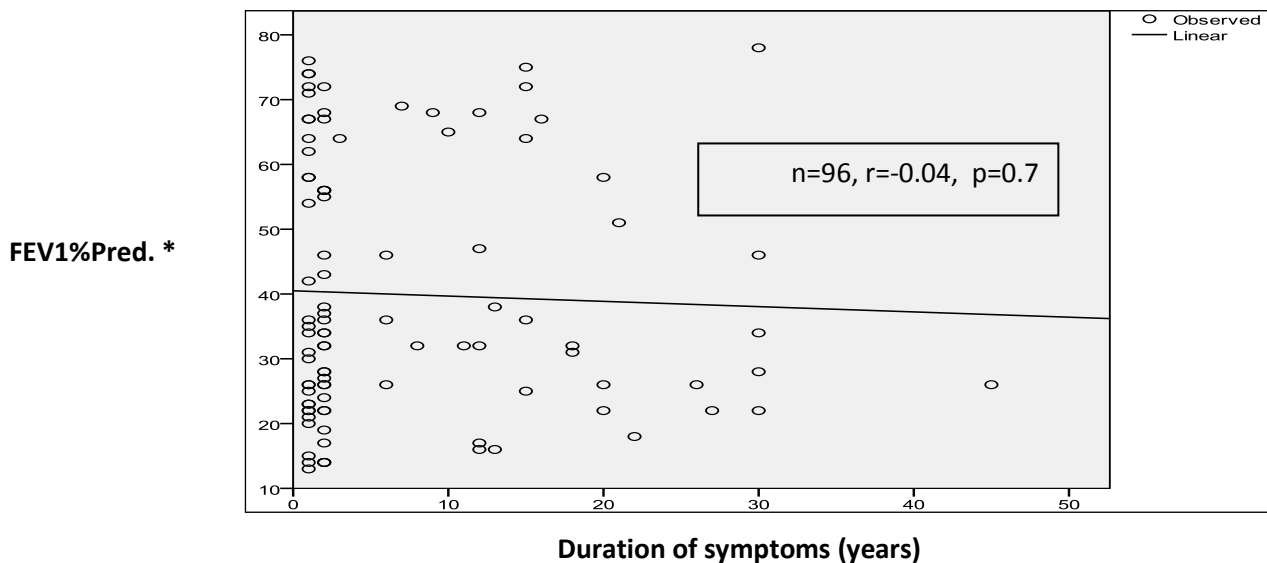

Duration of symptoms (years)

Figure 5. Relation between duration of symptoms (years) and severity of obstruction in hypoxic group

FEV1% Pred. *: forced expiratory volume in one second as per cent predicted

Correlations between oxygen saturation (SpO2) and duration of symptoms:

Results of relation between duration of symptoms and oxygen saturation (SpO2) in both groups were clarified in figures (7) and (8). There was positive linear non-significant correlation between them in both groups (in hypoxic group r=0.16, p=0.1, in non-hypoxic group r=0.07, p=0.5).
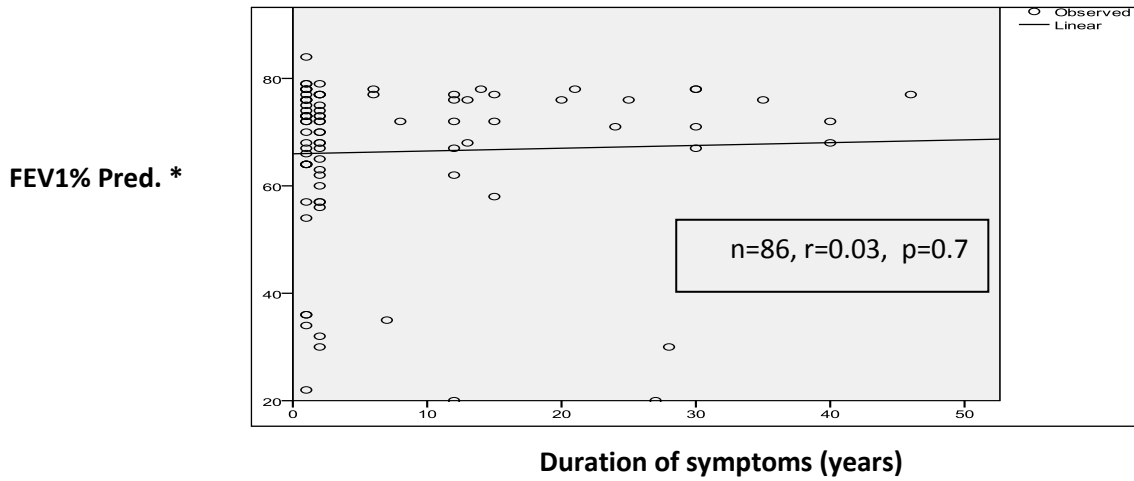
Figure 6. Relation between duration of symptoms (years) and severity of obstruction in non-hypoxic group

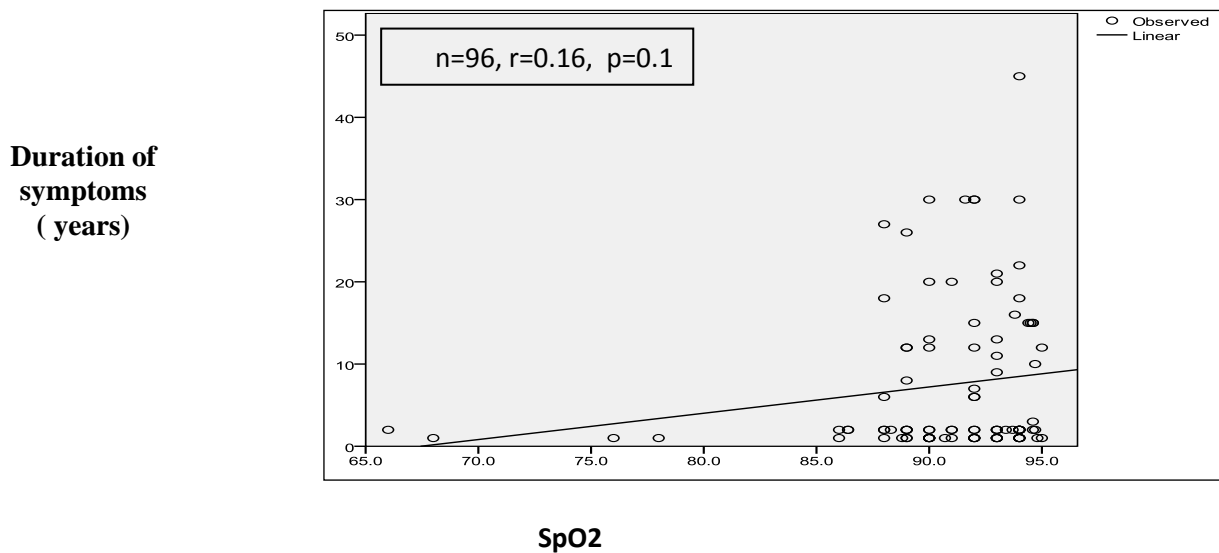FEV1% Pred. *: forced expiratory volume in one second as per cent predicted

Figure 7. Relation between oxygen saturation (SpO2) and duration of symptoms in hypoxic group
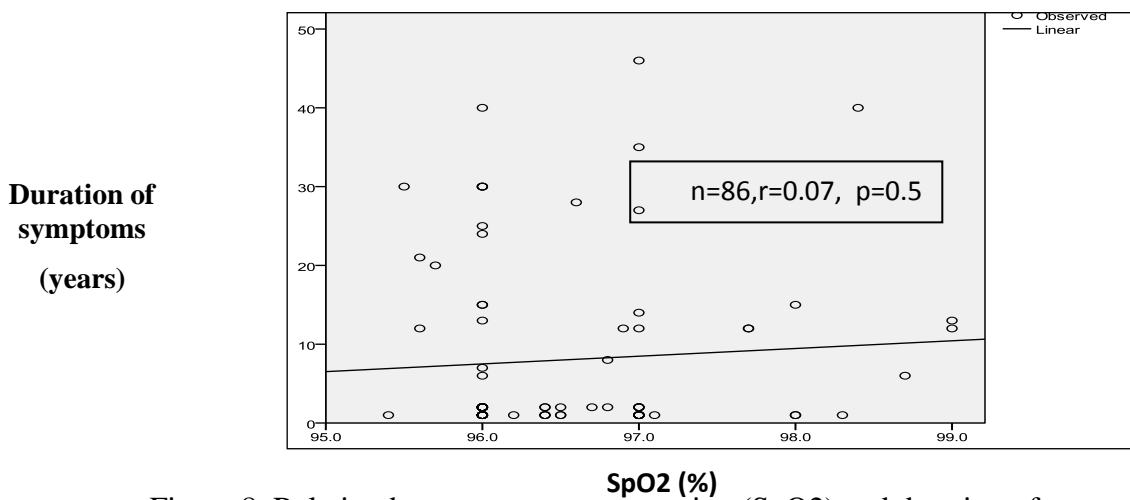

Figure 8. Relation between oxygen saturation (SpO2) and duration of symptoms in non-hypoxic group

Electrocardiographic (ECG) changes:

Table (3) shows the ECG changes in hypoxic and non-hypoxic groups, most patients in both groups had normal ECG changes (73% in hypoxic group and 90% in non-hypoxic group), the most common ECG finding in both groups was P pulmonale (11% in hypoxic group and 6% in non-hypoxic group).

Table 3. Electrocardiographic (ECG) distribution in hypoxic and non-hypoxic group

ECG finding	Hypoxic group		Non-hypoxic group		P value
	No.	%	No.	%	
Normal	70	73	77	90	0.1
P pulmonale	10	11	5	6	
P pulmonale and RAD*	7	7	2	2	
P pulmonale and RVH**	1	1	0	0	
p pulmonale, poor progression	1	1	0	0	
P pulmonale, poor progression, RAD	2	2	0	0	
P pulmonale, RAD,RVH	2	2	0	0	
P pulmonale, RVH, poor progression	1	1	0	0	
RAD	2	2	2	2	
Total	96	100	86	100	

*RAD :right axis deviation , **RVH: Right ventricular hypertrophy

Discussion

Patients characteristics:

Patients that were selected for this study included those who had COPD with a duration more than six months and they were divided into two groups (hypoxic and non-hypoxic) according to the results of oxygen saturation (SpO2), control healthy group was recorded and used for comparsions with some results only because large difference in readings between it and patients groups and this affects the results of comparisons and correlations between groups, in addition to that we studied the effects of hypoxia on patients and not on healthy population, but their data were taken as basic data for our results.

There was no significant difference in the mean of ages between hypoxic and non-hypoxic groups, the ages ranged from 31 to 70 in both groups. Patient more than 70 years old were excluded from the study because aging is associated with a progressive decrease in lung function.

In this study, most of patients were males in both groups, males form 66 % (63/96) in hypoxic group and 62% (53/86) in non-hypoxic group. This higher incidence of diseases in males can be attributed to smoking.

Patients in hypoxic group had lower body weight than non-hypoxic group with non-significant differences between them, this low weight in hypoxic patients might be due to poor nutrition in those patients.

Assessment of dyspnea (functional state)

Dyspnea is one of the most common symptoms in COPD and it is invariably present in all severity stages either at rest or under conditions of exercise. Dyspnea, unlike other outcomes for therapeutic interventions, is, however, a subjective phenomenon [7].

In this study we used Medical Research Council (MRC) score for assessment of dyspnea. There is up to 98% agreement between observers recording MRC breathlessness scores [8].

The study showed significant negative relation between functional state of patients and Spo2 in hypoxic group while non-significant relation between them in non-hypoxic group. This means that with the decrease in SpO2 (more hypoxia) there is increased grade of dyspnea (patients become more dyspnic).

Analysis of smoking state

Severity of smoking was assessed according to pack year, smoking was more severe in hypoxic group than non-hypoxic group and it was more in male than females, no smoker patient was found to

smoke less than 1 pack year. The majority had the habit of smoking for more than six years (92%). Severity of pack year was correlated with increasing age, this mean that patients smoke more with increasing age which might be due to delayed symptomatic effects of smoking on patients so patients continue to smoke with increasing amount in addition to increased addiction on tobacco and also increasing social pressure and daily life burdens with age in our country and this agree with a study performed by Bano *et al.,*2011 [9].

Severity of smoking was less in females than males but the severity of diseases was more against lower levels of exposure to smoking this means that females was more sensitive to the effects of smoking than males. This higher percentage of males can be attributed to smoking and it means that males need longer duration of exposure to smoking to get the same effects as females [10]. Predispositions between men and women may vary because of differences in lung morphology that modify the dispersion and deposition of cigarette smoke or differences in homeostatic processes affecting the efficacy of lung clearance [11].

In addition, the study showed significant negative correlation between pack years and severity of obstruction in hypoxic group while non-significant correlation between them in non-hypoxic group and this difference between groups happened because the number of patients with severe pack years in our study was largely greater in hypoxic group than non-hypoxic group and this explain the multiple toxic effects of smoking on the respiratory system.

In addition, it explain the relation between smoking and respiratory hypoxia because combustion of tobacco produces carbon monoxide (CO) which binds with hemoglobin in the red blood cells, this reduces the amount of hemoglobin available to bind with oxygen, CO will combine with the hemoglobin about 250 times more readily than oxygen, the hemoglobin involved in this combination is not available to carry oxygen to the tissues [12].

Analysis of electrocardiographic (ECG) changes:

The study showed that most patients has normal ECG changes and the predominant changes in both groups were P pulmonale and right axis deviation and this was consistent with a study by Rodman *et al.,*1990 [13]. In a study on COPD, Avinash,2008 [13] stated that the most common ECG abnormality was P pulmonale, which was present in 60 % of cases in contrast to 11% in our study in hypoxic group and 6% in non-hypoxic group.

Conclusions

The following conclusions can be drawn from the study:
1. Most of patients with hypoxia had more severe disease than patients with no hypoxia who had mostly mild disease.
2. Most patients had more severe smoking with increased duration of smoking, in addition patients with heavy smoking had more severe obstruction and hypoxia.
3. Few ECG changes occur in patients with COPD and were more predominant in hypoxic patients.
4. Duration of disease has no relation with severity of obstruction and hypoxia.

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