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The Correlation Between Chronic Obstructive Pulmonary Disease And Ischemic Heart Disease

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Abstract

Background: Heart disease in people with chronic obstructive pulmonary disease (COPD), in addition to pathological problems and death, can cause serious damage to social and economic status. Since the relationship between respiratory diseases and ischemic heart disease (IHD) has been sufficiently studied, but the study of the main clinical indicators related to COPD and IHD has been neglected.

Materials and methods: One hundred and seventeen patients were classified into 3 groups. The first group consisted of 42 patients with a combination of ischemic stable heart disease (chronic heart failure I - II FC) and COPD (GOLD 2-3). The second group included 40 patients with stable ischemic heart disease without concomitant COPD and the third group included 35 patients with COPD (GOLD 2-3) without ischemic heart disease. Patients were grouped according to age and duration of disease (5 to 14 years).

Results: The results of this study showed that patients with a combination of stable coronary artery disease and COPD recorded higher heart rate and shortness of breath than people with only stable ischemic heart disease. In addition, COPD showed a clinical picture with decreased volumetric spirographic parameters, a reliable increase in supraventricular extrasystole, and normally closed branch occlusion according to ECG data.

Conclusion: This study made it possible to show a very close relationship between COPD and IHD, which had intensifying reciprocal development mechanisms. In the future, this study will help develop guidelines for the correction, prognosis, and prevention of this associated pathology.

Keywords: Chronic obstructive Pulmonary disease, Coronary heart disease, Comorbidity, Clinical course, Shortness of breath, ECG.

La corrélation entre la maladie pulmonaire obstructive chronique et la cardiopathie ischémique

Résumé

Contexte: Les maladies cardiaques chez les personnes atteintes de maladie pulmonaire obstructive chronique (MPOC), en plus des problèmes pathologiques et de la mort, peuvent causer de graves dommages au statut social et économique. Depuis que la

relation entre les maladies respiratoires et les cardiopathies ischémiques (IHD) a été suffisamment étudiée, l'étude des principaux indicateurs cliniques liés à la BPCO et à l'IHD a été négligée.

Matériels et méthodes: Cent dix-sept patients ont été classés en 3 groupes. Le premier groupe était composé de 42 patients présentant une combinaison de cardiopathie ischémique stable (insuffisance cardiaque chronique I - II FC) et de BPCO (GOLD 2-3). Le deuxième groupe comprenait 40 patients atteints de cardiopathie ischémique stable sans BPCO concomitante et le troisième groupe comprenait 35 patients atteints de BPCO (GOLD 2-3) sans cardiopathie ischémique. Les patients ont été regroupés selon l'âge et la durée de la maladie (5 à 14 ans).

Résultats: Les résultats de cette étude ont montré que les patients atteints d'une combinaison de maladie coronarienne stable et de BPCO ont enregistré une fréquence cardiaque et un essoufflement plus élevés que les personnes atteintes uniquement d'une maladie cardiaque ischémique stable. De plus, la BPCO a montré un tableau clinique avec une diminution des paramètres spirographiques volumétriques, une augmentation fiable de l'extrasystole supraventriculaire et une occlusion de branche normalement fermée selon les données ECG.

Conclusion: Cette étude a permis de montrer une relation très étroite entre la BPCO et l'IHD, qui avait intensifié les mécanismes de développement réciproque. À l'avenir, cette étude aidera à développer des lignes directrices pour la correction, le pronostic et la prévention de cette pathologie associée.

Mots clés: Maladie pulmonaire obstructive chronique, Maladie coronarienne, Comorbidité, Évolution clinique, Essoufflement, ECG.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a disease that is more typical for patients over 40 years and is usually accompanied by concomitant diseases [1], which are the most common cause of death and disability due to lung disease [2, 3]. COPD is a broad classification of the group of diseases associated with chronic obstruction of the airflow inside or outside the lungs [4, 5]. Airway obstruction is a diffuse airway obstruction that increases airflow resistance [6]. Diseases such as chronic bronchitis [7], bronchiectasis [8], emphysema [9], and asthma [10] fall into the category of chronic obstructive pulmonary disease.

Analysis of data indicates a high frequency of the combination of IHD and COPD from 47.5% among patients with COPD to 61.7% among patients with IHD [11]. Attacks of chronic obstructive pulmonary disease are usually characterized by an increased shortness of breath and cough [12] and changes in the amount and type of sputum [13]. Attacks are the main reason for the admission of patients with chronic obstructive pulmonary disease in the hospital. Cardiac troponin (I) is used to detect myocardial necrotic disorders and has high sensitivity and specificity [14]. Numerous studies have shown cardiac troponin (I) as a marker of prognosis in patients [15]. Increased plasma levels of cardiac troponin (I), a highly specific marker for myocardial muscle [16], constitute the largest diagnostic criterion for myocardial necrosis [17].

Many researchers have focused their study on the relationship between chronic obstructive pulmonary disease (COPD) and ischemic heart disease (IHD) and have shown that these diseases are interrelated [18, 19, 20]. Various biological processes such as hypoxia [21], systemic inflammation [22], endothelial dysfunction [23], increased platelet reactivity [24], arterial stiffness [25], and right ventricular repair are involved in the development of COPD-IHD [26], so early diagnosis and treatment should be considered. Patients with COPD-IHD have the worst condition compared to

patients with COPD or IHD alone [27, 28]. These patients showed the risks of side effects and readmission to the hospital due to recurrent myocardial infarction [29], heart failure [30], coronary artery disease [31], and acute exacerbation of COPD [32], which significantly increase mortality [33]. In addition to common risk factors, various possible reasons for the interaction were discussed in the material, which is very important since the association of cardiovascular disease and COPD is associated with a poor prognosis. Concerning clinical symptoms, diagnosis of the predominant underlying disease and its contribution to COPD symptoms remains challenging. The situation is complicated by the fact that even when objective indicators of heart function are available, they do not necessarily correlate with the magnitude of symptoms. Moreover, cardiovascular disease was independently and often closely associated with all-cause mortality in patients with lung diseases [34, 35, 36].

Patients with chronic obstructive pulmonary disease (COPD) are more likely to develop cardiovascular disease [37]. About 30% of COPDs are due to cardiovascular disease [38]. Patients with COPD and acute ischemic heart disease (IHD) may have worse outcomes [39, 40]. Despite numerous studies on IHD-COPD, clinical course problems in patients with this pathology have not been adequately studied. The present analysis focuses on the contribution of cardiovascular disease to COPD symptoms and their relationship to the patient's diagnosis status and echocardiographic findings. This study aimed to determine the relationship between COPD and IHD according to the main clinical indicators.

2. Materials and Methods

A dynamic clinical and laboratory-instrumental examination of 117 patients aged between 53 and 75 years old (64.21±6.47 years) who were inpatient in the pulmonological and therapeutic departments of the OGBUZ “city hospital No.2 of Belgorod” was carried out. Three groups were identified among the examined: the first group (42 patients) consisted of patients with a combination of stable IHD (chronic heart failure I – II FC) and COPD; the second (40 patients) – patients with stable IHD without concomitant COPD; the third comparison group (35 patients) consisted of patients with COPD without IHD. Patients were grouped using age and disease duration (5 to 14 years). The diagnosis and severity of COPD were confirmed using spirometry under the recommendations of the global initiative for Chronic Obstructive Lung Disease (GOLD, 2019) [5]. At the time of hospitalization, all patients were in stable conditions, assessed by the absence of worsening symptoms, that is, no changes in the patient’s dyspnea, cough, and/ or sputum, other than the daily variability that was associated with treatment. The study included patients with stage I and II COPD, and stage II respiratory failure. All patients received regular treatment with inhaled bronchodilators and inhaled or non-inhaled steroids by current guidelines for a specific stage of the disease Global Initiative for Chronic Obstructive Lung Disease [41].

Among the examined patients, there were 72 men and 45 women, i.e. the majority were men (61.54%). During the study, the following information was collected from all patients and demographics, clinical manifestations, ongoing treatment, electro-methods, echocardiography, and spirometry were evaluated. Electrocardiography (ECG) determined the presence of right heart overload, rhythm disorders, left closed branch block (LBBB), right closed

branch block (RBBB). Echocardiographic data including left ventricular ejection fraction (LVEF) and diastolic dysfunction (DD) indices were identified. Echocardiographic data including left ventricular ejection fraction (LVEF) and diastolic dysfunction (DD) indices were recorded. The forced expiratory volume in the first second (FEV1), forced (expiratory) vital capacity (FVC), Tiffno's index (FEV1/FVC, %) were determined using spirometry. In addition, the Medical Research Council (mMRC) shortness of breath scale was determined and a COPD evaluation test (TOX) was performed. Data were processed by Statistica 6.0 software. The results were presented as M±SD, the mean range between quart (25 and 75 percent) and Med (per 25; at 75) was determined. Mean means of quantitative indices were compared using Kruskal-Wallis test and percentage comparison between groups was performed using $\chi 2$ test. Results were expressed at 5% probability level ($p < 0.05$).

3. Results

On initial examination, in patients with COP, the pulse was frequent, reaching 84.86±7.87 beats per minute. Also, in patients with comorbid pathology (83.28±7.65 beats per minute), a significant difference in the pulse rate of patients with IHD ($P<0.001$). Patients with COPD were also observed to have a higher RR compared to patients with IHD. It is typical for both groups with a combination of stable IHD and COPD (group 1) for patients with COPD without coronary artery disease (group 3) ($P<0.001$). There was no significant difference in blood pressure in patients with comorbidity. Patients with COPD, both in combination with IHD and without concomitant IHD, showed more pronounced dyspnea on the scale of dyspnea severity (SDS) mMRC (2.4±0.8) points in group 1, (2.2±0.1) points in group 3, while in group 2 the indicator was (1.7±0.12) points ($P<0.001$) (Fig.1).

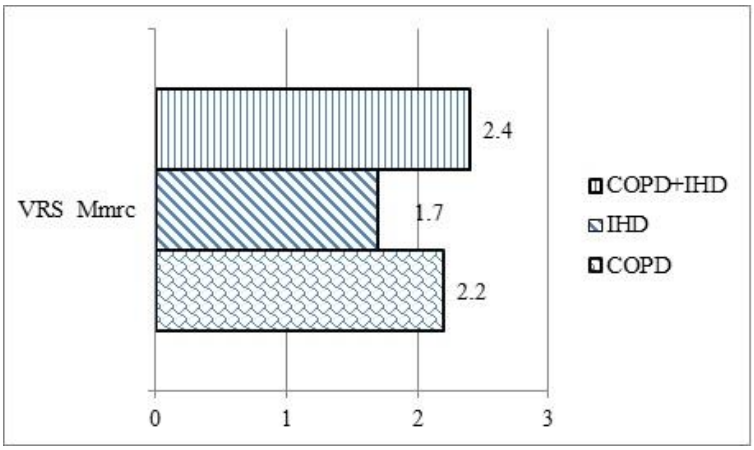

Fig. 1 Results of the questionnaire survey on the VRS (verbal rating scale) mMRC of various surveyed groups

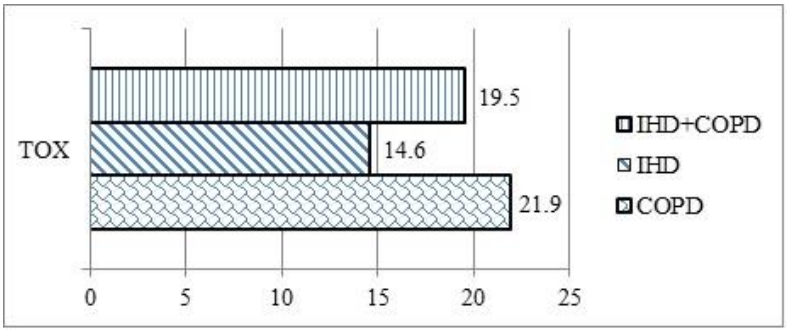

Fig. 2 Results of the questionnaire survey on TOX of various surveyed groups

The highest score on the COPD assessment test (TOX) was found in patients of group 1 with 19.5±2.3 points, while in group 2, it was 14.6±2.7 points (P<0.001) (Fig. 2). After recording a standard 12-lead ECG, signs of LV hypertrophy were present in all groups without a significant difference (Table 1).

Table 1. ECG indicators in patients with IHD, COPD and their combination

Indicators	Patients with IHD and COPD (group 1), n = 42	Patients with IHD (group 2), n = 40	Patients with COPD (group 3), n = 35	p_{1-2}	p_{1-3}	p_{2-3}
LV hypertrophy, abs., %	24 (57.14%)	24 (60%)	18 (51,43%)	0.651	0.763	0.448
RV hypertrophy. abs, %	1 (2.38%)	0 (0)	6 (7.14%)	0.326	0.109	0.028
RA hypertrophy, abs., %	8 (19.05%)	2 (5%)	10 (28.57%)	0.052	0.325	0,.005
SVE, abs., %	17 (40.48%)	3 (7.5%)	9 (25,71%)	0.003	0.173	0.032
PVC, abs., %	10 (23.81%)	6 (15%)	7 (20%)	0.314	0.688	0.568
AF, abs, %	9 (21.43%)	2 (5%)	5 (19.29%)	0.030	0.419	0.232
LBBB (incomplete), abs., %	4 (9.52%)	4 (10%)	1 (2.86%)	0.943	0.238	0.217
RBBB, abs., %	5 (11.9%)	1 (2.5%)	6 (17.14%)	0.103	0.514	0.030

Note: p_{1-2} is the difference between groups 1 and 2; p_{1-3} is the difference between groups 1 and 3, p_{2-3} is between groups 2 and 3. (LV – Left ventricle, RV – Right ventricle, RA – Right atrium, SVE – Supraventricular extrasystole, PVC – Premature ventricular contractions, AF – Atrial fibrillation, LBBB – Left bundle brunch block).

Note that, hypertrophy of the right chambers of the heart is rarely detected with a standard ECG. Signs of RV hypertrophy were often diagnosed among persons with COPD in 6 (7.14%) patients, while in the group of combined pathology in 1 (2.38%) patients (P=0.028). RA hypertrophy was found in 10 (28.57%) patients with COPD and 8 (19.05%) patients in the combined pathology group (P=0.0005). Right bundle branch block (RBBB) was more common in patients with COPD in the first group in 5 patients (11.9%), in the third group in 6 (17.14%), while among people with isolated IHD only in one (2.5%) patient (P_{1-2}=0.103, $P_{2-3=}$0.03). In patients with a combination of IHD and COPD, SVE (P_{1-2}=0.003, P_{1-3}=0.032) and episodes of AF (p_{1-3} = 0.030).

Comparative assessment of the parameters of the external respiratory function (ERF) did not reveal a probable difference between patients with a combination of IHD and COPD and those with COPD only (P>0.05). Accordingly, reliably high values of FEV1, FVC and the ratio of FEV1/FVC were determined in patients with IHD without concomitant COPD (P<0.001) (Table 2).

Table 2. Respiratory function parameters in patients with IHD, COPD and their comorbid course

Indicators	**Patients with IHD and COPD (group1), n = 42**	**Patients with IHD (group 2), n = 40**	**Patients with COPD (group 3) n = 35**	**p**
FEV1,%	61.5 ± 2.30 62 (60;63)	81.44 ± 4.00 81.5 (79;85)	57.55 ± 2.37 58 (56;59.5)	p_{1-2}<0.001 p_{1-3} > 0.05 p_{2-3}<0.001
FVC,%	74.97 ± 3.97 74.5 (72;76)	82.35 ± 3.87 82 (79.5;86)	72.06 ± 5.84 69 (67;78)	p_{1-2}<0.001 p_{1-3} > 0.05 p_{2-3}<0.001
FEV1/FVC,%	69.33 ± 4.07 68 (64;71)	79.25 ± 4.02 80 (75;82)	67.91 ± 3.04 67 (66;68)	p_{1-2}<0.001 p_{1-3} > 0.05 p_{2-3} < 0.001

Note: p_{1-2} is the difference in indicators between groups 1 and 2, p_{1-3} is between groups 1 and 3, and p $_{2-3}$ is between groups 2 and 3.

The decrease in volumetric spirometry parameters in groups 1 and 2 of patients confirms the presence of obstructive syndrome in patients of these groups.

Correlation relationships between the indicators of the first group showed a strong connection between the pulse of patients and the respiratory rate (r = 0.8), EED and FEV1(r = 0.7), EED and FEV1 / FVC, (r = 0.75). A medium relationship was between FP and TCO (r = 0.45), SVE and SMR mMRC (r = 0.5).

4. Discussion

The analysis showed that the spirometric indices that determine the severity of COPD were closely related to the indices that show cardiac activity. In patients with COPD with IHD, more severe dyspnea was observed on the scale of the severity of dyspnea, and right heart hypertrophy and atrial extrasystole were more common. For the other parameters, no significant differences were observed between the groups, which may indicate the overall pathogenic mechanism of development of the two pathologies.

This is confirmed by other studies, which found that shortness of breath, a common alarming symptom in people with chronic respiratory diseases, could be an indicator of the development of COPD, asthma, and IHD, and is associated with early mortality[42, 43, 44]. In patients with COPD, it is likely that exertional dyspnea, the most common symptom of both COPD and left ventricular failure. It is known to be mainly associated with respiratory disease, while does not consider cardiac causes in practice[45]. However, the risk and impact of heart failure in lung disease is particularly high and does not depend on the increased risk of IHD. Myocarditis, which occurs as a part of systemic inflammation in COPD, followed by interstitial myocardial fibrosis, leading to mechanical, electrical, and vasomotor myocardial dysfunction, is a widespread pathophysiological hypothesis[46, 47]. Myocardial damage (elevated troponin levels) is observed in chronic stable COPD, the magnitude of which is determined by the activation of the immune system[48, 49], and inflammatory biomarkers are independently associated with levels of natriuretic peptide[13]. Deshmukh K. et al.[50] discovered that patients with COPD and left ventricular diastolic dysfunction had significantly higher levels of circulating inflammatory and fibrotic biomarkers compared to patients with COPD without diastolic dysfunction and biomarkers of collagen remodeling are associated with increased mortality[51, 52]. However, the relationship between lung disease, inflammation, and heart failure is controversial, and mechanisms external to the myocardium such as decreased left ventricular preload due to pulmonary dysfunction, increased afterload due to arterial stiffness, and autonomic dysfunction has been proposed[53, 54, 55, 56].

The study showed that patients with a combination of COPD and stable IHD have a higher heart rate and more pronounced shortness of breath, in contrast to individuals with only stable IHD. In addition, COPD causes a decrease in volumetric spirographic parameters, reliably increases supraventricular extrasystole and blockade of the right bundle branch according to ECG data. Our study allowed us to prove a very close relationship between COPD and IHD, which have mutually aggravating mechanisms of development. In the future, this study will help to develop directions for correction, prognosis, and prevention of this comorbid pathology.

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