Medical Technology of Electrophotonics – Gas Discharge Visualization - in Evaluation of Cognitive Functions

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Abstract. For the control of the therapeutic effectiveness of the anti-depressant Simbalta and its influence to cognitive functions of the patients psycho-diagnostic methods and medical technology of Electrophotonic Imaging Capture (EPC) based on Gas Discharge Vizualisation (GDV) technique have been successfully applied. Results of psycho-diagnostics well correlate with the main EPC parameters.

Key words. psycho-diagnostics, Electrophotonic Imaging, Gas Discharge Vizualisation, cognitive functions, anti-depressant.

Introduction.

More and more attention of scientists from different fields of science is attracted by so named "human factor" which influence the safety of people in a modern world. For minimization of such influences an active selection of methods for objective evaluation not only psycho-physiological and physical state of a person, but as well important highest cerebral (cognitive) functions (HCF) is being done. It is well known that cognitive functions are closely interconnected. The most complicated functions of the brain are intellect, speech, praxis, gnosis, memory, attention. Depression of some HCF (memory, attention) is common for many neurological diseases, as well as for the process of treatment with psychotropic medications[1]. This may influence not only the quality of life, but the professional skill of people, in particular in professions with high level of attention (operators of air and railroad systems, military complexes, etc.). At the moment the most common is complex evaluation of HCF, including neurological evaluation, neuro-psychological testing, laboratory and instrumental methods of diagnostics, structural and functional neuro-visualization. At the same time the search of simple-in-use and objective diagnostic method complementary to the clinical studies of HCF activity in the process of neurological treatment is very important. Psychotropic medications actively used by neurologists in the process of anxiety-depression treatment, in particular, anti-depressants, may decrease active attention[2]. Priority in using medications of this group is defined by modern pharmaco-therapeutic tendencies for mono-therapy[3] with simultaneous influence on the complex of the main neurological syndromes, but their impact to the cognitive functions is not being evaluated objectively. In case of chronic pain anxiety-depression syndromes are quite common (15-20%)[4]. Keeping in mind similar character of their pathogenetic mechanisms[5] it make sense prescribing anti-depressants of balanced dual activity, for example, Simbalta[6]. A lot of data published on anti-depression and anti-anxiety effects of Simbalta, but much less – on its effects on chronic pain syndrome and cognitive functions. For the evaluation of the effects of treatment with anti-depressant Simbalta and its influence to cognitive functions clinical evaluation, psycho-diagnostics and measurements of stimulated by electrical field glow of fingers with medical electrophotonic capturing (EPC) technology have been used.

Materials and methods.

In accordance with approved protocol Simbalta was prescribed for patients for 2-month course by 60 mg per day. Therapy effectiveness was evaluated by the overall clinical situation, subjective questioner, visual analog pain scale, depression scale (CES-D), psycho-diagnostic tests and EPC/GDV parameters.

Inclusion criteria was chronic pain syndromes (headaches, back pains and their combinations) for the patients with dis-circulator encephalopathy (DE) and correlated disorders: depression and/or anxiety. 13 women and 18 men (n=31) aged 32-69 years (51.2+/-2.1 year) have been selected. DE diagnosis was confirmed by the previous clinical analysis.

Psychological testing included a panel of psycho-diagnostic methods aimed to study memory, attention, emotions, thinking process: "Shultze Tables", "Vexler Memory Scale", "Remembering 10 vocals", "Methodic of evaluation of the thinking speed", "Extra-parts exclusion", "Questioner feelings-activity-mood", "Self-evaluation scale by C. Spielberg and U. Khanin", "8 color Lusher test", "Zung depression scale" as well as psycho-diagnostic discussion.

The EPC camera is presently the state-of-the-art in bioelectrography[7]. It utilizes a high frequency (1024 Hz), high-voltage (10 kV) input to the finger (or other object to be measured), which is placed on the electrified glass lens of the EPC camera. Because the electrical current applied to the body is very low, most human subjects do not experience any sensation when exposing their fingertip to the camera. In practice, the applied electric field is pulsed on and off every 10 microseconds, and the fingertip is exposed for only 0.5 seconds. This causes a corona discharge of light-emitting plasma to stream outward from the fingertip. The light emitted from the finger is detected directly by a CCD (charge-coupled detector), which is the state-of-the-art in scientific instruments to measure extremely low-level light. The signal from the CCD is sent directly to a computer, and software analysis is done to calculate a variety of parameters that characterize the pattern of light emitted, including normalized area (NA), brightness, and form coefficient. Measurements were taken from all 10 fingers with (F) and without (WF) special polymer film which allows to avoid direct perspiration from the skin. The underlying principle of camera operation is similar to well-known Kirlian effect[8] but modern technology allows to have reproducible stable data with quantitative computer analysis.

Statistical analysis was done in Statistica v.6.0 program.

Results.

In the process of clinical examinations patients claimed frequent headaches, back pains, unreasonable anxiety, stress, uncontrollable aggression, vertigo, fast tiredness, low workability, sleep disorders, decrees of libido. Memory dysfunctions were mentioned as second claim after pain. In many cases the state of health was self-evaluated as bad, practically all patients demonstrated stable hypochondriac fixation.

Headaches were registered in 32.2% (n=10), cervico-cranialgia in 45.2% (n=14), mixed forms in 12.9% (n=4). Back pains were originated by vertebrae-gene neurological syndrome with degenerative-dystrophic changes of vertebra and were divided to muscle-tonic in 51.7% (n=15), root in 32.3% (n=10) and their combinations in 12.9% (n=4).

The level of pain syndrome presentation on the VAS scale was 5.21+/-0.59 before treatment and 4.04+/-0.77 after treatment. Decrease of pain syndrome was mentioned by 87.5% of patients, which was associated with increase of emotional status and better quality of sleep.

Averaged grade on CES-D scale was 22.31+/-2,24 before treatment (light stage depression) and 13.88+/-2.05 after treatment (no depression).

Subjective evaluation demonstrated positive effect of treatment for 94% of patients and no effect of decrease of state for 6%.

Subjective claims were confirmed by questioner's data: together with bad mood, increased level of depression, high level of anxiety and decrease of intellectual and motor activity was registered. Short-time mechanic memory was evaluated as 40% with norm 80%, eye memory as 65%, speech-logic memory as 60% and operative memory as 62.5%. Relatively well-kept were functions of the long-range memory. Cognitive functions of generalization, comparison and classification were supressed from light to significant level. In most cases patients operated with particular ideas based on direct impressions which characterized supression of analysis and synthesis and disorder of dynamics of the highest cognitive functions. Decrease of tempo of orientation and operational cognitive components and low indexes of nerve processes activity were registered.

Comparison of the results of psycho-diagnostics of cognitive functions (logic memory, attention, speed of thinking) with EPC parameters demonstrated statistically significant correlations. For example, the highest level of logic memory was associated with low levels of EPC normalized area index for the left hand (fig.1). Similar correlations between logic memory condition and EPC average brightness were found.
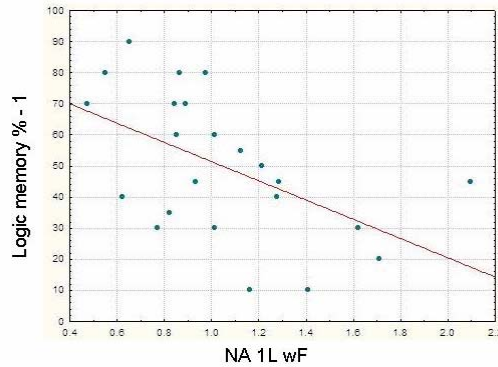

Fig. 1. Correlation of logic memory and normalized area for 1L finger wF – linear regression.
Logic memory %-1= 82.3-30.9x, Pearson correlation test r = -0.53, p = 0.01

Parameters of voluntary attention (in accordance with Shultz tables) were correlated with EPC normalized area and average brightness indexes of the right and left hands (fig. 2).
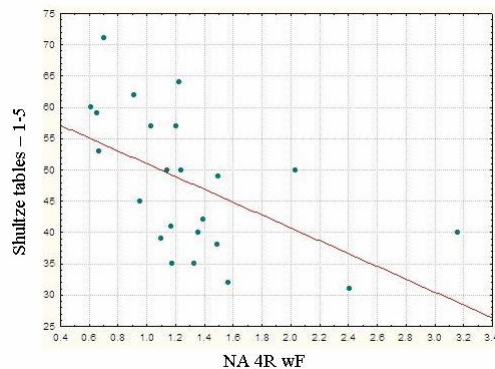

Fig. 2. Correlation of Shultze Tables' results (subtest 5) and normalized area for 4R finger wF – linear regression. Shultze Tables 1-5 = 61.2-10.3x, Pearson correlation test r = -0.54, p = 0.008

The speed of thinking was correlated with EPC normalized area of the left and right thumbs (fig.3). Before treatment these parameters were decreased: 13 points for the speed of thinking (the norm is 22).
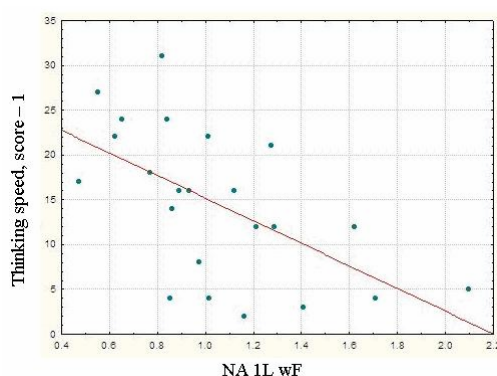
Fig. 3. Correlation of thinking speed and normalized area for 1L finger wF - linear regression. Thinking speed, score -1= 27.8-12.6x, Pearson correlation test r = -0.585, p = 0.003

After the course of treatment for most patients stabilization of psychic control, decrease of anxiety intensity, feeling of psychological dis-comfort and social helplessness were noted. Personal anxiety indexes after treatment remained at the same level as before, with simultaneous decrease of reactive anxiety; actual situation was accepted by patients as beneficial, having no danger, which was confirmed by Spielberg – Khanin test.

Positive dynamic was noted in subjective feelings, increase of the quality of life and balanced behavior. Mood became more stable, the level of activity, workability, emotional involvement, as well as the level of self-confidence and future perspectives had the positive evaluation. Dependence from others and necessity of their support and positive response was reduced significantly.

Change of mood, decrease of reflection and social dependence helped for free self-regulation and had positive impact on cognitive functions of memory and attention (fig.4, 5).
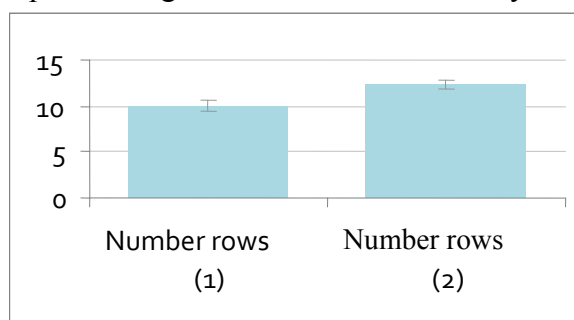

Fig. 4. Changes in short-term memory volume according to the subtest «number rows» before (1) and after (2) Simbalta treatment
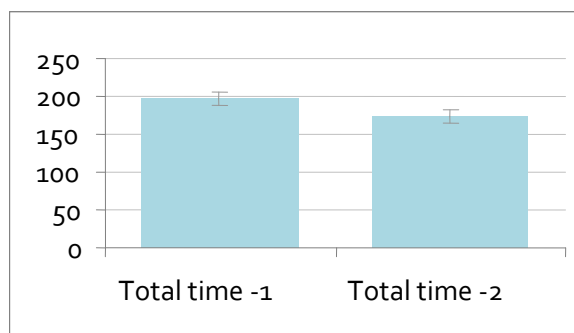

Fig. 5. Changes in functions of unconditioned attention according to Shultze Tables before (1) and after (2) Simbalta treatment

This had positive impact on psychic workability of patients. Comparison of Shultzze table data (the level of volunteer attention) demonstrated correlation with EPC normalized area and average brightness indexes of the right and left hands (fig. 6).
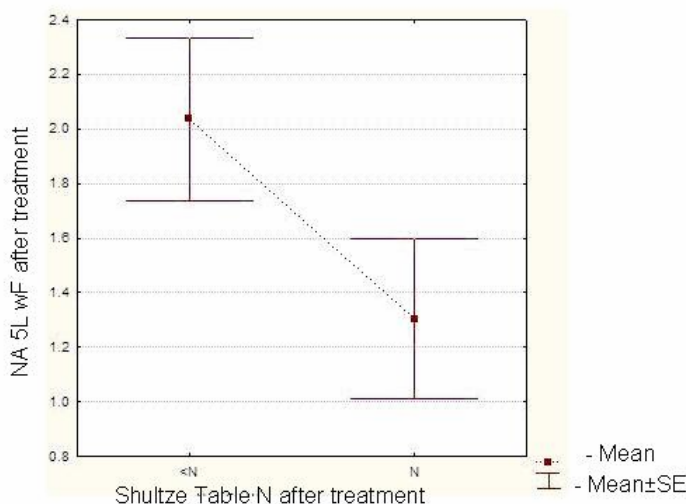

Fig.6. Values of normalized area for 5L finger wF in patients with normal (N) and lower (<N) results of Shultze tests (unconditioned attention).

Psycho emotional disorders presented as anxiety and depression correlated with EPC normalized area and form coefficient of the both hands. Data of Spielberg-Khanin questioner for situation anxiety had statistically significant correlation with EPC form coefficient index, while multi-directional correlations had been found with EPC area parameter. Depression index from Zung test had a tendency to correlation with EPC form coefficient index.

As a result of treatment chronic pain syndrome had decreased and both psycho-emotional and cognitive functions had improved.

Discussion

Clinical data confirmed the effectiveness of treatment of chronic pain syndrome and anxiety-depression disorders with Simbalta. Using of psycho-diagnostic methods allowed evaluate objectively positive dynamics of patients' state and improvement of cognitive functions – shot-time mechanic and operative memory.

Comparison of psycho-diagnostic data with EPC parameters for the first time demonstrated correlations between indexes of volunteer attention, logic memory and speed of thinking with EPC parameters of both thumbs.

In accordance with modern knowledge different parts of cerebrum provide cognitive functions and they are functionally interconnected as well as connected with somato-topic cerebral presentation of the hand where zone presenting thumbs has the biggest area[9]. We may assume interconnection of the bio-electric processes in the cerebral areas related to skin sensors of fingers and nearby areas of the brain responsible for cognitive functions, which may affect parameters of stimulated emission of the distal part of the same sensor – skin of fingers. Further investigation of these correlations from the point of view of modern science is necessary for explanation of this mechanism. Our results provide background for such research line.

More than 20 year ago it was assumed[10] that emotional functions result in modification of the energy reserves of the body. EPC method may become an integrative way of evaluation of such modifications which reflect not only on emotional, but on cognitive activity as well. This defines new tasks for the researchers exploring the EPC medical technology.

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