ORIGINAL ARTICLE

Functional Respiratory Disorders in Arterial Hypertension

OLEG MICHAILOVICH URYASEV, ALEXANDRA VICTOROVNA SOLOVIEVA, SERGEY IVANOVICH GLOTOV, LIDIA ANATOLEVNA ZHUKOVA, VADIM ANATOLEVICH LUNYAKOV, ELENA ANATOLEVNA ALEKSEEVA
Therapy Department, Ryazan State Medical University, Vysokovoltnaya str., 9, Ryazan, Russian Federation.
Correspondence to Sergey Ivanovich Glotov, Email: sergeyglot@mail.ru, +7 910-507-73-10, Vysokovoltnaya str., 9, Ryazan, Russian Federation

ABSTRACT

Aim: To study the features and causes of dyspnea in patients with arterial hypertension (AH).
Methods: A total of 112 hypertensive patients aged 35 to 68 years were examined, including 45 with stage I AH, and 67 with stage II. Patients noted dyspnea that did not correspond to the severity of morphofunctional changes in the respiratory and cardiovascular systems. ECG, chest X-ray, ECHO-cardiography, spirometry, analysis of gas and acid-base state of blood, capnography were performed. The severity of dyspnea was assessed using the Borg scale and visual analogue scale (VAS). To identify hypocapnic conditions, the degree of their severity, we used a questionnaire from the Department of Pulmonology, Nijmegen University.
Results: In 63 patients with hypertension (46 patients with stage I, 17 with stage II) hypocapnic type of ventilation was noted. The severity of dyspnea reached 6-7 points on the Borg scale and VAS. The hypercapnic type of respiratory disorders was diagnosed in 22 patients with hypertension. Instability of ventilation types was noted in 7 patients with stage II hypertension, and in 4 patients with stage I hypertension and 16 patients with stage II hypertension, normocapnic type of ventilation with respiratory arrhythmias was noted.
Conclusion: In AH stages I and II, there may be functional breathing disorders, which can be objectified by capnographic investigation. The questionnaire of the Department of Pulmonology of the University of Nijmegen (Holland) allows to identify hypocapnic conditions and determine their severity.
Keywords: Arterial hypertension, hyperventilation syndrome, dyspnea.

INTRODUCTION

Shortness of breath (dyspnea) is the most difficult problem in clinical medicine. The dictionary of medical terms gives the following definition: "shortness of breath is a violation of the rhythm, depth of breathing or increased work of the respiratory muscles, manifested, as a rule, by a subjective feeling of lack of air or difficulty in breathing".

In English-language literature, the term dyspnea is often used; sometimes other definitions are used - difficult breathing; uncomfortable breathing, etc. This terminological heterogeneity testifies to the clinical diversity of shortness of breath syndrome and the complexity of the underlying pathophysiological mechanisms.

G.F. Lang singled out subjective dyspnea, which is accompanied by a feeling of lack of air and objective, with a change in the nature of ventilation, and this dyspnea may not be accompanied by a feeling of lack of air[1]. A significant contribution to the clinical interpretation of dyspnea was made by Russian scientists: B.E. Votchal, A.G. Dembo, Yu.A. Andrianov, V.G. Boksha, I.S. Breslav[2], R.S. Vinnitskaya, M.I. Masuev[3], M.E. Marshak, N.A. Magazannik, V.A. Safonov, L.A. Shik, A.G. Chuchalin and others.

In the 80-90s of the 20th century, a new direction began to develop - dyspnea in hyperventilation syndrome (HVS). The founders of the theory of hot water supply were V.N. Abrosimov[4,5,6], N.N. Averko[7], S.I. Ovcharenko[8,9], Yu. Yu. Byalovsky[10], L.P. Malmberg[11] and others. The previously unused terms received the right to exist: “unknown dyspnea”, “clinically unexplained dyspnea” - clinically incomprehensible, unexplained, disproportionate dyspnea[12,13].

As we deepen into the pathophysiological mechanisms of dyspnea, the problem appears to be more and more complex, especially within the framework of its various variants. There is a variety of changes in the breathing pattern in HVS. Breathing can be manifested by rapid, arrhythmic, shallow breaths (gasps), a predominance of the chest type. In the presence of hyperresponsiveness of the bronchi in the HVS structure, a pattern of “fragile” breathing with a feeling of irregularity of respiratory movements is revealed. In cases where the phenomena of ventilation insufficiency are traced according to the restrictive type, the phenomenon of "heavy breathing" appears. In some patients, in conditions of increased bronchial patency, the already disturbed ventilation-perfusion ratios may increase, mainly due to an increase in the “dead” space - the “empty” breathing pattern[8,9].

Approximately every fifth patient with arterial hypertension (AH) complains of dyspnea. Dyspnea in this contingent is distinguished by clinical and pathophysiological diversity. Quite often, dyspnea syndrome occurs due to the development of heart failure in hypertension against the background of "hypertensive" remodeling of the heart, symmetric or asymmetric hypertrophy of its parts, degenerative restructuring of valve structures with the formation of valvular regurgitation, diastolic and / or systolic dysfunction; in some patients due to the development of secondary pulmonary hypertension (passive venous). Among the possible variants of respiratory disorders in patients with hypertension, the development of hypopnea / sleep apnea syndrome is quite frequent. A number of researchers note that dyspnea is more pronounced, the more frequent and prolonged periods of apnea and hypopnea are in patients with hypertension[14\]. Some features in the morphology of arterial chemoreceptors in patients with hypertension were revealed, in particular, enlarged carotid bodies, hyalinosis of the walls of small arterial vessels. It is assumed that

hypertension leads to a reduction in blood flow in the chemoreceptive tissue and ischemic stimulation of arterial chemoreceptors, which causes a lower threshold of excitation of arterial chemoreceptors[15,16].

In the mechanisms of dyspnea in patients with AH, disturbances in the respiratory regulation system are of certain importance. So, M. Mattes, among the various forms of respiratory disorders, singled out dyspnea, "which is especially common in hypertensive patients and which must be separated from the usual shortness of breath, which is characteristic of every circulatory failure"[17]. Myasnikov A.L. referred to the opinion of Staub[18], who suggested that "the brain integrates peripheral impulses, as a result of which a normal or pathological vascular reaction is created". The cause of shortness of breath in patients with hypertension lies in local circulatory disorders in the area of the respiratory center. "Cerebral asthma of hypertensive patients" - asthma attacks occurring without symptoms of left ventricular failure.

One of the most common variants of dyspnea syndrome in patients with hypertension is HVS. According to V.V. Shchekotov et al. (2011) HVS frequency in hypertension is 83%; HVS structure is heterogeneous - explicit ("positive"), stable, labile. Hyperventilation and endothelial dysfunction are associated in hypertensive patients. Endothelial dysfunction in his studies was verified by determining the number of desquamated endothelial cells in plasma by the method of Hladoveck (1978), by assessing the activity of von Willebrand factor. Compression test on the Puls Wade complex demonstrates the functional state of the endothelium[19,20].

METHODS

The work was carried out for 5 years (from 2014 to 2018) at the bases of the Department of Therapy of Ryazan state medical university. Patients with AH were examined in whom the main complaint was dyspnea. Dyspnea did not match the severity of the cardiovascular lesions. We examined 112 patients with hypertension with dyspnea syndrome at the age of 35 to 68 years, of which 45 with stage I hypertension (20 men and 25 women); Stage II - 67 (26 men and 41 women). The average age of the patients was 45.8 ± 4.7 years.

The study did not include patients with stage III hypertension, resistant hypertensive syndrome, patients with symptomatic hypertension, patients with respiratory failure of various origins, a combination of hypertension with any pathology of the bronchopulmonary system, ischemic heart disease, obesity (BMI ≥ 30 kg / m^2), diabetes mellitus, chronic renal failure and liver failure, severe neurological pathology, with sleep apnea / hypopnea, as well as severe mental pathology.

The peculiarity of the patients was that in addition to complaints typical for hypertension, the patients noted dyspnea, the severity of which did not correspond to the degree of functional changes in the cardiovascular system. In 75% of cases, dyspnea was interpreted by patients as a feeling of lack of air, shortness of breath, impossibility of full inhalation, exhalation, in 25% of cases - a feeling of obstruction in the chest, heaviness in the chest. The duration of the onset of shortness of breath was on average 3.5 years from the date of diagnosis of the disease.

In addition to the standard clinical study, instrumental study in accordance with the accepted standards of examination of the cardiovascular and respiratory systems, all patients underwent a mandatory capnographic study (gas analyzer "Normocap - 200 - OXY", Datex, Finland)[10].

Capnogram recording was carried out with calm breathing of the patient, while the partial tension of carbon dioxide in the alveolar air ($PACO_2$) was determined and a qualitative assessment of the curve architectonics was carried out. The test with voluntary hyperventilation was performed in the supine position. The patient breathed as deeply and frequently as possible for one minute. During a one-minute hyperventilation test and a 5-minute recovery period, a capnogram was continuously recorded using a capnograph. The stress tests were performed in the morning in an emergency room equipped with medication. The following indicators were calculated: PCO_2 and the number of respiratory movements initially, at the end of the test, at the 1st, 3rd, 5th minutes of the recovery period, the ratio of the initial level of PCO_2 to the level of PCO_2 at the 3rd and 5th minutes of the recovery period[21].

The severity of dyspnea was assessed using the visual analogue scale (VAS) and the Borg scale[6]. To identify hypocapnic (hyperventilation) conditions and severity, the Nijmegen University questionnaire was used by the questionnaire method with an assessment of symptoms on a 4-point scale[7].

Statistical analysis of the obtained data was carried out using the application package Statistica 10.0. The arithmetic mean (M), the error of the arithmetic mean (m). Differences were considered statistically significant at $p<0.05$.

RESULTS AND DISCUSSION

Ultrasound examination of the heart in patients with hypertension stage I did not reveal any pathology. In patients with stage II hypertension, there was a significant increase in the end-diastolic and end-systolic size of the left ventricle with preserved global contractility ($p <0.05$).

When studying the function of external respiration in patients with hypertension, deviations of spirographic parameters from the proper values were not observed. In 6 patients with hypertension (with a clinical picture of HVS), there were moderate deviations from the proper values of spirometric parameters ($p <0.05$). According to some authors, hyperventilation can lead to a decrease in pulmonary functional tests - a "false result"[8,9]. Indicators of gas composition (PaO_2 and $PaCO_2$) and acid-base state of arterial blood did not deviate from normal values.

The study of CO_2 exchange and parameters of respiration regulation demonstrated the presence of various changes in the $PACO_2$ content in the exhaled alveolar air in the group of examined patients. Was identified hypocapnic, hypercapnic, normocapnic type of ventilation with respiratory arrhythmias.

It was found that 63 hypertensive patients (46 patients with stage I, 17 - with stage II) with hypocapnic type of ventilation (the content of PCO_2 in exhaled air less than 30 mm Hg) had dyspnea, characterized by patients as a

"feeling of lack of air", "respiratory discomfort", "tightness in the chest", "congestion and a feeling of obstruction in the chest", frequent "dreary sighs" (gasps). The severity of dyspnea reached 6-7 points on the Borg scale and VAS.

The hypercapnic type of respiratory disorders (high content of $PACO_2$ in the exhaled air over 45 mm Hg) was diagnosed in 22 patients with hypertension. These patients characterized dyspnea as "dissatisfaction with breathing," "lack of air," the need for deep breaths, after which relief was noted. There was no association between dyspnea and exercise.

In 7 patients with stage II hypertension, there was an instability of the types of ventilation at different points of the study, and in 4 patients with stage I hypertension and 16 patients with stage II hypertension, normocapnic type of ventilation with respiratory arrhythmias on the capnogram was noted. The pathological types of capnographic curves in patients with hypertension are shown in Figures 1-3.

Figure 1. Hypocapnic type of ventilation (in hyperventilation syndrome)

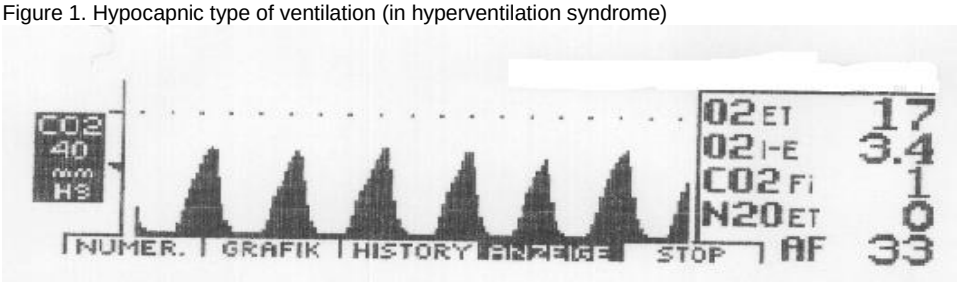

Figure 2. Hypercapnic type of ventilation

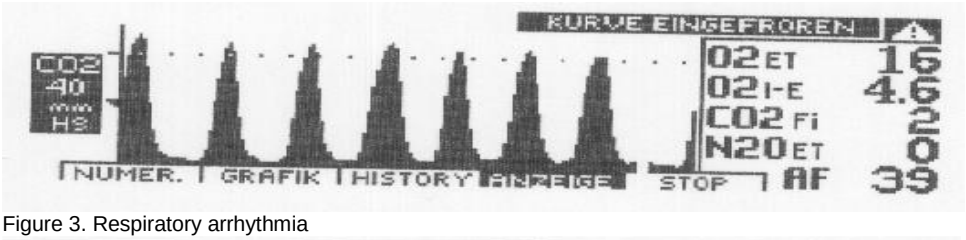

Figure 3. Respiratory arrhythmia

In 22 hypertensive patients with a hypocapnic type of ventilation, using a psychological questionnaire, hyperventilation syndrome of mild or moderate severity (25-38 points) was determined. Severe hyperventilation syndrome was diagnosed in 6 patients with hypertension with dyspnea syndrome (56-58 points). The PCO_2 values recorded by capnography directly correlated with the estimated severity of the hypocapnic state (PCO_2 30 mm Hg and below). The diagnostic significance of the psychophysiological test questionnaire in identifying hypocapnic conditions, taking into account capnographic data, was 70-80%.

CONCLUSION

In some patients with arterial hypertension stages I and II, dyspnea was noted as a manifestation of functional respiratory dysfunction. Its objectification was carried out using capnography and, in some cases, tests with voluntary hyperventilation[10]. Most often (55% of the examined) dyspnea was combined with hypocapnic type of ventilation and clinical manifestations of hyperventilation syndrome. However, 18% of hypercapnic patients and 16% of those with normal partial tension of $PACO_2$ in the alveolar air also had manifestations of dysfunctional breathing. In all 3 groups, respiratory arrhythmia was often noted.

The data obtained make it possible to consider a combination of hyperventilation syndrome manifestations (confirmed by capnography) with an unclear, unexplained dyspnea rather frequent. Capnography is a valuable diagnostic and differential diagnostic tool in patients with unclear and unexplained dyspnea.

The psychological questionnaire of the Department of Pulmonology at the University of Nijmegen (Holland) allows us to identify hypocapnic conditions and determine their severity. In a certain number of patients, dyspnea is caused by complex mechanisms of dysregulation of ventilation control against the background of cortical, sympathoadrenal and hypothalamic dysfunction, as evidenced by such factors as instability of the breathing

pattern, high frequency of detection of the hypocapnic type of ventilation. Undoubtedly, the presence of hyperventilation syndrome provokes increases in blood pressure, disrupts the quality of life and the treatment of these patients requires not only, and sometimes even not so much antihypertensive therapy, as hyperventilation syndrome correction with the inclusion of psychotropic drugs and respiratory gymnastics in the treatment regimens.

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