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EFFECTIVENESS OF BIOFEEDBACK IN THE CLOSED LOOP OF HEART RATE VARIABILITY AND PACED BREATHING IN THE PATIENTS WITH SOMATOFORM AUTONOMIC DYSFUNCTION

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To study the effectiveness of biofeedback (BFB) in the closed loop of heart rate variability (HRV) and paced breathing in patients with somatoform autonomic dysfunction (SAD) 20 patients with SAD (14 women and 6 men, mean age $19,53 \pm 1,55$) were examined. All probationers were divided into two groups comparable for sex and age: 1 - BFB group (15 patients), in which 7 sessions was held and 2 - the comparison group (5 patients), where only two sessions were completed -at the first and seventh day of the study. Additionally, all patients in both groups received diet food (Table № 10 by Pevzner), mebicar, glycine, tiotriazolin. Effectiveness of biofeedback was evaluated by comparing of parameters optimality (O), sensitivity (S), the efficiency (E) and the integral index BQI in both groups. It was determined that biofeedback in the closed loop of HRV and paced breathing allows to optimize the state of the regulatory systems of the body in patients with SAD, moreover the combination of biofeedback sessions in the test loop and medical treatment are significantly better than isolated pharmacological therapy. High effectiveness of biofeedback in closed loop of HRV and paced breathing in patients with SAD allows us to recommend it as independent method of treatment, and as a component of combined therapy of this disease.

KEY WORDS: somatoform autonomic dysfunction, biofeedback, heart rate variability, paced breathing

ЕФЕКТИВНІСТЬ БІОЛОГІЧНОГО ЗВОРОТНЬОГО ЗВ'ЯЗКУ В ЗАМКНУТОМУ КОНТУРІ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ І МЕТРОНОМІЗОВАНОГО ДИХАННЯ У ПАЦІЄНТІВ ІЗ СОМАТОФОРМНОЮ ВЕГЕТАТИВНОЮ ДИСФУНКЦІЄЮ

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Для вивчення ефективності біологічного зворотного зв'язку (БЗЗ) в замкнутому контурі варіабельності серцевого ритму (ВСР) і метрономізованого дихання у пацієнтів з соматоформною вегетативною дисфункцією (СВД) було обстежено 20 пацієнтів із СВД (14 жінок і 6 чоловіків, середній вік $19,53 \pm 1,55$ років). Всіх випробуваних розділили на 2 групи, відповідні за статтю та віком: 1 – група БОС (15 пацієнтів), в якій було проведено 7 сеансів, і 2 - група порівняння (5 пацієнтів), де було виконано тільки два сеанси – у перший та сьомий день дослідження. Крім того, всі пацієнти обох груп отримували дієтичне харчування (стіл № 10 по Певзнеру), мебікар, гліцин, тіотриазолін. Ефективність біологічного зворотного зв'язку оцінювали шляхом порівняння значень показників оптимальності (О), чутливості (S), ефективності (E) та інтегрального індексу BQI в обох групах пацієнтів. Встановлено, що БОС у замкнутому контурі ВСР і метрономізованого дихання дозволяє оптимізувати стан регуляторних систем організму у пацієнтів з СВД, більш того комбінація сеансів БОС у досліджуваному контурі і медикаментозного лікування значно перевершує по ефективності ізольовану медикаментозну терапію. Висока ефективність БОС у замкнутому контурі ВСР і метрономізованого дихання у пацієнтів з СВД дозволяє рекомендувати її і як самостійний засіб лікування, і як компонент комплексної терапії при даному захворюванні.

КЛЮЧОВІ СЛОВА: соматоформна вегетативна дисфункція, біологічний зворотний зв'язок, варіабельність серцевого ритму, метрономізоване дихання

ЭФФЕКТИВНОСТЬ ПРИМЕНЕНИЯ БИОЛОГИЧЕСКОЙ ОБРАТНОЙ СВЯЗИ В ЗАМКНУТОМ КОНТУРЕ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА И МЕТРОНОМИЗИРОВАННОГО ДЫХАНИЯ У ПАЦИЕНТОВ С СОМАТОФОРМНОЙ ВЕГЕТАТИВНОЙ ДИСФУНКЦИЕЙ

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Для изучения эффективности биологической обратной связи (БОС) в замкнутом контуре variability сердечного ритма (ВСР) и метрономизированного дыхания у больных с соматоформной вегетативной дисфункцией (СВД) было обследовано 20 пациентов с СВД (14 женщин и 6 мужчин, средний возраст $19,53 \pm 1,55$). Всех испытуемых разделили на 2 группы, сопоставимые по полу и возрасту: 1 – группа БОС (15 пациентов), в которой было проведено 7 сеансов и 2 - группа сравнения (5 пациентов), где выполнено только два сеанса – в первый и седьмой день исследования. Кроме того, все пациенты обеих групп получали диетическое питание (стол № 10 по Певзнеру), мебикар, глицин, тиотриазолин. Эффективность биологической обратной связи оценивали путем сравнения значений показателей оптимальности (О), чувствительности (S), эффективности (E) и интегрального индекса BQI в обеих группах пациентов. Установлено, что БОС в замкнутом контуре ВСР и метрономизированного дыхания позволяет оптимизировать состояние регуляторных систем организма у пациентов с СВД, более того комбинация сеансов БОС в исследуемом контуре и медикаментозного лечения значительно превосходит по эффективности изолированную фармакологическую терапию. Высокая эффективность БОС в замкнутом контуре ВСР и метрономизированного дыхания у пациентов с СВД позволяет рекомендовать ее и как самостоятельное средство лечения, и как компонент комплексной терапии при данном заболевании.

КЛЮЧЕВЫЕ СЛОВА: соматоформная вегетативная дисфункция, биологическая обратная связь, variability сердечного ритма, метрономизированное дыхание

INTRODUCTION

According to the results of studies in recent years, wide spread, especially in young and middle-aged persons, have received various functional disorders of the cardiovascular system [1, 2]. In 32-50 % of cases they are implemented in the form of somatoform autonomic dysfunction (SAD), which today is characterized as a poli-etiological functional disease of the cardiovascular system with neurogenic nature, based on the failure of adaptation of the regulatory systems of the body, which is manifested by a variety of clinical syndromes (neurologic, cerebrovascular, cardiac, respiratory, peripheral vascular), and their combinations [3, 4].

The main therapeutic measures in this disease is the use of various programs of autogenic therapy (construction of visual imagery, positive thinking) [5, 6] and relaxation (diaphragmatic breathing, muscle relaxation) [6, 7], aimed at restoring the balance of regulation, sometimes complemented by drug therapy [7].

A perspective treatment for patients with SAD can be biofeedback (BFB) in the closed loop of heart rate variability (HRV) and paced breath with the start from free breathing, which has established itself as an effective mean of restoring the balance of regulatory systems of the body in healthy people [8, 9] and patients with arterial hypertension [10].

Since there is no data in the literature about the effectiveness of the proposed method of biofeedback in patients with SAD, and the

question of treatment of this disease is still relevant [11, 12], we decided to perform this work.

The study was performed as a part of research KNU «Development and research of system of automatic control heart rate variability», № registration 0109U000622.

OBJECTIVE

The purpose of this study is to evaluate the effectiveness of biofeedback sessions in the closed loop of HRV and paced breathing with the start from free breathing in patients with SAD.

MATERIALS AND METHODS

The study involved 20 patients with SAD (14 women and 6 men, average age $19,53 \pm 1,55$). Inclusion criteria according to patients' complaints are false angina, anxiety, labile blood pressure, tachycardia, hyperaemia or skin cover pallor, palpitations, dissatisfaction breath, weakness, fatigue, headache, cold extremities in the absence of confirmed organic reasons of their causes, matching the results of laboratory and instrumental study age norm.

According to the objective of the study all patients were divided into 2 groups: 1 - BFB group (15 patients), 2 - the comparison group (5 patients). In group 1 seven daily sessions of BFB in the closed loop of HRV and paced breathing with the start from free breathing were held, in group 2 only two sessions in the first and seventh day of treatment were held.

Additionally, all patients in both groups received diet food (Table № 10 by Pevzner),

mebicar 300 mg three times a day, glycine 100 mg three times a day and tiotriazolini 4 ml once a day.

BFB sessions were held on a computer diagnostic complex «CardioLab 2009» («HAI-Medica») containing a special module «Biofeedback», consisting of software-related visual and sound metronome of breathing and the algorithm for determining the parameters of HRV.

HRV parameters were determined in the sliding buffer for a period of 1 minute by the dynamic spectral decomposition through the fast Fourier transform of lengths sequence of RR-intervals of monitor ECG records in the first standard lead with a sampling rate of 1000 Hz signal. All calculations was made in real time scale within the 7 minute session. Among HRV parameters powers of low frequency (V, 0,05 Hz), medium frequency (L, 0,05-0,15 Hz) and high frequency (H, 0,15-0,40 Hz) were evaluated, which then were converted into two-dimensional coordinate plane with axes L/H and V/(L + H), by corresponding powers of sympathovagal and neurohumoral regulation links [13].

In the first two minutes the adaptation algorithm initialization of module «Biofeedback» was took place, research subjects were breathing in the familiar for them rhythm, then for each subsequent minute specific

frequency of paced breathing by visual and sound metronome frequency tuning was set. Adaptation algorithm was consisted of the automatic search for such a breaching frequency at which the current values of L/H and V/(L + H) was approached as close as possible to the optimum zone [14].

Efficiency of BFB use was evaluated on the basis of proposed in [9] parameters of optimality (O), sensitivity (S), efficiency (E) and integral index BQI, which was calculated using MathCAD 15 in optimization algorithms in general (D), and in each of its phase space coordinates (L/H, V/(L + H)).

Statistical processing of results was performed in the program «Microsoft Excel 2003». Data of average values (M) and standard deviations (sd) of parameters O, S, E for indicators D, L/H, and V/(L + H) of the first and seventh sessions in both groups were recorded in the table.

Authenticities of differences between groups on the stages of the study and between the values of the index at the current stage and before treatment were determined by using of T-Wilcoxon test [15].

RESULTS AND DISCUSSION

Values of indicators O, S, E for D, L / H, V / (L + H) at 1 and 7 sessions in both groups are shown in the table.

Table

Values of indicators O, S, E for D, L / H, V / (L + H) at 1 and 7 sessions in both groups (M ± sd)

Parameters		Group 1		Group 2	
		1 session	7 session	admission	discharge
D	O	-4,09 ± 7,12	1,07 ± 2,60†	-0,90 ± 1,10*	-3,34 ± 6,53*†
	S	0,76 ± 0,41	0,77 ± 0,33†	0,41 ± 0,28*	0,49 ± 0,35*†
	E	0,05 ± 0,08	0,22 ± 0,25†	0,16 ± 0,21*	0,16 ± 0,22*†
L/H	O	-28,47 ± 61,56	-3,88 ± 8,11‡	-1,95 ± 2,96**	-12,46 ± 24,93**‡
	S	4,97 ± 1,60	5,78 ± 1,82†	4,49 ± 2,62*	5,32 ± 3,52*†
	E	0,82 ± 0,40	0,98 ± 0,02†	0,78 ± 0,44*	0,80 ± 0,45*†
V/(L+H)	O	-2,15 ± 1,04	-1,85 ± 0,98†	-1,67 ± 0,94*	-1,87 ± 1,26*†
	S	0,41 ± 0,26	0,40 ± 0,26†	0,33 ± 0,22*	0,37 ± 0,50*†
	E	0,07 ± 0,06	0,18 ± 0,13†	0,06 ± 0,13*	0,04 ± 0,08*†

Notes: * - P > 0.05 according to the indicator at the stage between the groups;

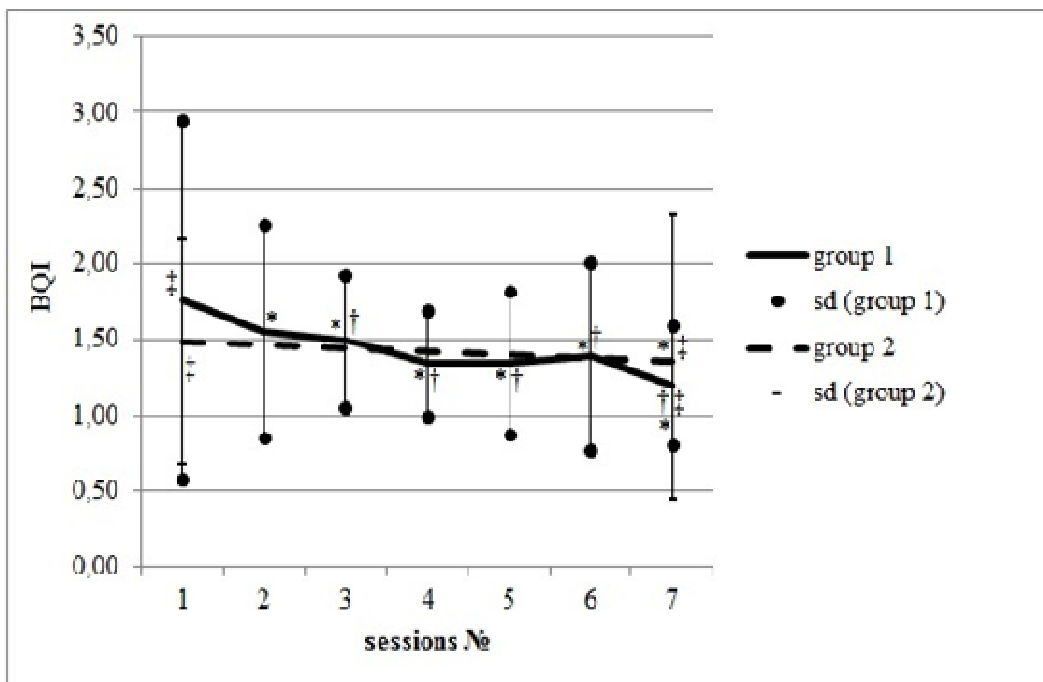
** - P < 0.05 according to the indicator at the stage between the groups;

† - P > 0.05 according to the indicator in the group against initial value;

‡ - P < 0.05 according to the indicator in the group against initial value.

Systematic BFB sessions at the same drug therapy promote better optimization of the studied parameters when they have almost identical initial values in compared series.

BQI index dynamics on all research subjects in both groups is shown in the Figure.



Notes:

- * - $P < 0.05$ at the sessions against initial values within a group;
- † - $P > 0.05$ in neighbouring sessions in group 1;
- ‡ - $P > 0.05$ between groups at the current session.

Systematic BFB sessions in group 1 promoted logical BQI index approximation to the optimum level, while in group 2 it remained unchanged against the values at admission.

SAD is a group of disorders that occur themselves as symptoms of internal organs or organ systems damage, however, do not have objectively recorded basis [11]. Most effective in the treatment of this condition are different neurophysiological trainings, allowing to restore the balance of the autonomic nervous system [5-7].

We have previously shown [9, 10] that an effective means of optimizing the balance of sympathovagal and neurohumoral regulation in healthy volunteers and patients with hypertension is biofeedback in the loop of paced breathing under the control of HRV parameters. As in the literature we could not find data on the effectiveness of the proposed technique in patients with SAD, this work was done.

Obtained results confirm the ability to optimize the state of the regulatory systems of the patients' body with SAD through BFB sessions in a closed loop of HRV and paced breathing with the start from free breathing.

Moreover, the combination of BFB sessions and drug treatment is significantly superior in effectiveness of the isolated pharmacological therapy.

In accordance with the obtained results, BFB in a closed loop of HRV and paced breathing should be considered as an important tool for correction of the regulatory systems condition in patients with SAD as an independent means of treatment, and as a component of a complex therapy.

CONCLUSIONS

1. Biofeedback in a closed loop of heart rate variability and paced breathing allow to optimize the regulatory systems condition of the body in patients with somatoform autonomic dysfunction.
2. Combination of biofeedback sessions and drug treatment is significantly superior in effectiveness of the isolated pharmacological therapy
3. The effectiveness of biofeedback in a closed loop of heart rate variability and paced breathing allows us to recommend it as an independent means of treatment and as a component of complex therapy for patients with somatoform autonomic dysfunction.

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