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Diffusion Lung Capacity of Patients with Arterial Hypertension

Diana Zelenika[1] and Nenad Karanović[2]

[1] Department of Internal Medicine, University Clinical Hospital Mostar, Mostar, Bosnia and Herzegovina
[2] Department of Anesthesiology, University Hospital Center Split, Split, Croatia

A B S T R A C T

The aim of this study was to investigate the diffusion lung capacity in patients with untreated hypertension. For this purpose, a total of 30 cases and 30 controls were included in the present study, which was based on several spirometry indicators in the analysis. The measurements were based on »single breath approach«. The results indicated that the two groups differed in several spirometry results, including vital capacity, maximum willing ventilation, but the overall lung diffusion capacity did not seem to be significantly different between cases and controls. The results suggest that although there is a strong link between respiratory and circulatory system, the overall lung diffusion capacity is not altered by the increased arterial pressure and hypertension. Furthermore, the results of this suggest the need for creation of the population-specific spirometry standards for the population of Herzegovina in order to provide more meaningful results of spirometry.

Key words: *lung, spirometry, arterial hypertension, diffusion capacity, standards, Herzegovina*

Introduction

Arterial hypertension is defined as the increased level of systolic and/or diastolic blood pressure. The main consequence of this situation is increased minute volume or peripheral resistance, both leading to increased workload[1]. However, the physiological mechanism associated with these changes is by far more complicated and it is governed by a multitude of other factors, including cardiac work, vascular system characteristics, total blood volume and blood viscosity[2]. This system is governed by four basic mechanisms – nervous, voluminous, humoral and adrenal, all being involved in the complex pathways, what is important for understanding of the disorders in the blood pressure determination[3,4].

Epidemiological and intervention studies suggest that there is no natural cut-off point at which hypertension can be diagnosed[5,6], and that each cut-off point should be individually defined[5]. Currently, formal hypertension cut-off point is considered as the systolic blood pressure of up to 17.2 kP (120 mmHg), while diastolic cut-off is 11.3 kP (85 mmHg), leading to the conclusion that hypertension is diagnosed when either of these two pressures crosses the cut-off point[5,6].

However, the measurement of the blood pressure should reside in a highly control measurement protocol, with diagnosis of hypertension being made only if three consecutive increased values of blood pressure are recorded in at least two separate measurements[7]. After this, a careful physical examination should establish the predominant patter of the blood pressure changes, diagnosis essential or secondary hypertension, whether there are other organs affected, or are there other risk factors that may aggravate hypertension[6]. Suggested laboratory tests include glucose, total cholesterol, HDL, triglycerides, uric acid, creatinine, sodium, potassium, hemoglobin, haematocrit, urine dip-test and ECG (occasionally postprandial glucose or oral glucose tolerance test should be performed if the initial glucose values are elevated)[8,9]. In addition, it should also be noted that various phenomena within lungs can also affect blood pressure, in several ways.

The aim of this study was to measure the total diffusion capacity of the lungs in patients with arterial hypertension.

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Patients and Methods

A total of 30 patients with untreated arterial hypertension were included in the current study. All patients were men, aged 30–55 years. Exclusion criteria were secondary hypertension, pulmonary diseases, cardiac defects, arrhythmia, conduction problems, ischemic heart disease and those whose functional capacity was NYHA III-IV. Additionally, smokers were also excluded. The control group consisted of the same number of respondents without indication of arterial hypertension. The study was performed during May 2007-March 2009, at the Sports Medicine Center Diomed in Split, Croatia.

All patients underwent spirometry measurement, according to the American Thoracic Society protocol[10]. The measurement included vital capacity (VC), forced vital capacity (FVC), forces expiratory volume in one second (FEV1), Tiffeneaun index (the ratio of FEV1/FVC), maximum willing ventilation (MWV), maximum expiratory flow at 50% FVC (MEF50) and forced expiratory flow at 25% FVC (MEF25), presenting the flow-volume curve[11].

The diffusion lung capacity was measured using »single breath« approach, with carbon monoxide emission using Cosmed 4. The patient initially exhales to reach the residual volume, and then quickly inhales the test mixture (0.2–0.3% CO, 10–14% He, 18–21% O2, the rest N2). After the inhalation, at least 90% of the vital capacity should be retained and the respiratory muscles relaxed. This inhibits negative thoracic pressure which could affect the results. Ten seconds after apnea patients are asked to exhale quickly. The first 600–800 ml is collected into a bag for the analysis. The analysis includes CO and He concentration, and is repeated five minutes after the initial procedures[12]. The results depend on several parameters, such as age, height and gender[13].

Statistical analysis included t-test for two numerical groups with normal data distribution. The significance was set at $p<0.05$.

Results

A total of 30 cases and 30 controls were included in the present study. The initial analysis suggested some differences in terms of the basic characteristics (Table 1). Similarly, significant differences were seen in some lung indicators. The average VC of cases was 80.66±5.82, while in controls the average values for the same parameter was 97.00±8.17 (t=8.91; p<0.001). The average FEV1 in cases was 70.53±4.99 %, while in controls it was 86.83±7.17 % (t=10.21; p<0.001). Similar differences were recorded for other indicators (Table 2).

TABLE 1
CLINICAL CHARACTERISTICS OF THE INCLUDED PATIENTS AND CONTROLS

Variable	Mean and standard deviation		t	p
	Cases	Controls		
Age	54.0±7.2	59.0±19.4	1.30	<0.201
Height	178.46±5.11	182.36±7.28	2.40	0.020
Weight	96.6±19.8	83.9±11.9	3.00	<0.004
Body mass index	31.5±4.0	26.4±2.8	5.72	<0.001

TABLE 2
SPIROMETRY RESULTS, DIFFUSION CAPACITY AND OTHER LUNG INDICATORS OF THE CASES AND CONTROLS

Variable	Mean and standard deviation		t	p
	Cases	Controls		
VC	80.6±5.8	97.0±8.1	8.91	<0.001
FEV1	70.5±4.9	86.8±7.1	10.21	<0.001
MWV	79.6±8.8	98.8±11.2	7.35	<0.001
DLCO	93.5±8.4	93.6±6.4	0.05	0.959
KCO	77.5±7.4	88.7±5.2	6.75	<0.001

Discussion

The results of this study show that some lung parameters change in patients with hypertension. This is primarily related to various functional lung capacity indicators. The lung diffusion capacity may be used as one of the basic diagnostic tools in the cardio-respiratory system evaluation. Although some of these indicators may have limited meaning, they nevertheless provide unique insight into the mechanisms leading to the affected lung function[14].

The efficacy of the gas exchange in the lungs depends on a number of potential factors, such as thickness and the total surface of the alveolar membrane, volume of the blood in these capillaries, hemoglobin concentration and the affinity towards carbon monoxide and the ventilation-perfusion ratio, it becomes obvious that there is a myriad of possible conditions which may affect it[15,16].

In terms of this study, it should be noted that the cases and controls differed in the weight and body mass index, but neither of these two characteristics is likely to affect the functional diagnostics of the lung as well as the diffusion capacity[10]. Additionally, the Cotes correction was planned (which is usually used to adjusts the findings in cases of polycytemia, and hemoglobin)[17]. However, neither of the patients was required to undergo this correction. Also, we did not need to adjust for the carboxyhemoglobin concentration, as neither of the patients required such a correction.

It might seem that the spirometry has limited value in hypertension diagnostics. However, it is a diagnostic tool for the lung capacity, which is linked to the arterial hypertension. Yet, the main value of spirometry is associated with lung function, and the results should be adjusted for age, height and gender[13].

The results of spirometry were within suggested ranges in most patients. However, we did record a significant difference in VC between cases and controls, as well as

the FEV1 and MWV. This could be associated with the wide tolerance of the normal spirometry range. While the lower limit is 80% of the standard values, this might not be treated as the referent range for any population, and in this case it might suggest that it does not provide a good reference range for the population of Herzegovina which is likely to have greater average values for most parameters. Additionally, the range also seems to wide, 40% of standard value. The main conclusion of this line of research is that the population in Herzegovina is different from the expected norm and that the future studies should focus on creation of the population-specific spirometry standards.

The results show that the diffusion capacity in both cases and controls was close to 94% of standard values, suggesting that there was no significant difference between these groups. This suggests that the diffusion capacity of the lung remains stable even in the cases of untreated hypertension[18].

The shortcomings of this study include the low number of patients and controls, the possibility that other mechanisms may be in place and the possibility that there are different clinical and histological types of diseases under study, which might have different implications on results due to possible various mechanisms that lead to the diseases development. However, this study presents almost a pioneering attempt to understand the link between the lung diffusion capacity and arterial hypertension. The main conclusion is the need to create the population-specific spirometry range curves, aiming to provide more precise and more informative estimates for the lung indicators in the population of Herzegovina.

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D. Zelenika

Department of Internal Medicine, University Clinical Hospital Mostar, Bijeli brijeg bb, 88000 Mostar, Bosnia and Herzegovina
e-mail: diana.zelenika@gmail.com

DIFUZIJSKI KAPACITET PLUĆA KOD PACIJENATA S HIPERTENZIJOM

SAŽETAK

Cilj ovog rada bio je istražiti povezanost između difuzijskog kapaciteta pluća i arterijske hipertenzije. U tu svrhu prikupljeni su podaci 30 pacijenata sa neliječenom hipertenzijom i 30 kontrola, kojima je urađena spirometrija kao glavni pokazatelj funkcionalne sposobnosti pluća. Mjerenja su se zasnivala na metodi jednog udaha. Rezultati pokazuju da su postojale statistički značajne razlike u nekim rezultatima spirometrije, uključujući vitalni kapacitet, najveću voljnu ventilaciju, ali da ukupan difuzijski potencijal pluća nije bio umanjen kod pacijenata s neliječenom hipertenzijom. Unatoč snažnoj povezanosti plućnog i krvožilnog sustava, difuzijski kapacitet nije umanjen kod pacijenata sa hipertenzijom. Dodatan rezultat ovog rada je ukazivanje na potrebu izrade spirometrijskih normi za populaciju Hercegovine.