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ELECTRO-PHOTONIC EMISSION ANALYSIS IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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21 polymorbid patients with chronic obstructive pulmonary disease and 85 functionally healthy respondents were obtained by the method of electro-photonic emission analysis. It was found that patients with noncommunicable diseases with chronic obstructive pulmonary disease had significant differences in качественных physical and mathematical parameters of electro-photonic emission analysis, which characterize the shape of the glow compared to functionally healthy young respondents. This testifies to a different course of metabolic processes in them. As the scientific search for adequate and technically simple techniques for use in clinical settings continues, the electro-photonic emission analysis method deserves close attention as a promising candidate for scientific research into the integral level of cellular metabolism/mitochondrial activity. Many questions about the mechanisms of biophotonic communication remain unanswered, so biophotonics of the human body is an important and promising direction for internal medicine and science in general.

Key words: noncommunicable diseases, chronic obstructive pulmonary disease, electro-photonic emission analysis, biophoton, ultra-weak photon emission.

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АНАЛІЗ ЕЛЕКТРОФОТОННОЇ ЕМІСІЇ У ХВОРИХ НА ХРОНІЧНУ ОБСТРУКТИВНУ ХВОРОБУ ЛЕГЕНЬ

Методом аналізу електрофотонної емісії було обстежено 21 поліморбідного хворого на хронічну обструктивну хворобу легень та 85 функціонально здорових респондентів. Встановлено, що у хворих на неінфекційні захворювання: хронічну обструктивну хворобу легень спостерігаються суттєві відмінності в якісних фізико-математичних параметрах аналізу електрофотонного випромінювання, які характеризують форму світіння порівняно з функціонально здоровими молодими респондентами. Це свідчить про інший перебіг у них метаболічних процесів. Оскільки науковий пошук адекватних і технічно простих методів для використання в клінічних умовах триває, метод аналізу електрофотонної емісії заслуговує на пильну увагу як багатообіцяючий кандидат для наукових досліджень інтегрального рівня клітинного метаболізму/активності мітохондрій. Багато питань про механізми біофотонічного зв'язку залишаються без відповіді, тому біофотоніка людського організму є важливим і перспективним напрямком внутрішньої медицини та науки в цілому.

Ключові слова: хронічна обструктивна хвороба легень, неінфекційні захворювання, аналіз електрофотонної емісії, біофотон, надслабка емісія фотонів.

The study is a fragment of the research project "Development of algorithms and technology for introducing a healthy lifestyle in patients with non-communicable diseases based on the study of functional status", state registration No. 0121U108237.

Chronic obstructive pulmonary disease (COPD) refers to non-communicable diseases (NCDs) and is a major medical and social problem [10]. According to the World Health Organization, COPD ranks third as the leading cause of death from NCDs. COPD is also the seventh leading cause of ill health in the world (measured in disability-adjusted life years) [12]. It has been established that the universal pathogenetic mechanism of NCDs is mitochondrial dysfunction [1, 9]. Tobacco smoke and other toxic agents have a direct damaging effect on the mitochondria of the cells of the upper respiratory tract. The consequences of toxic effects on mitochondria are disorders of the bioenergetic state of cells, the occurrence of cellular hypoxia, damage to mitochondrial deoxyribonucleic acid with subsequent initiation of mechanisms of apoptosis and degradation of mitochondria with a decrease in their number, inflammation, aging and immunological changes [13]. Impaired function of cells of the upper respiratory tract and their pathological morphohistological changes are a consequence of the progression of mitochondrial dysfunction.

Studying the emission of biophotons may be a promising method for indirectly assessing the functional activity of mitochondria. It should be noted that Ultraweak Photon Emission (UPE) is a universal phenomenon of cell functioning, which is manifested by the release of light energy in the form of photons during cellular metabolism [3]. Many scientists believe that the appearance of UPE is explained by the metabolic and signaling activity of mitochondria. In recent years, scientific interest in studying the role of biophotons in the human body has increased [11]. Therefore, the study of biophoton emission in patients

with NCDs is relevant. This may reveal new pathogenetic mechanisms of NCDs and COPD in particular and new fundamental aspects of the functioning of the human body.

The purpose of the study was to investigate the phenomenon of electro-photonic emission by the method of electro-photonic emission analysis in patients with noncommunicable diseases with chronic obstructive pulmonary disease and functionally healthy respondents for a further thorough diagnosis and loss of fundamental knowledge of the etiology and pathogenesis of disease of internal organs.

Materials and methods. 106 people were included in an open, non-randomized, controlled study. Group 1 consisted of patients (G1, n=21, median age –49 (36; 65), men – 81 %) with NCDs with a verified diagnosis of COPD (GOLD B patients [5]) as the main disease in combination with other comorbid pathology. Group 2 (control) consisted of functionally healthy young respondents (G2, n=85, median age – 24 (23; 26), men – 58 %).

The patients were examined at the Pulmonology Center of the Department of Internal Medicine and Emergency Medicine. The degree of respiratory failure was determined based on the results of spirography. In addition to the mandatory examinations, all patients and respondents underwent photographic registration of biophoton emission of ten fingers: thumb left (1L), index left (2L), middle left (3L), ring left (4L), little left (5L), thumb right (1R), index right (2R), middle right (3R), ring right (4R), little right (5R). The electro-photonic emission analysis method was used (EPEA) [9, 10]. EPEA was performed on a digital software certified measuring hardware device Bio-Well 2.0 (United States). The parameters were evaluated: 1) area is number of pixels of the glow image (GI); 2) area (C) is ratio of area of the finger glow to the area of glow of calibration cylinder (for sector or whole image); 3) normalized area is the ratio of GI area to the area of the inner oval; 4) intensity is average intensity of all the pixels from the GI; 5) inner area is overall number of pixels in the inner oval; 6) energy is energy of glow in $*10^{-2}$ Joules; 7) form coefficient (FC) is calculated according to the formula: $FC=L^2/S$, where L is the length of the GI external contour and S is the GI Area; 8) entropy coefficient (EC) is the ratio of outer contour to the inner contour lengths; 9) inner contour length in pixels; 10) inner contour radius in pixels; 11) outer contour length in pixels; 12) outer contour radius in pixels; 13) stress (c.u.) is a numerical assessment of the patient's psycho-emotional and functional state on the basis of determining the curvature of the outer contour of the radiation of photons of the fingers; 14) energy (E, Joule/J, the total energy level for the whole body) is a numerical estimate of the light energy of the photographed photon radiation, multiplied by the area, intensity and correction factor; 15) balance (B, %), balance left and right (BL and BR, %) are indicators of the difference between of the left and right hands [6].

The study was approved by the Ethics Committee Commission on Ethical Issues and Bioethics of the Poltava State Medical University (Approval Code: 214; Approval Date: 23/03/2023). All applicable ethical rules have been observed. Statistical analysis was performed using the Prism 5.0 software package. The data obtained are presented as mean values with their mean error (M±m). Mann-Whitney U-test was used to compare and determine the statistical significance of differences between groups. The differences were considered significant at $p<0.05$.

Results of the study and their discussion. We obtained significantly different EPEA parameters in the comparison groups. The results of EPEA digital images of each finger in the study groups are shown in Tables 1 and 2.

Area of luminescence and Area (C) did not differ significantly in the comparison groups. A significant difference in the intensity of the glow was established in the indicators R1, R2, R3, R4, R5, L4 of the fingers in the comparison groups. A significant difference in the glow energy was established in the indicators R1, R2, R3, L1 of the fingers in the comparison groups. EC was significantly different on all fingers. FC was significantly different at R3, R5, L2, L3, L5. There, many significant differences were established in the parameters inner contour length, outer contour length, outer contour radius. This indicates a qualitative difference in the activity of metabolic processes in patients with COPD and functionally healthy young people. This supports the idea that in healthy people and patients with COPD, the generation of biophotons in cells and biophoton signaling occur differently.

Group analysis of energy levels did not reveal significant differences between group G1 (42.58±9.13 J) and group G2 (54.89±25.79 J). The scale of clinical interpretation of the E was as follows: E – 0–20 J – it's very low level, 20-40 J – it's low level, 40–70 J – it's optimal level, 70–90 J – it's increased level, 90–100 J – it's high level. During the individual analysis, it was established that 12 (57 %) patients had optimal energy levels, and 9 (43 %) patients had low levels in group G1. In group G1, 81 (95 %) respondents had an optimal energy level, and 4 (5 %) patients had a high level. Thus, individual energy indicators in the group of patients with COPD were lower than in the group of healthy respondents, despite the absence of significant differences between the statistical indicators in the groups.

Table 1

Comparative characteristics of the physical and mathematical parameters of EPEA in study groups: part 1

P	Area			Area (C)			Normalized Area		
F/G	G1	G2	P value	G1	G2	P value	G1	G2	P value
1L	11000±196	11566±200	0.14	0.066±0.46	0.082±0.482	0.17	1.327±0.59	1.61±0.656	0.009
2L	10432±188	10995±195	0.42	0.1229±0.5	0.1653±0.49	0.94	1.53±0.46	2.28±0.97	0.0001
3L	10519±168	11059±191	0.34	0.060±0.50	0.147±0.475	0.61	1.681±1.77	2.131±0.93	<0.0001
4L	10297±188	11003±186	0.20	-0.065±0.5	0.048±0.465	0.51	1.84±0.839	2.436±0.78	0.0004
5L	10449±183	10828±196	0.97	-0.167±0.49	-0.075±0.47	0.98	2.268±0.99	3.096±1.20	0.0039
1R	10700±198	11487±207	0.05	-0.182±0.47	0.057±0.479	0.015	1.272±0.74	1.664±0.62	0.0014
2R	10251±179	10951±189	0.22	-0.008±0.52	0.179±0.492	0.23	1.105±0.55	2.373±0.97	<0.0001
3R	10438±191	11117±205	0.21	0.022±0.54	0.177± 0.517	0.40	1.394±0.43	2.104±0.76	<0.0001
4R	10560±211	10905±191	0.50	-0.0057±0.6	0.0024±0.48	0.93	1.941±0.60	2.428±0.92	0.0371
5R	10446±217	10883±179	0.87	-0.135±0.48	-0.051±0.484	0.92	2.183±0.93	3.203±1.24	0.0003
P	Intensity			Inner area			Energy		
F/G	G1	G2	P value	G1	G2	P value	G1	G2	P value
1L	91.21±7.12	94.78±7.27	0.06	9434±3395	8139±3032	0.045	4.248±0.93	4.79±1.32	0.045
2L	95.28±6.47	98.35±7.44	0.18	7259±1810	5544± 2302	0.0003	4.225±0.97	4.722±1.31	0.22
3L	96.55±8.73	98.58±6.90	0.33	7360±3063	5839±1965	0.0032	4.312±0.94	4.762±1.24	0.22
4L	95.8±7.144	99.76±6.29	0.0441	6380±2499	4920±1633	0.0025	4.191±0.96	4.796±1.27	0.07
5L	98.84±6.87	101.57±7.1	0.33	5335±1995	4054±1733	0.0036	4.387±0.97	4.802±1.34	0.65
1R	88.49±8.92	95.96±7.43	0.0007	10373±4265	7768±2863	0.0061	4.044±1.079	4.813±1.28	0.0007
2R	93.28±8.33	98.32±7.51	0.022	7611±2935	5312±2228	0.0001	4.066±0.97	4.707±1.333	0.035
3R	94.28±6.1	98.38±6.65	0.0287	8011±2330	5822±1874	0.0001	4.179±0.9	4.781±1.367	0.06
4R	95.94±6.24	99.94±6.93	0.032	5874±1804	5018±1742	0.06	4.303±1.051	4.762±1.312	0.21
5R	98.94±6.84	102.2±7.68	0.36	5492±2034	3926±1677	0.0006	4.402±0.964	4.857±1.287	0.53

Note: P is short forms of the Parameter; F/G is short forms of the Finger/Group; P value – the difference Mann-Whitney test between the characteristics of the study groups.

Group analysis of the stress level indicator did not establish a significant difference between groups G1 (3.74±0.64 c.u.) and G2 (3.58±0.55 c.u.). Stress was at the level of anxiety in both groups according to the scale of clinical interpretation: 0–2 c.u. – it's calm state, 2–3 c.u. – it's optimal condition, 3–4 c.u. – it's anxiety, 4–6 c.u. – it's average condition, 6–8 c.u. – it's increased stress levels, 8–10 c.u. – it's distress. During the individual analysis, it was established that 81 % (17/21) of patients had an anxiety and 19 % (4/21) of patients had mean condition level of stress in group G1. There was anxiety in 72 % (62/85) of respondents, average condition in 18 % (15/85) of respondents and optimal condition in 10 % (8/85) respondents in group G2.

Group analysis of photon emission balance parameters not established a significant difference in B between groups G1 (95.08±4.07 %) and G2 (96.73±3.17 %). But significant differences were established between BL and BR in the comparison groups. The BL in the G1 group was 80.99±12.71 % and in the G2 group was 90.47±7.35 % (p=0.0014). The BR in the G1 group was 86.25±10.53 % and in the G2 group was 91.8±5.7 % (p=0.0326). The scale of clinical interpretation of balance indicators was as follows: B – 0-50 % – it's very low balance; 50–90 % – it's low balance; 90–100 % – it's optimal balance; BL, % 0–5% – it's optimal balance; 5–10 % – it's average imbalance; 10 % – >15% – it's severe imbalance; BR, % – 0–5 % – it's optimal balance; 5–10 % – it's average imbalance 10 % – >15 % – it's severe imbalance. During the individual analysis, it was established that there was severe imbalance in 67 % (14/21) of patients and average imbalance in 19 % (4/21) on the right arm in group G1. Also, there was severe imbalance in 52 % (11/21) of patients and average imbalance in 29 % (6/21) of patients on the left arm in group G1. In group G2, severe imbalance was established in 26% (22/85) of respondents and average imbalance in 48% (41/85) of respondents on the right arm. There was severe imbalance in 37 % (31/85) of respondents and average imbalance in 38 % (33/85) on the left arm in group G2. This indicates the presence of signs of autonomic imbalance and a preclinical predictor of pathology in the G2 group of functionally healthy respondents. At the same time, in group G1 in patients with COPD, a

larger number of people have the phenomenon of lateralization, which indicates a greater degree of autonomic dysfunction in them.

Table 2

Comparative characteristics of the physical and mathematical parameters of EPEA in study groups: part 2

P	Form Coefficient (FC)			Entropy Coefficient (EC)			Inner contour length		
F/G	G1	G2	P value	G1	G2	P value	G1	G2	P value
1L	2.455±0.235	2.506±0.326	0.68	1.79±0.18	1.95±0.26	0.004	429.8±71.01	388.7±66.39	0.01
2L	2.337±0.179	2.574±0.365	0.007	1.805±0.190	2.132±0.309	<0.0001	384.6±44.1	327.9±59.51	<0.0001
3L	2.298±0.577	2.56±0.29	0.0029	1.79±0.60	2.094±0.38	<0.0001	371.4±109.2	337.1±54.19	0.0005
4L	2.476±0.253	2.626±0.326	0.74	1.911±0.222	2.174±0.283	<0.0001	361.8±59.34	316.5±46.5	0.0006
5L	2.46±0.249	2.65±0.353	0.0072	2.021±0.29	2.358±0.395	0.0003	332.2±58.82	285.2±56.91	0.0012
1R	2.499±0.3913	2.468±0.307	0.77	1.803±0.25	1.947±0.234	0.0098	441.5±83.79	382.7±62.66	0.0023
2R	2.471±0.265	2.588±0.342	0.1	1.826±0.141	2.166±0.297	<0.0001	390.4±58.77	320.6±57.5	<0.0001
3R	2.501±0.28	2.583±0.276	0.19	1.824±0.157	2.086±0.243	<0.0001	400.7±52.03	338±47.99	<0.0001
4R	2.638±0.346	2.634±0.292	0.77	1.996±0.203	2.179±0.272	0.0037	350.8±47.78	316.7±49.34	0.0037
5R	2.521±0.291	2.65±0.353	0.0176	2.007±0.259	2.403±0.372	<0.0001	338.9±57.41	280.3±56.28	0.0001
P	Inner contour radius			Outer contour length			Outer contour radius		
F/G	G1	G2	P value	G1	G2	P value	G1	G2	P value
1L	53.68±10.18	49.94±9.07	0.04	758.7±74.84	743.9±67.28	0.33	77.68±9.30	74.95±7.35	0.14
2L	47.46±6.16	41.09±8.03	0.0003	688.2±44.01	684±57.81	0.30	71.35±6.01	68.03±6.82	0.02
3L	46.2±14.14	42.4±7.16	0.0037	672.3±162.6	691.5±52.68	0.51	69.54±17.48	68.95±5.92	0.022
4L	44.14±8.284	39.02±6.072	0.0031	681.3±55.38	677±48.28	0.91	69.56±7.158	66.68±5.22	0.07
5L	40.36±7.56	35.11±7.198	0.0039	658.8±47.44	653.1±57.47	0.67	67.12±5.618	64.02±6.148	0.0071
1R	55.96±12.16	48.78±8.85	0.0064	777.4±79.94	731.5±66.38	0.0211	79.04±9.35	74.22±7.419	0.0378
2R	48.32±8.571	40.19±7.982	0.0001	707.6±79.84	680.1±61.11	0.13	72.03±6.939	67.44±6.757	0.0066
3R	49.82±7.296	42.41±6.722	0.0001	724.4±52.8	695.1±49.89	0.00198	73.64±7.007	69±5.741	0.0123
4R	42.6±6.684	39.29±6.681	0.06	691.6±42.13	678.9±51.63	0.14	68.66±6.62	66.81±5.4	0.19
5R	41±7.651	34.51±6.978	0.006	667.4±50.84	655.9±65.34	0.27	67.53±6.349	63.66±5.795	0.0084

Note: P is short forms of the Parameter; F/G is short forms of the Finger/Group; P value – the difference Mann-Whitney U-test between the characteristics of the study groups.

The results obtained complement the understanding of the pathogenetic role of biophotons in diseases of internal organs and are consistent with the results that we obtained earlier when studying the emission of biophotons in patients with coronary heart disease and in patients with essential hypertension [7]. In all these studies, significant differences in AEPE parameters were established in comparison groups with functionally healthy respondents. An interesting fact of comparing all the results we obtained is that in patients with coronary heart disease and in patients with arterial hypertension, significant differences were identified in all physical and mathematical parameters of EPEA in study groups, while in patients with COPD such parameters as Area of luminescence and Area (C), and the overall energy level did not differ significantly from the level of functionally healthy respondents. Changes in biophoton emission in patients with COPD were largely qualitative: FC, EC, Inner contour length, Outer contour length, Inner contour radius, Outer contour radius changed significantly. At the same time, a selective nature of changes in the emission of biophotons on some fingers was noted. However, to search for a systemic dependence of the occurrence of this selectivity of local changes in biophoton emission, further research is necessary to draw an objective conclusion. In general, if we analyze all the results, we can state that in the tissues of healthy people and patients with NCDs, quantitatively and qualitatively different levels of metabolism and mitochondrial activity are observed. At the same time, more severe and complicated forms of NCDs (for example, coronary heart disease complicated by myocardial infarction) are characterized by more multiple and pronounced changes in AEPE parameters than, for example, COPD (GOLD B patients).

It is important to note that the AEPE method is not a direct method for assessing mitochondrial function, but it does provide objective information about the total metabolic rate at the cellular and tissue levels *in vivo* at the time of measurement. This is so because the generation of biophotons is the final stage of energy exchange in living organisms and a component of intercellular signaling in living organisms [2].

Therefore, it is quite logical that it is possible to indirectly assess the level of metabolism and mitochondrial activity when studying the physical and mathematical parameters of biophoton emission. As the scientific search for adequate and technically simple techniques for use in clinical settings continues, the AEPE method deserves close attention as a promising candidate for scientific research into the integral level of cellular metabolism/mitochondrial activity.

Nowadays, interest in the study of biophotons is growing [2, 4, 8]. It is now categorically obvious that electromagnetic signaling plays a significant role in the transfer of information and energy between cells, tissues and organs. Biophotons are a previously missing fundamental link in understanding the mechanisms of high-speed communication and how such a complex multi-hierarchical system as the human body becomes one functional whole. Therefore, continuing further research in this direction is promising. This may contribute to understanding the processes of changes in the interaction and functional state of organs when comorbidity and multimorbidity occur in NCDs. Although at the moment many questions about the mechanisms of biophotonic communication remain unanswered, this is still a very important and promising direction for internal medicine and science in general.

Conclusions

1. Patients with NCDs with COPD (GOLD B patients) had significant differences in qualitative physical and mathematical parameters of EPEA, which characterize the shape of the glow (Form Coefficient, Entropy Coefficient, Inner contour length, Outer contour length, Inner contour radius, Outer contour radius) compared to functionally healthy young respondents, which testifies to a different course of metabolic processes in them.

2. As the scientific search for adequate and technically simple techniques for use in clinical settings continues, the AEPE method deserves close attention as a promising candidate for scientific research into the integral level of cellular metabolism/mitochondrial activity.

3. Many questions about the mechanisms of biophotonic communication remain unanswered, so biophotonics of the human body is an important and promising direction for internal medicine and science in general.

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