

Objective Measurement of Pain Intensity by Electrostimulation of Biological Active Points

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Abstract – We have established a good correlation between electrical pulse amplitude set by the patient at computerized electroacupuncture stimulation and pain intensity determined according to visual pain scale. Our results show that the value of the pulse amplitude can be used as an objective index of pain intensity before or in the process of pain syndrome treatment.

Keywords – electroacupuncture; biologically active points; bowel irritable syndrome; visual pain scale; pain intensity

I. INTRODUCTION

The effective pain treatment needs objective estimation of pain level. At present this estimation is mainly based on subjective psychological methods such as visual pain scale (VPS) [1,2]. During the practice of application of KES-01-MIDA apparatus [3,4] in the computerized electroacupuncture (CEAP) treatment of painful form of bowel irritable syndrome (BIS) [5-7] we found out that the stimulation amplitude of the electric pulse is connected with pain intensity felt by patients. We present the results of

research of the correlation between the pain intensity estimated by the patients with the help of VPS and the value of amplitude of the stimulation pulse set by the patient during CEAP treatment.

II. MATERIALS AND METHODS

We observed 19 patients with painful form of BIS (diagnosis was verified according to Rome criteria II [5,6]). They were treated by complex therapy, which included five everyday séances of CEAP with KES-01-MIDA apparatus. This device allows applying positive or negative trapezoidal voltage pulses alternately to 16 biologically active points (BAP) with individually adjusted amplitude (up to 10 V, regulated by patient), duration (4-750 ms) and frequency (0.2-125 Hz depending on pulse duration). The device also automatically measures the amplitude of all voltage pulses and electrical resistance of BAP before and after séance keeping them in the database.

Table I. The CEAP séance program for patients with BIS (one cycle).

№	Acupuncture points (BAP)*	Pulse type	Pulse duration, ms	Stimulation time, s***	Frequency, Hz	Pulse amplitude, V
1	P. sympatic I (left)	1(2)**	10	50	10	0.1-10****
2	P. sympatic I (right)	1(2)	10	50	10	0.1-10
3	P. Th IV-S II (left)	1	10	75	10	0.1-10
4	P. Th IV-S II (right)	1	10	75	10	0.1-10
5	P. shen-men (left)	1	4	70	15	0.1-10
6	P. shen-men (right)	1	4	70	15	0.1-10
7	P. small intestine (left)	1	15	30	15	0.1-10
8	P. small intestine (right)	1	15	30	15	0.1-10
9	P. solar plexus (left)	1	10	70	10	0.1-10
10	P. solar plexus (right)	1	10	70	10	0.1-10
11	P. stomach (left)	1	10	30	10	0.1-10
12	P. stomach (right)	1	10	30	10	0.1-10
13	P. spleen (left)	1	4	30	10	0.1-10
14	P. spleen (right)	1	4	30	10	0.1-10
15	P. plain muscles tone (left)	1(2)	20	70	15	0.1-10
16	P. plain muscle tone (right)	1(2)	20	70	15	0.1-10

* - after [8]

** - type 1 is positive trapezium, type 2 is negative trapezium

*** - the overall time of the séance is determined by the number of repetitions of the cycles: 3-5-7-5-3 from the first to the fifth séance

**** - the amplitude is set by patients themselves according to their sensation

The empirically determined scheme of CEAP treatment is shown in table 1; electrical pulses were applied successively to auricular BAP. At the beginning of the first séance (“Adaptation” regime of the apparatus) the amplitude of pulses was set by patients raising the voltage until they feel discomfort. At the beginning of the “Stimulation” regime the amplitude is slightly (usually 3%) reduced, and this initial value U_i is kept in PC memory. During the séance the patient adjusts the pulse amplitude according to his feeling. The last value of pulse amplitude is also kept in PC memory and serves as the start value for the next séance. The final value of pulse amplitude U_f was measured in the end of the five-day CEAP treatment and also kept in PC memory.

At the beginning and one day after the CEAP treatment the patients were asked to evaluate the pain intensity with VPS instrument.

The data analysis was carried out in the following way. The values of U_i and U_f were simple averaged for all 16 BAP; afterwards the averaged values U_{iav} and U_{fav} were used. The values U_{iav} were correlated (after Pearson) to initial VPS data of pain intensity using Statistica 6.0 (StatSoft) program.

Similarly the pain intensity changes (differences between final and initial VPS pain values) were correlated to the differences $U_{fav} - U_{iav}$. The data are represented as Mean \pm Standard Error.

III. RESULTS AND DISCUSSION

The results are presented on Figs.1, 2.

As it is evident from Fig.1 the relation between initial values of VPS pain intensity and average initial pulse amplitude can be well approximated with a linear function ($r = 0.78, p < 0.001$). A similar linear dependence is observed between the change of pain intensity and the difference $U_{fav} - U_{iav}$ (Fig.1). It means that the CEAP electrical pulse amplitude (set by patient according to his sensation) can be used for objective measurement of pain syndrome intensity. We noted also that the decrease of stimulation pulse amplitude is practically the same for all the BAP of the scheme; it means that it may be possible to measure pain intensity using only a limited number (or even one) of BAP.

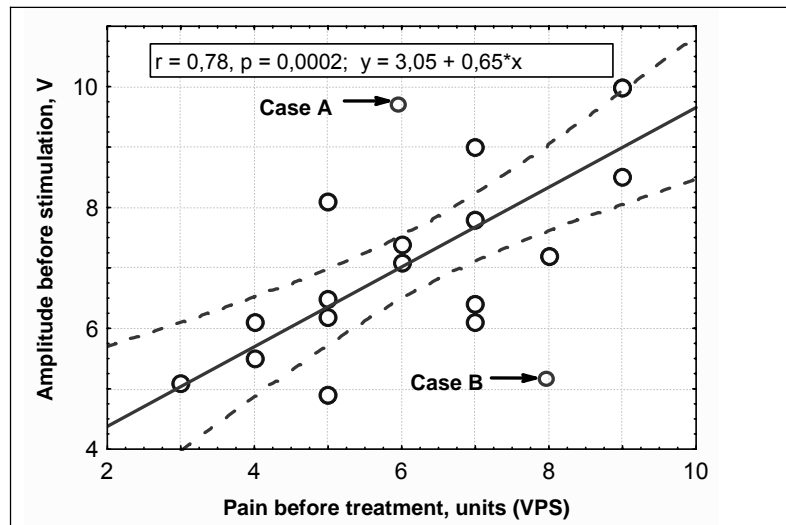


Fig. 1. The mean amplitude of initial CEAP stimulation pulses set by patients vs pain intensity (according to VPS) before treatment; $n = 19$.

Two cases (Case A and Case B) were excluded from the analysis. Theoretically Case A can be related either to a hyper low sensitivity of skin to electric impact or to an incorrect use of VPS by patient (subjective underestimation of pain intensity). Similarly Case B can be related either to a hyper high sensitivity of skin to electric impact or to subjective pain overestimation or even to simulation of pain syndrome. The data shown on Fig.2 seem to confirm the first hypothesis in Case A: though after the treatment the VPS pain appreciated by the patient reduced considerably (from 6 to 1 unit), the amplitude of electric pulse felt by the patient changed insignificantly (from 9.8 to 8.5 V), remaining the highest value in the group. Also the data of Fig.2 seem to

confirm the pain simulation hypothesis in Case B: it was the only case of increase of VPS pain intensity (from 8 to 9 units) with simultaneous decrease of the amplitude of electric pulse (from 5.2 to 4.1 V).

As a result of treatment the average VPS pain intensity of the group decreased from 6.3 ± 0.4 to 3.4 ± 0.3 units ($p < 0.001$ by t-test for dependent samples). The value of stimulation pulse amplitude (which was diminished by the patients from séance to séance) changed in a similar manner – from 7.2 ± 0.4 to 3.7 ± 0.2 V, $p < 0.001$ (fig. 3). Perhaps the presence of pain (abdominal in our case) causes the decreased sensitivity of BAP to electric impact.

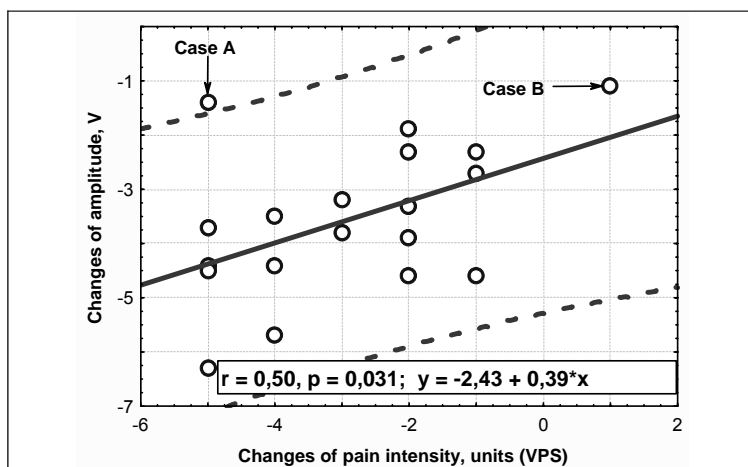


Fig. 2. The changes of mean amplitude of CEAP stimulation pulses vs the change of pain intensity (according to VPS) as the result of treatment of BIS (n = 19).

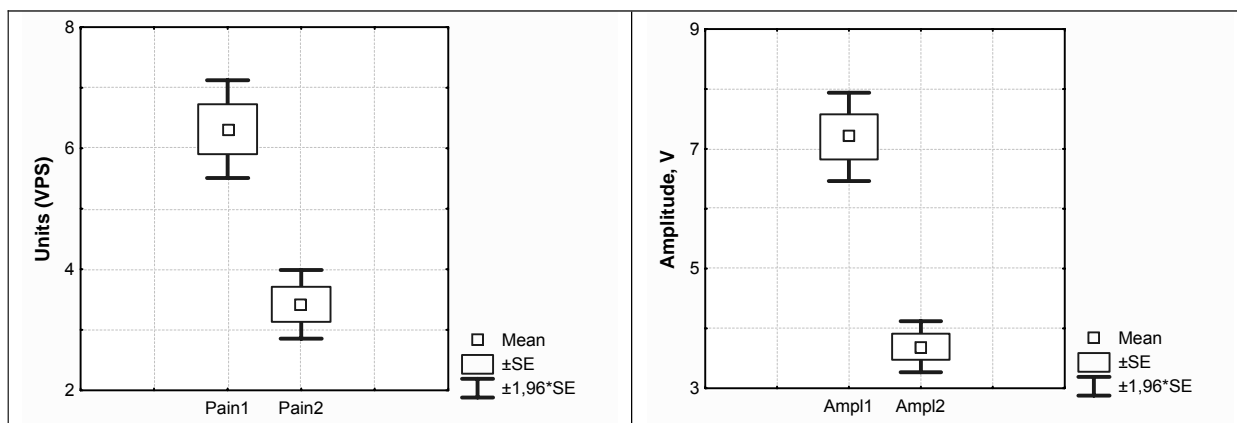


Fig. 3. The dynamics of pain syndrome intensity according to VPS (left) and mean amplitude of CEAP stimulation pulses (right) during the treatment of BIS (n = 19). Control points: 1 – before treatment; 2 – after 5-day treatment.

IV RESUME

When using computer electroacupuncture for treatment of patients with apparent pain (painful form of bowel irritable syndrome in our case) the level of pain (subjectively determined by visual pain scale) is closely related to electrical pulse amplitude (selected by the patient during treatment) applied to biologically active points. The linear correlation dependence between pain intensity and CEAP pulse amplitude and their changes during treatment presents practical interest for apparatus based measurement of pain level. It seems that the combination of CEAP and VPS makes possible to find out patients with pain hyper- and hypo sensitivity and to differentiate between real and simulated pain. However the practical realization of pain measurement device needs additional clinical research, including different causes of pain syndrome.

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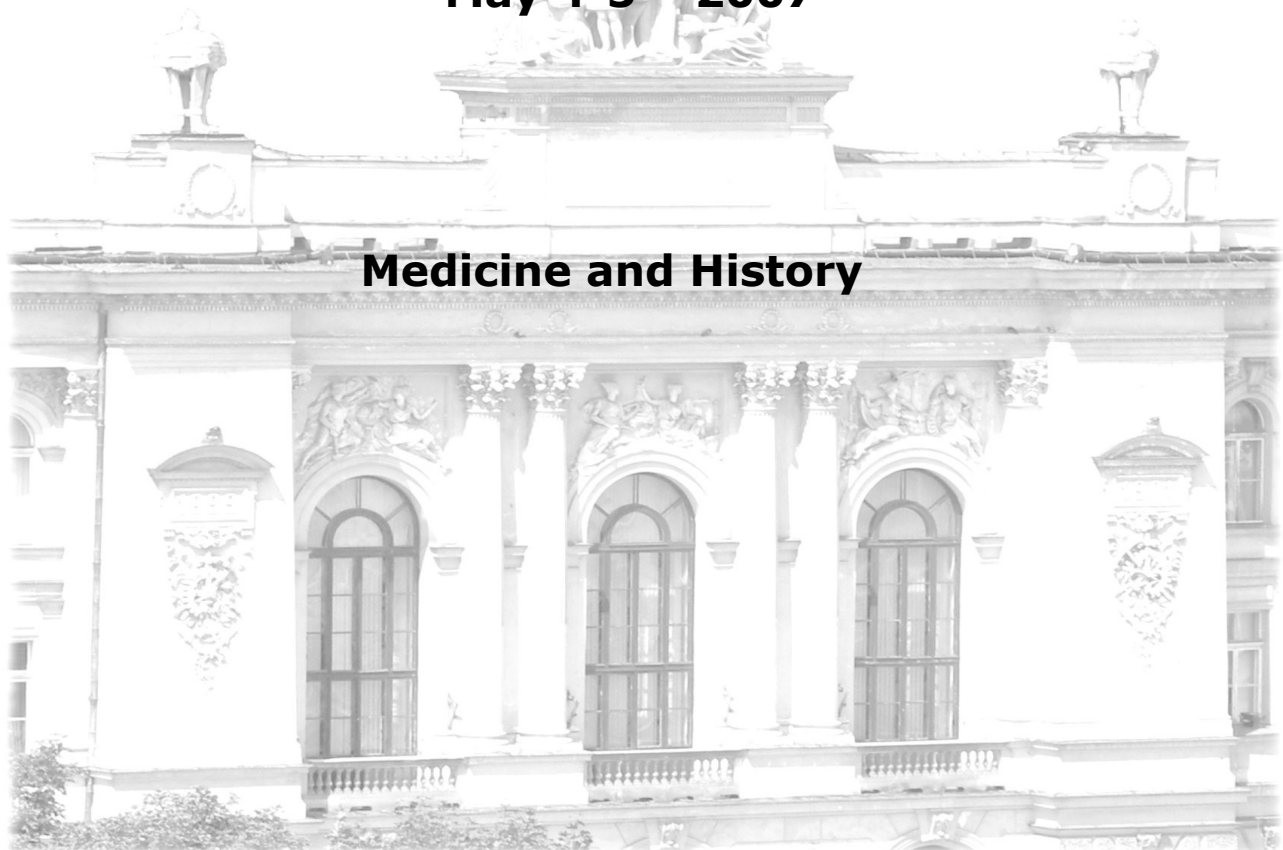
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IEEE Catalog Number: 07EX1720C

ISBN: 1-4244-1080-0

Library of Congress: 2007921695

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