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Original Article

Correlations and diagnostic tools for metabolic syndrome (MetS) and chronic obstructive pulmonary disease (COPD)

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Abstract: Background: Regarding the importance of obesity in patients with chronic obstructive pulmonary disease (COPD), we aimed to evaluate of correlation between metabolic syndrome (MetS) and COPD. Methods: In this cross-sectional study, 96 patients with COPD were evaluated. This study was conducted in 2016-2018. The severity of COPD was determined by Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017 criteria. We investigated the correlations between MetS with COPD and possible diagnostic tools. Results: Of all COPD patients, 86.5% had MetS, and the means of waist circumference, fasting blood glucose, systolic and diastolic blood pressure, body mass index, and triglyceride in patients with MetS were significantly higher than the patients without MetS ($P < 0.05$). We showed that forced expiratory volume in 1 second (FEV1) with a 37% cutoff had 92.8% and 69.2% sensitivity and specificity, respectively (area of the curve: 0.51, 0.31-0.71). Conclusion: MetS is prevalent among COPD and FEV1 could be considered as important diagnostic tool for COPD.

Keywords: Metabolic syndrome, chronic obstructive pulmonary disease

Introduction

Chronic obstructive pulmonary disease (COPD) is a progressive and complex disease and one of the world's leading causes of mortality and morbidity. COPD not only causes airway inflammation but also systemic inflammation [1]. The exact relationship between these two inflammatory processes is still unknown. Systemic inflammation is a response to comorbidities in patients with COPD. The diagnosis of COPD is considered as a forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) ratio is less than 70 percent of the predicted value [1-3]. Symptoms of COPD include shortness of breath, especially during physical activities, wheezing, and chronic cough that could be associated with sputum.

Metabolic syndrome (MetS) has a prevalence of 20% to 30% and is a physiological and biochemical disorder. The diagnostic criteria for metabolic syndrome include obesity, high blood pressure, high blood triglycerides, low levels of high density lipoprotein level (HDL) cholesterol and insulin resistance [4, 5]. The exact diagnostic criteria for MetS are having three or more of the following:

- Waistline of 40 inches or more for men and 35 inches or more for women.
- Blood pressure more than 130/85 mmHg or treatment with anti-hypertensive medications.
- Triglyceride level above 150 mg/dl.
- Fasting blood sugar (FBS) level more than 100 mg/dl or treatments with glucose-lowering medications.
- HDL less than 40 mg/dl (men) or under 50 mg/dl (women) [5].

The prevalence of this syndrome has been rising in recent years, with 20-25% of adults today suffering from this syndrome [6]. MetS and COPD now affect various clinical conditions that significantly impact general health. The incidence of both diseases will likely increase, with growing pressure on the global economy.

The two disorders have a significant relationship, and the epidemiological and clinical data show a substantial connection between the MetS and lung function impairment [7-9]. Recently, the relationship between MetS and pulmonary diseases has been studied. A study revealed that the incidence of MetS in patients with obstructive sleep apnea was nine times higher than that of others [10]. There is no evidence of COPD prevalence among patients with MetS. Although smoking does not seem to be a factor in discriminating between patients with and without metabolic syndrome, the data of epidemiological studies is still essentially contradictory [11].

At the same time, the protective effect of smoking and diabetes has been noted [12]. Similarly, the impact of smoking on body mass index remains an unresolved issue, as in many studies, high [13] and low levels of body mass index [14] have been reported with smoking.

Therefore, considering the controversial results about the association of MetS and COPD in different studies, we decided to investigate and compare the association of MetS with COPD according to Gold 2017 criteria.

Methods and material

Study design

This cross-sectional study was performed on 96 patients with COPD who were referred to al-Zahra Hospital between 2017 and 2018. The ethics code of this research was IR.MUI.MED.REC.1399.644.

Inclusion criteria included ambulatory patients, diagnosis of COPD by a pulmonologist, diagnosis of disease severity by computed tomography (CT) scan and spirometry according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017 criteria, and signing the written informed consent to participate in this study. Patients with exacerbated state of the disease or attack in the last two months did not enter the study. The exclusion criteria were having any autoimmune, inflammatory, and infectious diseases and patients with previous pulmonary disorders or any cancer.

Primary evaluations

The pulmonologist determined the severity of the disease according to the patient's history and clinical symptoms, spirometry, and CT scan. The severity of the disease is divided into 4 categories using the GOLD 2017 criterion, including stage 1 or mild (FEV1 > 80, FEV1/FVC < 70%), stage 2 or moderate (FEV: 50-80%, FEV1/FVC < 70%), stage 3 or severe (FEV: 30-49%, FEV1/FVC < 70%), and stage 4 or very severe (FEV1 < 30%, FEV1/FVC < 70%) [15].

Data gathering and analysis

After identifying the severity of the disease, the demographic checklist, including age, gender, height and weight, history of smoking, and renal disease, was given to the patients. MetS risk factors included insulin resistance, obesity (especially abdominal obesity), high blood pressure, elevated fasting glucose, hyperglycemia, and lipid disorders. If a person had three of the following five complications, (s)he was diagnosed with a metabolic syndrome. MetS criteria were considered in these patients, as mentioned in the introduction. Thus, tests including blood glucose check, triglyceride, HDL, blood urea nitrogen (BUN), and creatinine, were requested for all patients. Body mass index (BMI), abdominal fat, and blood pressure were also evaluated. Therefore, after identifying the severity of COPD, patients should be screened for the factors of MetS and examined for the association of these factors in different COPD severity rates. COPD severity was based on the GOLD criteria: GOLD grade I was defined as a forced expiratory volume in 1 second (FEV1) > 80% predicted; GOLD grade II as an FEV1 of 50-80% predicted; GOLD grade III as an FEV1 of 30-50% predicted; and GOLD grade IV as an FEV1 < 30% predicted [15, 16].

We analyzed and compared different variables between two groups (with and without metabolic syndrome). Furthermore, we assessed the difference between the two groups regarding COPD severity according to age, gender, waist circumference, body mass index (BMI), systolic

Table 1. The variables studied in this study in two groups of patients with and without metabolic syndrome

Variables		Total	Patients with metabolic syndrome	Patients without metabolic syndrome	*P*-value
Age		62.72 ± 7.84	62.84 ± 7.87	62.01 ± 7.97	0.61
Gender	Man	85 (88.5%)	74 (89.2%)	11 (84.6%)	0.63
	Female	11 (11.5%)	9 (10.8%)	2 (15.4%)	
Severity COPD	Mild	14 (14.6%)	11 (13.3%)	3 (23.1%)	0.62
	medium	50 (52.1%)	45 (54.2%)	5 (38.5%)	
	Intense	28 (29.2%)	24 (28.9%)	4 (30.8%)	
	Very intense	4 (4.2%)	3 (3.6%)	1 (7.7%)	
Waist size		104.91 ± 12.33	107.08 ± 11.79	91.07 ± 3.81	< 0.001
BMI		29.98 ± 3.55	31.10 ± 2.14	22.84 ± 2.15	< 0.001
SBP		133.01 ± 13.73	135.43 ± 12.84	117.46 ± 7.99	< 0.001
DBP		81.84 ± 10.78	83.86 ± 9.70	68.92 ± 8.24	< 0.001
FBS		118.36 ± 20.04	123.60 ± 16.04	84.92 ± 4.49	< 0.001
TG		139.84 ± 32.32	145.24 ± 31.25	105.38 ± 10.44	< 0.001
HDL		39.27 ± 3.55	37.50 ± 10.08	50.53 ± 6.33	< 0.001

COPD: Chronic obstructive pulmonary disease, BMI: Body mass index, SBP: Systolic blood pressure, DBP: diastolic blood pressure, FBS: Fasting blood sugar, TG: Triglyceride, HDL: High-density lipoprotein.

blood pressure (SBP), diastolic blood pressure (DBP), FBS, triglyceride (TG), and HDL. The receiver operating characteristic (ROC) curve was used to determine a sensitivity and specificity of a cutoff for FEV1 in patients.

Statistical analysis

Data analyses were then carried out in Statistical Package for Social Sciences (SPSS) (version 24, SPSS Inc., Chicago, IL) and the tests used in this study included Chi-square, ANOVA, and Pearson correlation. *P*-value < 0.05 was considered as significance threshold.

Results

Study population and characteristics

A total of 96 patients participated in this study. They were divided into MetS (74 males and nine females) and those without MetS (11 males and two females). There were no significant differences between the two groups based on age, gender, and COPD severity (P > 0.05). The mean waist circumference, BMI, SBP, DBP, FBS, and TG were significantly higher in patients with MetS than in those without MetS (P < 0.001). However, the mean HDL in patients with MetS was considerably lower than in those without MetS (P < 0.001) (**Table 1**).

COPD evaluations

The severity of COPD was mild (14.6%), moderate (52.1%), severe (29.2%), and very severe (4.2%). There was no significant difference between the two groups regarding COPD severity according to age, gender, waist circumference, BMI, SBP, DBP, FBS, TG, and HDL (P > 0.05). Also, Based on the ROC curve considering the 37% cutoff for FEV1, sensitivity and specificity were calculated at 92.8% and 69.2%, respectively (area of the curve: 0.51, 0.31-0.71) (**Figure 1**).

Discussion

The present study showed that most patients had moderate severity of COPD and 86.5% suffered from metabolic syndrome. Moreover, there was no significant relationship between COPD severity rates by age, gender, waist circumference, BMI, SBP, DBP, FBS, TG, and HDL.

In addition, abdominal obesity, hypertension, and hyperglycemia were higher in subjects with COPD [9, 10]. The mean waist circumference, blood pressure, and blood glucose were higher than usual. A study in Iran showed that the prevalence of MetS was 48% in patients with pulmonary complications such as COPD and chronic bronchitis. MetS was positively related to age, abdominal obesity, high FBS, TG, and

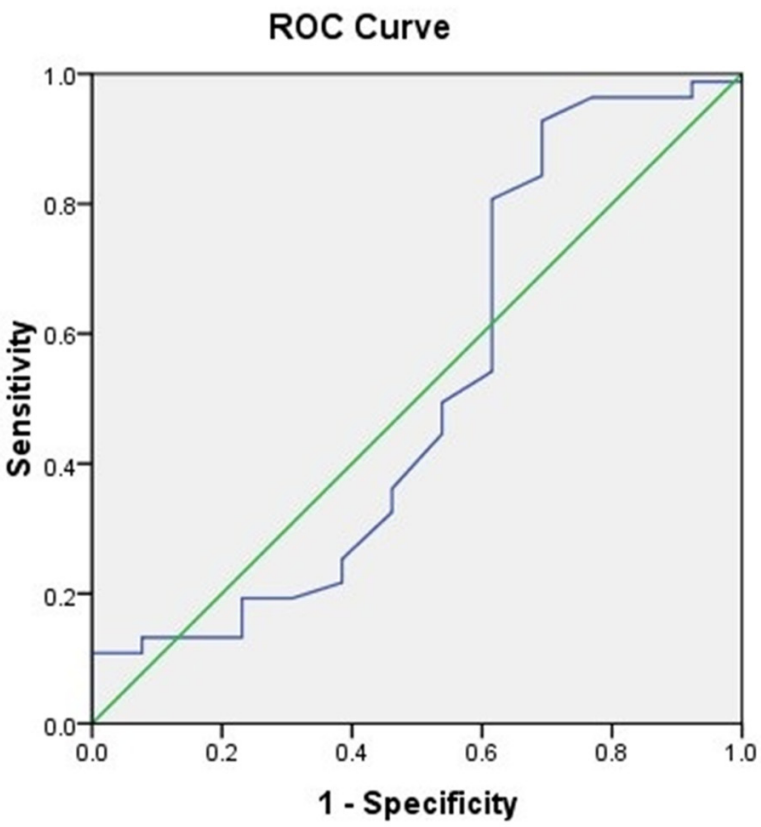

Figure 1. ROC curve for calculating of sensitivity and specificity based on FEV1.

positive C-reactive protein (CRP). This study also stated that age and inflammatory processes are the most important mechanisms involved in the onset of this syndrome [17]. The results of this study were consistent with the present research considering the presence of abdominal obesity, high FBS, high TG, and positive CRP in subjects with metabolic syndrome.

In another study, the prevalence of MetS was 33.3, 48.8%, 31.6%, and 23.1% for stages I, II, III, and IV, respectively. There was also no significant relationship between MetS and different GOLD stages [18, 19]. The present study also showed that the prevalence of MetS in various GOLD stages was as follows: 14.6% (mild or I), 52.1% (moderate or II), 29.2% (severe or III), and 4.2% (very severe or IV).

There was also no significant relationship between the different stages of COPD and metabolic syndrome. In a study that compared patients with MetS and COPD, MetS alone and COPD alone, Piazzolla and colleagues concluded the prevalence of MetS in patients with COPD referred to the outpatient clinic was 62%. The results of their study were consistent with our findings. The new finding of this study included that vitamin D levels and insulin resistance were studied in patients, and it was stated that there is a strong relationship between smoking and vitamin D levels and insulin resistance [9, 20]. Some studies have indicated that patients with MetS and COPD risk increased morbidity and mortality [21]. Therefore, considering the prevalence of MetS in COPD patients in our study, it seems that more planning is needed to manage these patients to reduce the complications of the two diseases.

Some current research limitations include restricted sample size, and non-examination of inflammatory factors in these patients. Another limitation of this research was the lack of a control group to compare our data. It is recommended that further studies should be performed on larger populations. However, the results of our research are reliable, and physicians should pay attention to COPD in patients with MetS.

Conclusion

It seems that the prevalence of MetS in patients with COPD was more than in other previous studies, and this may be due to the lower quality of life of these patients. On the other hand, most of our patients were males; but more studies were needed to improve the health status of these patients. In addition, there was no relationship between the different severity rates of COPD and the prevalence of MetS or risk factors.

Disclosure of conflict of interest

None.

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