Research Article

Clinical Overview of Chronic Obstructive Pulmonary Disease Patients with Myocardial Perfusion Defect

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Abstract: Background: Increased hospitalization and death rates up to 2-3 times greater due to cardiovascular diseases have been reported in Chronic Obstructive Pulmonary Disease (COPD) cases. Inflammation, neurohumoral activation, and increased oxidative stress are involved in the etiopathogenesis of both disease groups.

Objective: The study aimed to retrospectively evaluate the patients with COPD with perfusion defects (ischemia/infarct) in myocardial perfusion scintigraphy and investigate the clinical features of these patients.

Materials and Methods: Patients with COPD were included in the study by examining the files of 196 patients who had perfusion defects by performing myocardial perfusion scintigraphy (MPS) in the Nuclear Medicine Clinic of our hospital between January 2019-2021. Demographic data, comorbidities, areas of involvement in myocardial perfusion scintigraphy, pulmonary function test (PFT), smoking history, modified Medical Research Council (mMRC) score, pulse oxygen saturation, and echocardiography (ECHO) data were recorded.

Results: COPD was detected in 6 (3%) of 196 patients. All of these cases were male and the age range was 67.2 ± 7.4 years. All 6 cases were male, and the mean age was 67.2 ± 7.4 years. They all had a history of heavy smoking (52.5 ± 30.9 packs/year). The mean forced expiratory volume in 1 second (FEV1) was 49.6 ± 8.9%, and pulse oxygen saturation was 93.2 ± 3.3%. In ECHO, systolic pulmonary artery pressure (PAPs) was higher than normal in 2 patients; one had advanced mitral insufficiency and heart failure. In the MPS of 4 patients, an infarct was observed in the area supplied by the right coronary artery (RCA). While there was no comorbid disease in 2 patients, comorbid diseases were present in 4. There was no significant difference between the non-COPD group and the COPD group in terms of age and gender. In the non-COPD group, the most common LAD localized defect (35.3%) and RCA localized defect (23.2%) were detected, while the most common RCA defect (50%) was found in the COPD group. However, it was not statistically significant due to the small sample size.

Conclusion: In COPD cases, it was determined that infarct developed in the male gender, advanced age and advanced stage, and especially in the area fed with RCA if exposed to heavy smoking. It is considered that the ischemic changes observed in RCA in COPD may have a role in the development of right heart failure.

Keywords: COPD, Ischemia, Myocardial perfusion scintigraphy, Inflammation, Neurohumoral activation, Systolic pulmonary artery pressure.

INTRODUCTION

Increased hospitalization rates [1,2] and increased death rates up to 2-3 times greater due to cardiovascular diseases have been reported in Chronic Obstructive Pulmonary Disease (COPD) cases [3]. As COPD disease progresses, the incidence of myocardial infarction (MI) increases as well [4]. Both COPD and cardiovascular diseases have been associated with inflammation, neurohumoral activation, and increased oxidative stress [5-7]. When factors such as advanced age, male gender [8, 9], smoking, and obesity, which are common etiological factors, are excluded, the coexistence of both diseases is common [10]. Furthermore, it is known that physical inactivity frequently occurs with musculoskeletal weakness secondary to systemic inflammation in COPD patients and is a critical risk factor for coronary artery disease.

Other cardiovascular risk factors, such as diabetes mellitus and hypertension, are also more common in COPD patients [11]. There are also studies on slow coronary blood flow in COPD. The etiology of slow coronary blood flow is unclear, but endothelial activation and inflammation have been emphasized [12]. It was thought that the deterioration or slowing of the coronary circulation in COPD might be related to cardiovascular diseases [13].

The present study aimed to retrospectively evaluate the patients with COPD with perfusion defects (ischemia/infarct) in myocardial perfusion scintigraphy (MPS) and investigate their clinical features.

MATERIALS AND METHODS

The files of 226 patients who were found to have myocardial ischemia/infarction by performing myocardial perfusion scintigraphy (SPECT) Tc-99m examination in the Nuclear Medicine Clinic of our hospital between January 2019-2021 were reviewed. Thirty patients were excluded from the study due to lack of comorbidity data.

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Demographic data, comorbidities, smoking history, modified Medical Research Council (mMRC) score, areas of perfusion defect involvement in myocardial scintigraphy, pulse oxygen saturation, pulmonary function test (PFT), and echocardiography (ECHO) data of the patients were recorded.

Myocardial Perfusion Scintigraphy (MPS)

It is the most commonly used method for the evaluation of myocardial perfusion. MPS determines the hemodynamic importance of vascular stenosis and gives information about small vessel functions. MPS is a noninvasive and reliable test used in the detection of myocardial ischemia and scar, evaluation of its localization and extent, evaluation of the physiological significance of border stenosis, evaluation of myocardial viability and prediction of functional recovery after revascularization, evaluation of risk and prognosis after myocardial infarction and before noncardiac surgery.

The right ventricle is supplied by the conus branch of the right coronary artery (RCA). The anterolateral wall is supplied by the acute marginal branch of the RCA, and the posterior wall and the posterior 1/3 of the septum are supplied by the posterior descending arterial branch of the RCA. The right ventricular anterior wall is supplied by both the left anterior descending (LAD) artery and the conus branch. The moderator band artery originating from the first septal branch of the LAD passes through the right ventricular moderator band and supplies the anterolateral wall.

According to myocardial involvement areas; the left Anterior Descending artery (LAD) supplies the anterior, septum, anteroseptal, and apical; the right coronary artery (RCA) supplies the inferior, inferobasal, and inferoseptal; circumflex artery (Cx) supplies the lateral, inferolateral, and anterolateral segments. In our study, after the intravenous administration of Technetium-99m- Sestamibi 22 mCi as a radiopharmaceutical agent, stress and MPS SPECT at rest the next day, and Gated SPECT myocardial perfusion scintigraphy synchronized with MPS during stress shooting was performed. Ethics committee approval was obtained in Abant Izzet Baysal University (Decision no: 2022/211, date: 26.07.2022).

STATISTICAL ANALYSIS

The analysis of the data obtained as a result of the research was performed in the SPSS 20 statistical package program. Descriptive statistical methods (frequency, arithmetic mean, standard deviation, median, minimum, maximum, crosstabs) were used, and the compliance to normal distribution was evaluated with the Kolmogorov-Smirnov test. The Mann-Whitney U test compared two independent groups by the median values of the groups that did not show normal distribution. The Chi-square test examined the relationship between categorical variables. Statistical significance level was accepted as a p-value of <0.05.

RESULTS

COPD was detected in 6 (3%) of 196 patients. There was no significant difference between the non-COPD group and the COPD group in terms of age and gender (p:0.249, p: 0238). In the non-COPD group, the most common LAD localized defect (35.3%) and RCA localized defect (23.2%) were detected, while the most common RCA defect (50%) was found in the COPD group (p:0.056, Table **1**). However, it was not statistically significant due to the small sample size.

All of the patients with COPD were male and the age range was 67.2±7.4 years. They all had a history of heavy smoking (52.5 ±30.9 pack/year). The mean forced expiratory volume in 1 second (FEV1) was 49.6 ± 8.9%, and pulse oxygen saturation was 93.2 ± 3.3%. While there was no comorbid disease in 2 patients, comorbid diseases were present in 4 patients (Table **2**).

Table 1. Comparison of Demographic Data and MPS Defect Localizations according to the Presence of COPD in Patients with Perfusion Defect in MPS.

	COPD (n: 6)	**Non-COPD (n: 190)**	**Total Patients (n: 196)**	**p value**
Age	68.5 (58-76)	62.5 (37-86)	62.6 (37-86)	0.249
Gender				
Female	0 (0%)	36 (18.9%)	36 (18.4%)	0.238
Male	6 (100%)	154 (81.1%)	160 (81.6%)	
MPS defect				
LAD	0 (0%)	67 (35.3%)	67 (34.2%)	
RCA	3 (50%)	44 (23.2%)	47 (24%)	0.056
Cx	1 (16.7%)	12 (6.3%)	13 (6.6%)	
LAD, RCA	1 (16.7%)	32 (16.8)	33 (16.8%)	
LAD, Cx	1 (16.7%)	3 (1.6%)	4 (2%)	
RCA, Cx	0 (0%)	12 (6.3%)	12 (6.1%)	
LAD,RCA,Cx	0 (0%)	20 (10.5%)	20 (10.2%)	

LAD: Left Anterior Descending artery, Cx: Circumflex artery, RCA: Right coronary artery.

Table 2. Comparison of Demographic, PFT, and Clinical Findings of the Cases.

Case	Age	Gender	Cigarette p/y	FEV1%	FVC%	FEV1/FVC%	SpO_2	mMRC	Comorbid Disease
1	59	M	40	40	54	58	89	2	Heart failure, AF, CAD
2	76	M	80	-	-	-	92	3	No
3	73	M	20	53	63	64	94	1	Pneumoconiosis, DM
4	58	M	45	63	59	66	94	1	No
5	67	M	100	44	72	48	93	3	CAD,HT
6	70	M	30	48	65	57	98	1	CAD, HL, HT

FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 second, SpO2: Oxygen saturation measured by pulse oximetry, mMRC: Modified Medical Research Council score, AF: Atrıal fibrılatıon, CAD: Coronary artery disease, DM: Diabetes mellitus, HT: Hypertension,HL: Hyperlipidemia.

Table 3. Comparison of the ECHO Findings of the Cases.

Case	PABs (mmHg)	EF%	TR	MI	Other ECHO Findings
1	65	25	Moderate	Severe	-
2	Normal	60	No	Mild	-
3	48	50	Mild	Mild	Right heart dilated, LV hypertrophic
4	27	65	No	No	-
5	Normal	55	No	No	LV hypertrophic, grade 1 DD
6	31	50	mild	Mild	LV segmentary wall motion defect, grade 1 DD

PABs: Systolic pulmonary artery pressure, TR: Tricuspid regurgitation, MI: Mitral insufficiency, ECHO: Echocardiography, LV: Left ventricle, DD: Diastolic dysfunction.

Table 4. Comparison of Myocardial Perfusion Scintigraphy Findings of the Cases.

Case	The Myocardial Perfusion Defect Area	Vessel Localization
1	At the apex, the inferolateral wall in the mid and apical segments	LAD, CX
2	At inferior, inferoseptal basal	RCA
3	On inferior wall	RCA
4	At the base of the lateral wall	CX
5	At the inferior wall mid and basal	RCA
6	At the inferior and apex	RCA, LAD

LAD: Left Anterior Descending artery, Cx: Circumflex artery, RCA: Right coronary artery.

PABs were higher than normal in 2 patients on ECHO; one had severe mitral regurgitation (MR) and left heart failure (Table **3**). RCA infarct-ischemia was observed in the MPS of 4 patients (Table **4**).

DISCUSSION

In 115 patients with stable COPD, myocardial infarction (MI) was most frequently detected in the anterior (34.4%), basal (30%), and lateral (35.6%) walls [4], while in our study, 4 of 6 patients had perfusion defects in the inferior and inferoseptal wall, which are the areas supplied by RCA. Pulmonary hypertension and right ventricular hypertrophy (RV) were detected on ECHO in only one of the patients with RCA perfusion defects. In normal conditions, the thin-walled RV must exert little effort to generate stroke volume into the low-resistance pulmonary vascular circulation. This changes when there is pulmonary hypertension, leading to an increase in the RV's oxygen demand and changes in coronary flow, ultimately making the RV more susceptible to ischemia [14-16]. Pulmonary hypertension was present in 2 cases in our study. While one of these cases had severe mitral regurgitation, the other did not have valvular disease. This result suggests that there may be a perfusion disorder in the areas fed by RCA, even without pulmonary hypertension added to the picture in COPD patients.

Right ventricular involvement is predominantly present in inferior AMI caused by proximal RCA occlusion, with a prevalence of up to 30% depending on the diagnostic parameter used [17,18]. Right ventricular myocardial infarction (RVMI) may also occur due to occlusion of the left circumflex artery in cases where the left coronary system is dominant. Rarely, LAD occlusion may also cause infarction in the inferior of the right ventricle [19- 21]. RVMI causes suppression of right ventricular functions, thus causing right heart failure and

low stroke volume [22].

Recently, our knowledge has increased that the effects of inflammation in COPD are not limited to the lungs and airways, but also affect many organ systems [6]. It is thought that systemic inflammation in COPD accelerates the formation and development of coronary artery disease independent of risk factors [23]. In patients with COPD who smoke more than 10 packs/year and are older than 40 years, respiratory, cardiovascular, and metabolic systems should be evaluated in detail, and chronic systemic inflammatory syndrome should be investigated [24]. COPD and coronary artery disease are more common in males [8, 9]. Our cases were also male, elderly, and heavy smokers. Diseases with other cardiovascular risk factors, such as HT and DM, are also more common in COPD than in healthy individuals [11]. In our study, while there was no additional disease in 2 patients, the others had previously known diseases such as CAD, hypertension, hyperlipidemia, and DM.

As COPD progresses, it may be associated with an increased incidence of MI [4], hypoxemia, a more immobile lifestyle due to decreased physical performance, right heart dilatation, and the development of pulmonary hypertension. Pulse oxygen saturation was <95% in all but 1 of our cases. COPD-related hypoxia has been associated with the activation of the renin-angiotensin system, which leads to decreased renal blood flow and peripheral vasoconstriction, and ultimately to increased oxidative stress that increases the risk of MI [7]. The modified Medical Research Council (MRC), which provides a quantitative assessment of the degree of respiratory distress, shows the degree of dyspnea in response to activities ranging from light exertion to heavy exercise. In our study, mMRC was evaluated as 3 in 2 cases, 2 in 1 case, and 1 in 3 cases. As the mMRC score increases, patients try to exert less effort. Physical activity is also decreased in COPD patients due to musculoskeletal weakness secondary to systemic inflammation.

LIMITATION

Our limitation was the low number of COPD cases with myocardial perfusion defects in this study. Despite this, the detection of perfusion defects in the area fed by RCA, in most cases, sheds light on further studies with larger patient data.

CONCLUSION

In our COPD cases, it was determined that infarct ischemia developed, especially in the area fed by RCA. Therefore, it is thought that the ischemic changes observed in RCA in COPD may have a role in developing right heart failure.

AUTHORS' CONTRIBUTION

All authors' have contributed equally.

CONFLICT OF INTEREST

Declared none.

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