

Clinical case

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EFFECTIVENESS OF BIOFEEDBACK IN A CLOSED LOOP OF HEART RATE VARIABILITY PARAMETERS AND PACED BREATHING IN PATIENTS WITH ARTERIAL HYPERTENSION IN REAL CLINICAL PRACTICE

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On example of clinical analysis of two comparable in all parameters patients with arterial hypertension application of biofeedback (BFB) in the closed loop of heart rate variability (HRV) and paced breathing was evaluated. Both patients received standard medical therapy according to the guidelines of the Association of Cardiologists of Ukraine, in patient 1 additionally was conducted 10 sessions of BFB in investigated loop. Effectiveness of the proposed method was evaluated by comparing the values of systolic, diastolic, pulse blood pressure (SBP, DBP and PD, respectively) and integral indicator of regulatory systems' state - BQI index within 10 days from starting treatment. Supplement of standard pharmacotherapy by biofeedback sessions in closed loop of HRV and paced breathing is significantly better than isolated drug treatment in the control of SBP, DBP and PD due to optimization of regulatory systems' state. Obtained data allow to recommend this technique in clinical practice.

KEY WORDS: arterial hypertension, biofeedback, heart rate variability, paced breathing

ЕФЕКТИВНІСТЬ БІОЛОГІЧНОГО ЗВОРОТНОГО ЗВ'ЯЗКУ В КОНТУРІ ПАРАМЕТРІВ ВАРІАБЕЛЬНОСТІ СЕРЦЕВОГО РИТМУ І МЕТРОНОМІЗОВАНОГО ДИХАННЯ У ПАЦІЄНТІВ З АРТЕРІАЛЬНОЮ ГІПЕРТЕНЗІЄЮ В РЕАЛЬНІЙ КЛІНІЧНІЙ ПРАКТИЦІ

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На прикладі клінічного розбору двох, порівнянних за всіма параметрами, пацієнтів з артеріальною гіпертензією оцінено використання біологічного зворотного зв'язку (БОС) в контурі варіабельності серцевого ритму (ВСР) та метрономізованого дихання в реальній клінічній практиці. Обидва пацієнти отримували стандартну медикаментозну терапію відповідно до рекомендацій Асоціації кардіологів України, пацієнту 1 додатково проведено 10 сеансів БОС в досліджуваному контурі. Ефективність запропонованої методики оцінювалася на підставі порівняння значень систолічного, діастолічного, пульсового артеріального тиску (САТ, ДАТ і ПД, відповідно) і інтегрального індикатора стану регуляторних систем - індексу ВQІ протягом 10 днів від початку лікування. Доповнення стандартної фармакотерапії сеансами БОС в замкнутому контурі ВСР і метрономізованого дихання значно перевищує по ефективності ізольоване медикаментозне лікування в контролі САТ, ДАТ і ПД за рахунок оптимізації стану системи регуляції. Отримані дані дозволяють рекомендувати методику в клінічну практику.

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

ЭФФЕКТИВНОСТЬ БИОЛОГИЧЕСКОЙ ОБРАТНОЙ СВЯЗИ В КОНТУРЕ ПАРАМЕТРОВ ВАРИАБЕЛЬНОСТИ СЕРДЕЧНОГО РИТМА И МЕТРОНОМИЗИРОВАННОГО ДЫХАНИЯ У ПАЦИЕНТОВ С АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ В РЕАЛЬНОЙ КЛИНИЧЕСКОЙ ПРАКТИКЕ

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На примере клинического разбора двух, сопоставимых по всем параметрам, пациентов с артериальной гипертензией оценено использование биологической обратной связи (БОС) в контуре variability сердечного ритма (ВСР) и метрономизированного дыхания в реальной клинической практике. Оба пациента получали стандартную медикаментозную терапию согласно рекомендациям Ассоциации кардиологов Украины, пациенту 1 дополнительно проведено 10 сеансов БОС в изучаемом контуре. Эффективность предложенной методики оценивалась на основании сравнения значений систолического, диастолического, пульсового артериального давления (САД, ДАД и ПД, соответственно) и интегрального индикатора состояния регуляторных систем – индекса ВQI в течение 10 дней от начала лечения. Дополнение стандартной фармакотерапии сеансами БОС в замкнутом контуре ВСР и метрономизированного дыхания значительно превосходит по эффективности изолированное медикаментозное лечение в контроле САД, ДАД и ПД за счет оптимизации состояния системы регуляции. Полученные данные позволяют рекомендовать методику в клиническую практику.

КЛЮЧЕВЫЕ СЛОВА: артериальная гипертензия, биологическая обратная связь, variability сердечного ритма, метрономизированное дыхание

INTRODUCTION

Arterial hypertension (AH) is a serious, debilitating disease, which is not only medical but also social and economic problem worldwide: about 45 % of adults aged from 25 years old have high blood pressure, 74.3 % are aware about the disease, just 43 % are treated, efficacy of the treatment is only 13 % [1]. Key point of this disease is an imbalance of regulatory systems in the body with predominance of the sympathetic nervous system branch [2]. Low efficiency of pharmacotherapy boosted searching for non-drug methods [3]. Promising tool of adjunctive therapy in patients with AH can be biofeedback (BFB) in the closed loop of paced breathing under the control of heart rate variability (HRV) parameters [4]. In these comparable cases we want to show you effectiveness of this method in real clinical practice.

OBJECTIVE

Purpose of the research is to study the effectiveness of biofeedback in a closed loop of heart rate variability and paced breathing in two comparable in all parameters patients with arterial hypertension in real clinical practice.

MATERIALS AND METHODS

Patient 1

Male, 64 y/o, retired, lives in the city, admitted to the hospital in November 2014.

Complaints on admittance: periodical increase of BP up to 150/95 mm Hg, usually in the morning, followed by headache in occipital area and/or dizziness.

Anamnesis morbi: Arterial hypertension since 2000 with maximum BP 155/95 mm Hg. Usual BP 120-130/70-80 mm Hg. Multiple

hospitalizations and treatment in outpatient clinic. Previous hospitalization in November 2013, after discharge ignored prescribed treatment. Current hospitalization due to complaints described above.

Anamnesis vitae: Appendectomy in young age. Tuberculosis, diabetes mellitus, STD, viral hepatitis, rheumatism, psychiatric diseases in the anamnesis denies. No pernicious habits. No alcohol abuse. Heredity is uncomplicated. No allergic reactions in the past.

Status presence objectivus: Patient's overall condition is satisfactory, consciousness is clear, position is active. Ectomorph body type. Growth 175 cm, weight 68 kg, waist 90 cm, BMI 22,0 kg/m². Skin and visible mucous are pale-pink, clear. Peripheral lymph nodes are not enlarged. Thyroid gland can't be palpated. Skeletal-muscular system without features. Respiratory system: clear lung sound during percussion, vesicular breathing during auscultation without additional sounds. Cardiovascular system: heart rate is rhythmic, tones are muffled, accent of the S2 on aorta. HR = pulse = 65 bpm. BP 150/95 mm Hg. Abdomen is normal in size, soft and painless during palpation. Liver under the edge of ribs arch, painless. No peripheral edema.

Patient 2

Male, 60 y/o, retired, lives in the city, admitted to the hospital in October 2014.

Complaints on admittance: episodic increase of BP up to 150/90 mm Hg, usually in the morning, which followed by headache in frontal and temporal areas.

Anamnesis morbi: Arterial hypertension since 1995 with maximum BP 155/95 mm Hg. Usual BP 120/70 mm Hg. Multiple hospitalizations and treatment in outpatient

clinic. Previous hospitalization in January 2014, after discharge regularly took indapamide 2,5 mg in the morning. Current hospitalization due to same complaints.

Anamnesis vitae: Right wrist joint fracture in 1983. Tuberculosis, diabetes mellitus, STD, viral hepatitis, rheumatism, psychiatric diseases in the anamnesis denies. No pernicious habits. No alcohol abuse. Heredity is uncomplicated. No allergic reactions in the past.

Status presence objectivus: Patient's overall condition is satisfactory, consciousness is clear, position is active. Ectomorphic body type. Growth 170 cm, weight 60 kg, waist 84 cm, BMI 21,0 kg/m². Skin and visible mucous are pale-pink, clear. Peripheral lymph nodes are not enlarged. Thyroid gland can't be palpated. Skeletal-muscular system without features. Respiratory system: clear lung sound during percussion, vesicular breathing during auscultation without additional sounds. Cardiovascular system: heart rate is rhythmic, tones are muffled, accent of the S2 on aorta. HR = pulse = 68 bpm. BP 150/90 mm Hg. Abdomen is normal in size, soft and painless during palpation. Liver under the edge of ribs arch, painless. No peripheral edema.

INVESTIGATION PLAN IN THE HOSPITAL

- Clinic blood count
- Urinalysis
- Biochemical blood test (bilirubin, ALT, AST, glucose, creatinine, Na, K)
- Lipid profile
- Chest x-ray
- ECG
- Heart ultrasound with Doppler
- Kidneys ultrasound with Doppler
- Ophthalmologist consultation

INVESTIGATION RESULTS

Clinic blood count: indexes are in normal range in both patients.

Urinalysis: indexes are in normal range in both patients.

Biochemical blood test: indexes are in normal range in both patients.

Lipid profile: indexes are in normal range in both patients.

Chest x-ray: normal in both patients.

ECG: patient 1: sinus rhythm, regular, HR 61 bpm, hypertrophy of myocardium of left ventricle by wave's ratio criterion; patient 2: sinus rhythm, regular, HR 64 bpm,

hypertrophy of myocardium of left ventricle by wave's ratio criterion.

Heart ultrasound with Doppler: patient 1: hypertrophy of myocardium of left ventricle (LV posterior wall thickness: 12 mm, interventricular septum: 11,8 mm), systolic function is preserved (EF = 61 %); patient 2: hypertrophy of myocardium of left ventricle (LV posterior wall thickness: 12,3 mm, interventricular septum: 12,0 mm), systolic function is preserved (EF = 64 %).

Kidneys ultrasound with Doppler: patient 1: incomplete doubling of left kidney, micro urolithiasis; patient 2: microurolithiasis.

Ophthalmologist consultation: patient 1: angiopathy of retinal vessels of both eyes; patient 2: Angiopathy of retinal vessels of both eyes.

CLINICAL DIAGNOSIS

Patient 1: Arterial hypertension II stage 1 degree, HF 0 stage, moderate additional risk.

Patient 2: Arterial hypertension II stage 1 degree, HF 0 stage, moderate additional risk.

TREATMENT

Lifestyle modification: control of body weight, diet, regular exercises.

Drugs therapy: perindopril 5 mg 1 time per day in the evening, aspirin-cardio 100 mg in the evening.

Non-drug therapy: patient 1 – 10 biofeedback sessions in the loop of paced breathing under the control of heart rate variability parameters; patient 2 – 10 pseudosessions without inclusion of feedback under the control of heart rate variability parameters.

Biofeedback sessions were performed on a computer diagnostic complex «CardioLab2009» («XAI-Medica») with additional custom module «Biofeedback», including software related audible and visual breathing metronome and dynamic algorithm for determining the current value of HRV indices, changed under paced breathing influence.

HRV parameters were estimated in slide buffer for 1 minute through dynamic spectral decomposition by fast Fourier transform of R-R intervals sequence of lead I ECG records with 1000 Hz digitization frequency. All calculations were conducted in real-time during 7-minute biofeedback session. Power of low (V, up to 0,05 Hz), medium (L, 0,05-0,15 Hz) and high

(H, 0,15-0,40 Hz) HRV parameters were estimated, then they were transformed into two-dimensional coordinate space with L/H and V/(L+H) axes, which correspond to power of sympathovagal and neurohumoral balances of regulation [5].

During biofeedback session, initialization of adaptation algorithm of biofeedback module was conducted in first 2 minutes, when patient breathe in his normal rhythm. After that for each following minute exact frequency of paced breathing was set through frequency rearrangement of aural-visual breathing metronome. Adaptation algorithm consists in automatic seeking of such frequency, when current L/H and V/(L+H) values are maximally approximate to optimum zone [6].

Efficacy of biofeedback was evaluated by comparing the values of systolic, diastolic and pulse blood pressure (SBP, DBP and PP, respectively); BQI integral index – parameter

that reflects all qualitative changes of biofeedback process: optimality (O, estimation of farness of regulatory systems from optimal state during whole period of session), sensitivity (S, estimation of receptivity of regulatory systems to paced breathing), effectiveness (E, estimation of approaching range of HRV parameters to optimal physiological state during execution of optimal bioreverse control algorithm) [7].

Statistical analysis of the results for each subject was carried out using Microsoft Excel computer software.

RESULTS AND DISCUSSION

Dynamic of SBP, DBP, and PP in both patients on background of the treatment presents in fig.1. During the same treatment in both patients systemic biofeedback implementation contributed to lower values aforementioned indices.

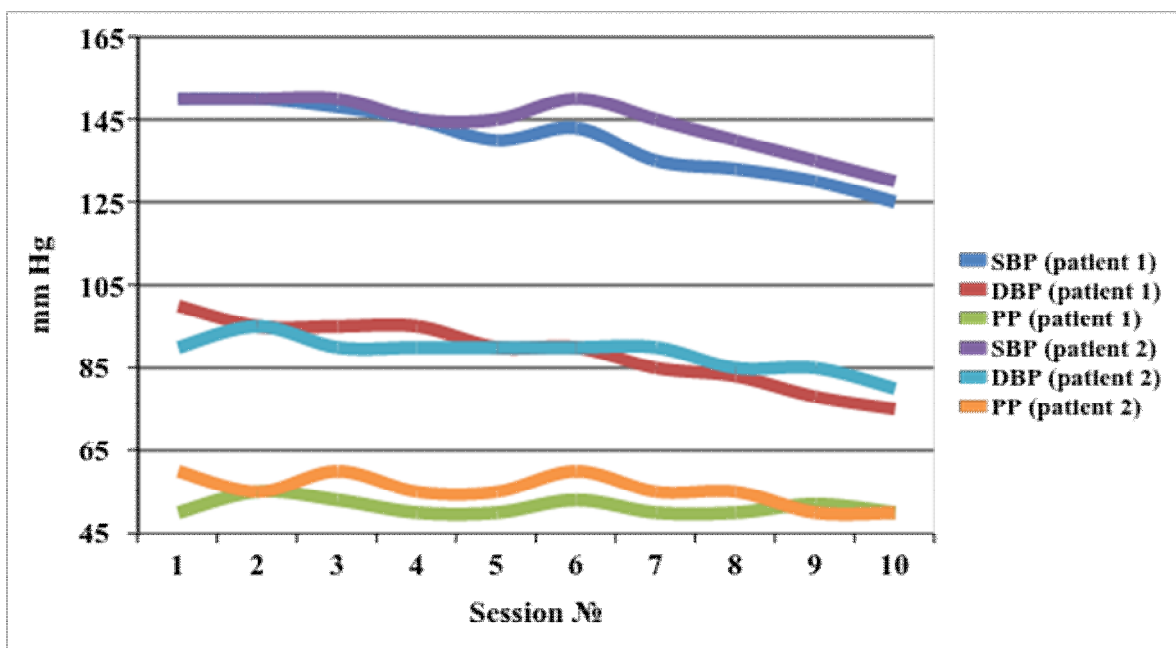


Fig.1. SBP, DBP, and PP dynamic in both patients during the treatment

BQI index dynamic in both patients during 10 sessions presents in fig.2. Systematic biofeedback sessions in patient 1 contributed natural approximation of regulation to the

optimal level, whereas in patient 2 it index fluctuated within suboptimal level without reaching the target level.

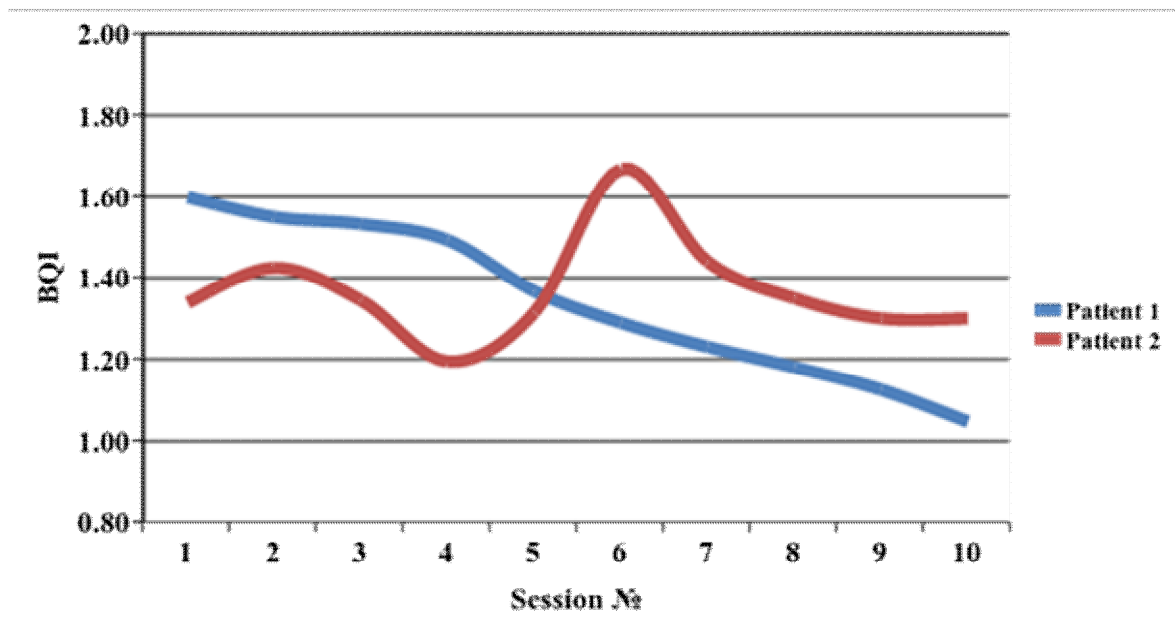


Fig.2. BQI index dynamic in both patients during 10 days of treatment

Arterial hypertension is the most common chronic disease among adults [1]. Pharmacotherapy still does not allow to reach optimum level of blood pressure in some patients that stimulated the development of non-drug methods of treating [3].

Biofeedback with a contour of HRV and paced breathing is one of the promising methods for increase of blood pressure controllability [4]. Supplement of standard pharmacotherapy by biofeedback sessions in closed loop of HRV and paced breathing is significantly better than isolated drug treatment in the control of SBP, DBP and PD due to optimization of regulatory systems' state. The effectiveness of biofeedback in a closed loop of heart rate variability and paced breathing allows us to recommend it as a component of complex therapy for patients with arterial hypertension.

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 arterial hypertension.

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 a component of complex therapy for patients with arterial hypertension.

PROSPECTS FOR FUTURE STUDIES

It is interesting to evaluate the effectiveness of biofeedback sessions in the investigated loop in patients with arterial hypertension depending from the stage and degree of the disease.

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