

DYNAMICS OF BLOOD PRESSURE AND HEART RATE VARIABILITY PARAMETERS DURING BIOFEEDBACK IN LOOP OF HEART RATE VARIABILITY AND PACED BREATHING IN PATIENTS WITH DIFFICULT-TO-CONTROL ARTERIAL HYPERTENSION ON THE BACKGROUND OF DRUG

Tymoshenko O. S., Yabluchansky M. I.

V. N. Karazin Kharkiv National University, Kharkiv, Ukraine

60 patients with difficult-to-control arterial hypertension (DTCAH) were examined (average age is 59.0 ± 9.4 years). The changes in blood pressure (BP) and parameters of heart rate variability (HRV) during biofeedback sessions (BFB) in loop of paced breathing (PB) in patients with DTCAH on the background of standard drug therapy were assessed. It has been established that the systematic sessions of BFB in loop of PB in patients with DTCAH allow to increase the total power of the HRV spectrum, VLF and HF, and also improve control of BP. BFB in loop of PB can be recommended as an adjunctive method to the standard drug therapy for patients with DTCAH.

KEY WORDS: biofeedback, heart rate variability, difficult-to-control hypertension

ДИНАМІКА АРТЕРІАЛЬНОГО ТИСКУ ТА ПАРАМЕТРІВ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ ПРИ ПРОВЕДЕННІ СЕАНСІВ БІОЛОГІЧНОГО ЗВОРОТНОГО ЗВ'ЯЗКУ З КОНТУРОМ МЕТРОНОМІЗОВАНОГО ДИХАННЯ У ХВОРИХ НА ВАЖКОКОНТРОЛЬОВАНУ АРТЕРІАЛЬНУ ГІПЕРТЕНЗІЮ НА ТЛІ МЕДИКАМЕНТОЗНОЇ ТЕРАПІЇ

Тимошенко О. С., Яблучанський М. І.

Харківський національний університет імені В. Н. Каразіна, м. Харків, Україна

Обстежено 60 пацієнтів з важкоконтрольованою артеріальною гіпертензією (ВАГ) (середній вік $59,0 \pm 9,4$ років). Були оцінені зміни артеріального тиску (АТ) і параметрів варіабельності серцевого ритму (ВСР) при проведенні сеансів біологічного зворотного зв'язку (БЗЗ) з контуром метрономізованого дихання (МД) у пацієнтів з ВАГ на тлі стандартної медикаментозної терапії. Встановлено, що систематичне проведення сеансів БЗЗ в контурі МД у пацієнтів з ВАГ дозволяє збільшити загальну потужність спектра ВСР, показників VLF і HF, а також покращує контроль АТ. Сеанси БЗЗ в контурі МД можуть бути рекомендовані в якості доповнення до стандартної медикаментозної терапії пацієнтам з ВАГ.

КЛЮЧОВІ СЛОВА: біологічний зворотний зв'язок, варіабельність серцевого ритму, важкоконтрольована артеріальна гіпертензія

ДИНАМИКА АРТЕРИАЛЬНОГО ДАВЛЕНИЯ И ПАРАМЕТРОВ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА ПРИ ПРОВЕДЕНИИ СЕАНСОВ БИОЛОГИЧЕСКОЙ ОБРАТНОЙ СВЯЗИ С КОНТУРОМ МЕТРОНОМИЗИРОВАННОГО ДЫХАНИЯ У ПАЦИЕНТОВ С ТРУДНОКОНТРОЛИРУЕМОЙ АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ НА ФОНЕ МЕДИКАМЕНТОЗНОЙ ТЕРАПИИ

Тимошенко Е. С., Яблучанский Н. И.

Харьковский национальный университет имени В. Н. Каразина, г. Харьков, Украина

Обследовано 60 пациентов с трудноконтролируемой артериальной гипертензией (ТАГ) (средний возраст $59,0 \pm 9,4$ лет). Были оценены изменения артериального давления (АД) и параметров вариабельности сердечного ритма (ВСР) при проведении сеансов биологической обратной связи (БОС) с контуром метрономизированного дыхания (МД) у пациентов с ТАГ на фоне стандартной медикаментозной терапии. Установлено, что систематическое проведение сеансов БОС в контуре МД

у пациентов с ТАГ позволяет увеличить общую мощность спектра ВСП, показателей VLF и HF, а также улучшает контроль АД. Сеансы БОС в контуре МД могут быть рекомендованы в качестве дополнения к стандартной медикаментозной терапии пациентам с ТАГ.

КЛЮЧЕВЫЕ СЛОВА: биологическая обратная связь, вариабельность сердечного ритма, трудноконтролируемая артериальная гипертензия

INTRODUCTION

The inability to achieve the target level of blood pressure (BP) using three- and more-component drug therapy characterizes the difficult-to-control arterial hypertension (DTCAH). The prevalence of DTCAH in the population of people with arterial hypertension (AH) is from 15 to 30 % [1]. And the incidence of true refractory hypertension reaches 30 % of the total number of patients with DTCAH [2]. An insufficient effect of drug therapy is a prerequisite for finding additional, non-pharmacological methods of treatment. One of such methods is biofeedback (BFB) in loop of heart rate variability and paced breathing (PB).

Data from clinical trials demonstrate the efficacy of BFB in loop of heart rate variability (HRV) and PB for the treatment of patients with AH [3]. Systematic sessions of BFB in loop of HRV and PB affect the balance of the sympathetic and parasympathetic components of the autonomic nervous system [4]. Accordingly, the method influences BP and helps in achieving its control. However, in patients with DTCAH, the effectiveness of the method was not studied. It seems interesting to assess the response of BP and HRV parameters in patients with DTCAH on the background of drug support.

OBJECTIVE

Assessment of changes in BP and parameters of HRV during sessions of BFB in loop of HRV and PB in patients with DTCAH on the background of standard drug therapy.

MATERIALS AND METHODS

On the clinical base of the Kharkov city outpatient clinic № 24 and the State Institution «Kharkov Clinical Hospital for Railway Transport № 1» 60 patients with DTCAH were examined. The study involved 32 men and 28 women. Average age $59 \pm 9,4$ years. All patients participating in the study were randomly divided into two subgroups: BFB group with PB (33 patients) – main subgroup, comparison subgroup (27 patients).

The criterion of DTCAH was the presence of a persistent increase in BP above the target level, despite the simultaneous use of three or more antihypertensive drugs of various classes in adequate therapeutic doses, including a diuretic.

Exclusion criteria were heart failure functional class IV, acute coronary syndrome, rhythm and conduction disorders, diabetes mellitus, chronic respiratory insufficiency, bronchial asthma, chronic obstructive pulmonary diseases, peptic ulcer and duodenal ulcer at the stage of exacerbation, systemic diseases of connective tissue, tumors.

BP was measured by the Korotkov method with the tonometer Little doctor LD-91 in the sitting position after 15-minute rest.

The BFB was held in a sitting position after a 15-minute rest using a computer system CardioLab 2009 («HAI-Medica», Ukraine) with the «Biofeedback» module. The calculation of HRV parameters was carried out in real time within the 7-minute session.

The following parameters of HRV were determined in all subjects in 5-minute intervals to assess the state of regulatory systems [5]:

- TP – total power of the spectrum, a measure of the power of the effects of neurohumoral reactions (ms²);
- VLF – the power of the very low-frequency spectrum is associated with thermoregulation, renin-angiotensin system and sympathetic nervous system (ms²);
- LF – the power of the low-frequency spectrum is associated mainly with the sympathetic and partially parasympathetic links of regulation (ms²);
- HF – the power of the high-frequency domain of the spectrum is associated mainly with the parasympathetic regulating unit (ms²).

Accordingly with the purpose of the study, all patients were divided into two subgroups: basic (with BFB and PB) and a subgroup of comparison. For patients in the main subgroup, the breathing rate was set by the Biofeedback program module under the control of HRV parameters using the algorithm for finding the

optimal frequency of PB at the start with free breathing, while for patients of the comparison subgroup BFB sessions were simulated with respiratory rate equal to the free breathing frequency.

All patients received the same therapy in accordance with the recommendations on the prevention and treatment of AH of the Ukrainian and European associations of cardiologists [6]. Given the severity of hypertension, the presence of target organ damage and concomitant pathology, the following combinations of antihypertensive drugs were prescribed:

– Angiotensin-converting enzyme (ACE) inhibitor / renin-angiotensin-aldosterone blocker (RAAB) + calcium channel blocker (CCB) + diuretic.

– ACE inhibitor / blocker RAAB + CCB + diuretic + mineralocorticoid antagonist.

– Beta-adrenoblockers + ACE inhibitor / blocker RAAB + CCB + diuretic.

– ACE inhibitor / blocker RAAB + CCB + diuretic + antihypertensive drug with central action.

Statistical analysis was performed by using Microsoft Excel. In the table were recorded average values (M) and standard deviations (sd) of TP, VLF, LF, HF in patients with BFB in loop of heart rate variability and PB and in patients of comparison subgroup. The significance of differences of each of the indexes was determined by using the Student's t-test for unrelated samples.

RESULTS AND DISCUSSION

Changes in BP in patients with DTCAH in the subgroup with BFB in loop of PB and in the comparison subgroup are presented in Table 1.

Table 1

Changes in blood pressure in subgroups of patients with DTCAH during treatment (M ± sd, mm Hg)

BP indexes	Subgroups of patients							
	Main subgroup				Comparison subgroup			
	Phases of research							
	Before treatment	3 month	6 month	1 year	Before treatment	3 month	6 month	1 year
SBP (M ± sd, mm Hg)	181 ± 20,8*	176 ± 15,7*	155 ± 10,7	149 ± 6,2	180 ± 18,9	179 ± 21,5**	168 ± 17,2**	157 ± 7,9
DBP (M ± sd, mm Hg)	101 ± 12,2	95 ± 8,5#	92 ± 6,9#	88 ± 3,1	102 ± 13,2	96 ± 8,2	94 ± 7,4	95 ± 4,9

Note: * – $P < 0.05$ in the series against the initial values; ** – $P < 0.05$ between series at the current stage; # – $P < 0.05$ in the series against the previous stage.

Antihypertensive therapy in combination with BFB in loop of PB showed more significant decrease in BP in patients with DTCAH than in patients with BFB without PB. After a three-month treatment in patients of subgroups with BFB in loop of PB SBP decreased by 1.02 times, DBP - by 1.06 times. At the stage of half-yearly treatment the dynamics of BP was looked as follows: SBP decreased by 1.2 times, DBP – by 1.1 times. The results of one-year follow-up showed that

SBP decreased by 1.2 times, DBP – by 1.14 times.

After a three-month stage of therapy the SBP in the comparison group decreased by 1.005 times, DBP – by 1.06 times. After half a year the SBP decreased by 1.07 times, DBP - by 1.08 times. At the annual stage SBP decreased by 1.1 times, DBP – by 1.07 times.

Table 2 shows the parameters of HRV in the subgroup of patients with BFB in loop of PB and in the comparison subgroup.

Table 2

**Change in HRV parameters in subgroups of patients with BFB in loop of PB
and in the comparison subgroup (M ± sd, ms²)**

HRV indexes	Subgroups of patients							
	Main subgroup				Comparison subgroup			
	Phases of research							
	Before treatment	3 month	6 month	1 year	Before treatment	3 month	6 month	1 year
TP	1632 ± 1589	1853 ± 1736	1945 ± 1583	1973 ± 1496	1535 ± 1383	1503 ± 1175***	1426 ± 1327***	1497 ± 1425***
VLF	630 ± 838	783 ± 954**	963 ± 825**	836 ± 793**	572 ± 521	528 ± 517#	583 ± 536#	595 ± 427
LF	637 ± 757	698 ± 730	665 ± 835	648 ± 698	560 ± 867}	538 ± 624}	603 ± 674	627 ± 526
HF	335 ± 446*	472 ± 528*	438 ± 516	416 ± 549	357 ± 375	372 ± 493	324 ± 295	363 ± 305

Note: * – $P < 0.01$ in the series against the initial values; } – $P < 0.01$ between series at the current stage; ** – $P < 0.05$ in the series against the initial values; *** – $P < 0.05$ between series at the current stage; # – $P < 0.05$ in the series against the previous stage.

The baseline values of TP and VLF in the subgroup of patients with BFB and patients from comparison subgroup were almost identical ($P < 0.05$). Starting from the three-month stage BFB in loop of PB showed a positive effect on the HRV parameters, their more significant increase was observed with further preservation of the trend, while in the comparison subgroup they did not change during the entire monitoring period.

The initial level of HF in the compare subgroups was comparable ($P < 0.05$). BFB in loop of PB provided an increase in the indicator during monitoring period, whereas in the comparison subgroup it did not change significantly. The LF value remained almost the same in both subgroups ($P < 0.05$).

Comparison of BP and HRV parameters in patients with DTCAH in the main subgroup showed their synchronous positive dynamics, whereas in the comparison subgroup there were no significant changes.

The obtained results indicate that addition of drug therapy with BFB in loop of HRV and PB allows achieving better BP control in patients with DTCAH, which corresponds to the data in

patients with controlled hypertension [3, 4]. There are no publications on the effectiveness of the use of BFB in loop of HRV and PB in patients with DTCAH in literature.

The results of the study indicate that BFB in loop of HRV and PB can be used in patients with DTCAH to improve the quality of its control, which makes it possible to recommend the method as a component of non-drug treatment for patients with DTCAH.

CONCLUSIONS

1. Systematic sessions of BFB in loop of PB in patients with DTCAH allow increasing the overall power of the spectrum of HRV, including its components – VLF and HF, and also improve control of BP, while one drug therapy does not significantly effect on them.

2. BFB sessions in loop of PB can be recommended as a supplement to standard medical therapy for patients with DTCAH.

The efficacy of BFB in loop of HRV and PB in patients with DTCAH and controlled hypertension is the interest to compare in the future.

REFERENCES

1. Achelrod D. Systematic review and meta-analysis of the prevalence of resistant hypertension in treated hypertensive populations / D. Achelrod, U. Wenzel, S. Frey. // Am J Hypertens. – 2015. – № 28. – p. 355–361.
2. Comparative epidemiology of resistant hypertension in chronic kidney disease and the general hypertensive population / [P. A. Sarafidis, P. I. Georgianos, P. E. Zebekakis, et al.]. // Semin Nephrol. – 2014. – № 34. – p. 483–491.

3. Belal S. A. S Vliyanie seansov biologicheskoy obratnoy svyazi s zamknu-tyim konturom variabelnosti serdechnogo ritma i metronomizirovannogo dyihaniya na kontrol sistolicheskogo arterialnogo davleniya na fone standartnoy medikamentoznoy terapii u patsientov s arterialnoy gipertenziey / S. A. S. Belal, N. A. Vodyanitskaya, N. I. Yabluchanskiy. // Visnik Harkivskogo natsionalnogo universitetu im. V. N. Karazina, seriya: «Meditsina». – 2015. – № 29. – S. 11–21.
4. Otsenka effektivnosti primeneniya biologicheskoy obratnoy svyazi v zamknutom konture variabelnosti serdechnogo ritma i metro-nomizirovannogo dyihaniya u patsientov s arterialnoy gipertenziey / A. L. Kulik, E. Yu. Schmidt, A. V. Martynenko, N. I. Yabluchanskiy. // Visnik Harkivskogo natsionalnogo universitetu imeni V. N. Karazina, seriya: «Meditsina». – 2011. – № 22. – S. 29–37.
5. Yabluchanskiy N. I. Variabelnost serdechnogo ritma v pomosch prakticheskomu vrachu / N. I. Yabluchanskiy A. V. Martlnenko // – X.: Dlya nastoyaschih vrachey, 2010. – 131 s.
6. ESH/ESC Guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC) // Journal of Hypertension. – 2013. – Vol. 31, Is. 7. – P 1281–1357.