The change of the skin electroconductivity and cardiointervalography indicators under the influence of different physical factors

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Abstract. The study of the optimal health-improving technologies with the physical factors usage, including odorant influence with the use of the essential oil both separately and in combination with the physical exercises, is a promising scientific area. A trustworthy change of the vegetative regulation mechanisms towards their optimization both under the impact of combining the physical load with a prolonged contact with the essential oils, and only of the essential oils usage, besides the more pronounced differences were registered in the first case. All the registered changes were of a relatively prolonged character. The decrease in the parasympathetic influence on the heart, based on the analysis of the heart rate variability according to R.M. Bayevsky, was accompanied with the decrease in the average value of skin’s EC. The combination of the physical load with the essential oils’ prolonged contact leads to a trustworthy decrease in the EC values in BHS of the heart meridian, characterizing myocardium and endocardium on the right. It can be applied to objectivize the integral changes of the vegetative innervation state and in the complex with other methods – to determine their primary sympathetic and parasympathetic orientation.

1. Introduction

The risk of the regulatory mechanism’s disorder increases among the female population at the lowered motor activity and in the additional looming condition of the unfavourable ecological situation; this leads to the decrease in the adaptive abilities. The increase in the adaptive efficiency of practically healthy people but with lowered reserved abilities and age-related peculiarities is an important medical issue. The improvement of the human’s adaptation in the modern society is impossible without a wide usage of natural and preformed physical factors. Physical loads and prolonged inhalations of the essential oils’ (EO) mixtures in the natural concentrations refer to the latter. They actively influence the vegetative regulation and the adaptive processes [1, 2]. The main advantage of these methods while affecting the human body is their physiology and naturalness. The study of the optimum health-improving technologies, using the physical factors, including odorant influence with the usage of EO, both separately and in the combination with physical loads, is a promising scientific area.

The analysis of the heart rate variability (HRV) is a modern methodology of the research and evaluation of the body’s regulatory systems, in particular the functional state of the vegetative nervous system’s different divisions. At present the methods of HRV analysis are widely spread due to their scientific and applied significance; every year these methods get more wide-spread [1-3]. The
interconnections between the HRV indicators and age-sex aspects of the schoolchildren’s loads are studied well; sufficient experience is accumulated in order to use the method of the extreme impact in medicine, in different areas of the applied physiology, in surgery for the anaesthesia control, in neurology for the differential evaluation of morphological and functional lesions, even in oncology the attempts were done in order to use it for evaluating the degree of the metabolic disorders [1, 4].

“Electropuncture diagnostics”, which is known and has been used for the last 30 years, allows forming diagnostic propositions and treatment tactics on the basis of the declination in the spots, which the electroconductivity being measured in, from the average. It is well-known that the skin is closely connected with all the organs and systems of the body; it is distinguished by especially strong links with the nervous system and particular its vegetative division [5, 6]. The research of dermographism, perspiration, and thermometry of the skin are the classical methods of evaluating the state of the vegetative nervous system (VNS), though considerably rare the method of electrodermal resistance, which is relatively simple and known long ago, is applied. Probably it is connected with a low reiteration of the results and the complexity of the obtained values’ analysis; this is explained by the insufficient maintenance of the range of technical and methodological aspects [7-8].

However, the significance of the exposure of the joint study and the skin electroconductivity indicators’ change analysis as well as of the cardiointervalography under the influence of many physical factors is topical and is of great practical interest in the area of restorative medicine and human’s physiology.

2. Task setting
The objective of the research was the comparison of the results of studying the vegetative balance, obtained by different methods; and the evaluation of the possibility to use the skin’s electroconductivity values for the objectivization of the vegetative innervation state’s changes, arisen under the influence of the inhalation with the essential oils’ mixture separately and in combination with the physical load.

3. Research and its methods
Forty-five women of 22-25 years old with the lowered level of the physical capacity for work (9.3±1.1 kgm/min/kg) participated in the research. The research of the physical efficiency was done on the bicycle ergometer VE-02 by the two-stage test according to the methodology of V.L. Karpman. Three groups were formed.

The control group consisted of 18 people. In Group 1 (n=13) prolonged inhalations with the mixture of the essential oils of rose, lavender, sage and coriander – “Polyol” in the natural concentrations 1-1.5 mg/m³ in the amount of 24 procedures – were used as the corrective influence. In Group 2 (n=14), combined with the “Polyol” inhalations, 24 lessons of physical exercises in the aerobic mode according to N.M. Amosov’s methodology were conducted. During eight-week training course of 24 lessons, 40-50 minutes each, were conducted; during this period the women ran on average 80 km. The training pulse was calculated individually and varied in the range of 140-165 beat/min.

The evaluation of the vegetative regulation state was done in the beginning and the end of the experiment, and also to assess the stability of the obtained results the evaluation was done 2-3 weeks later since the end of the experiment with the help of the heart rate variability analysis according to R. M. Bayevsky. The following indicators were analyzed: mode (Mo, ms), and spectral heart rate indicators; high-frequency component (HF, %), low-frequency waves of the 1st order (LF, %), low-frequency waves (VLF, %).

The research of the skin’s electroconductivity was done in the same period on the MPTK “Medissa” in 24 biological hot spots (BHS) of the hands according to the 2nd stage of the main algorithm examination concerning BHS choice during the diagnostics in accordance with the modified Voll’s electroacupuncture methodology [5, 6].

The processing of the experimental data was done with the usage of the softwear package STATISTICA-6.0. The evaluation of divergence of the indications’ distribution was done with the
help of the Kolmogorov-Smirnov test. To assess the interconnection between the indications under the study the Spearman’s rank correlation coefficient was implemented. The analysis of the intensity indicators’ differences between the groups under the research in the independent samples were done by the non-parametric criterion of the Mann-Whitney test, Me; for the linked samples the Wilcoxon test was used.

4. Results of the research

While analyzing the obtained results, a trustworthy change of the vegetative regulation mechanisms towards their optimization was registered both under the influence of a combined physical load with a prolonged contact with the essential oils, and while using only essential oils; however more expressed differences were marked in the first case (Table 1).

Table 1. The change of the mode of the cardiac cycle length (Mo, ms) before and after corrective measures under the influence of different physical factors, Me.

| №  | Groups of the examinees | Mo, ms Before | Mo, ms After | Credibility* |
|----|-------------------------|---------------|--------------|--------------|
| 1  | Control (n=18)          | 834           | 820          | -            |
| 2  | The first main (n=13)   | 850           | 690          | p<0.05       |
| 3  | The second main (n=14)  | 870           | 660          | p<0.01       |
|    | Credibility (1-2)       | -             | p<0.05       | -            |
|    | Credibility (1-3)       | -             | p<0.05       | -            |
|    | Credibility (2-3)       | -             | -            | -            |

Note: comparison for the linked samples was done by the non-parametric criterion of the Wilcoxon test.

The mode of the cardiac cycle length (Mo, ms) characterizes the parasympathetic regulation, and its increase evidenced the strengthening of autoregulating influences. In the women with a lowered level of physical efficiency the vagotonic tone orientation prevailed. In our case it is the manifestation of regulatory mechanisms’ disbalance; and vegetative regulation did not provide the somatic needs in the process of the load test. The vegetative disbalance caused non-optimal vegetative assurance of the activity of the examined women under the physical load; this affected the decrease in the level of the physical efficiency.

In Group 1 after eight-week’s influence of the essential oils’ mixture (rose, lavender and coriander) “Polyol” in the natural concentrations there was registered a credible decrease in the values of Mo indicators at rest on average in the group from 850 ms at the beginning of the research to 690 ms at the end (p<0.05). After the complex influence in Group 2 Mo lowered from 870 ms at the beginning of the experiment to 660 ms at the end (p<0.01). The obtained considerable decrease in the Mo indicator showed the weakening of parasympathetic influences and activation of the sympathetic over-segmental level of the regulation. On condition that the women, being examined, initially demonstrated the vagotonic predominance of ensuring the motion activity on the background of the lowered physical efficiency level, the strengthening of the sympathetic phenomena can be considered as the balancing of regulatory mechanisms.

During the analysis of the heart rate variability’s spectral indicators it was found out that the structure of the distribution of the heart rate’s frequency components had trustworthy changed in Group 2 under the complex influence (Table 2).

This redistribution occurred due to the lowering of the high-frequency component of the heart rate (HF, %) on average in the group from 44% to 26-35% (p<0.01). The decrease in the parasympathetic influence on the heart drew closer the distribution of the spectra to the optimum values.
### Table 2. The change of the spectral indicators of the heart rate variability before and after the corrective measures under the influence of different physical factors.

| №  | Groups of the examinees | Indicators |
|----|-------------------------|------------|
|    |                         | LF, %      | VLF, % | HF, % |
| 1  | Control (n=18)          |            |        |       |
|    | Before                  | 38         | 26     | 36    |
|    | After                   | 37         | 24     | 39    |
|    | Credibility             |            |        |       |
|    | The first main (n=13)   | p<0.05     | -      | p<0.05|
|    | Before                  | 28         | 29     | 43    |
|    | After                   | 39         | 31     | 30    |
| 2  | The main second (n=14)  |            |        |       |
|    | Before                  | 26         | 30     | 44    |
|    | After                   | 47         | 20     | 33    |
|    | Credibility             | p<0.01     | p<0.05 | p<0.01|

Note: the comparison for the linked samples was done by the non-parametric Wilcoxon test.

Low-frequency spectrum (LF, %), determined both by parasympathetic and sympathetic impacts under the influence of stimulating action of the essential oils increased on average by 8 % (p<0.05), and in the group under the complex influence it increased by 21 % (p<0.05).

The waves of a very low frequency (VLF, %), reflecting cerebral ergotropic influences on the underlying levels and allowing to estimate the brain’s functional state, characterize the sympathetic activity. In this research they have reliably decreased in the state of the rest in Group 2 under the complex influence on average from 30% to 20% (p<0.01), reflecting the decrease in the level of psycho-emotional stress. The obtained results correspond to the dynamics of the mode values of the heart cycle length.

The electric skin potentials change under the influence of the reflex irritations, originated in the inner organs, and also depending on the CNS state [5]. When assessing the values of the skin’s electroconductivity (EC) in the biological hot spots (BHS) of the hands, it was found out that the average EC value in comparison with the initial values in Group 1 decreased by 16.4% (from 50.38±2.64 c.u. to 42.94±2.5 (p<0.05)) and by 19.9% in Group 2 (from 52.14±1.95 c.u. to 41.32±1.32 (p<0.01)). The initial difference of the average values between the body sides both in the control group and in the main Groups 1, 2 remained statistically unreliable.

The dynamics of the values in the researched separate representative BHS of the heart meridian in the most degree was manifested in the EC values changes in Group 2 in the spots, characterizing the myocardium on the right, on average by 15.5% (p<0.01), and endocardium on the right on average by 11.4 (p<0.05). In Group 1 there were not registered similar reliable differences.

Therefore, more manifested EC changes were obtained in Group 2 under the complex influence. They were accompanied with the values’ lowering and were related to such indicators as an average EC value, and BHS of the heart meridian, characterizing myocardium and endocardium on the right.

The decrease in parasympathetic influence on the heart, based on the heart rate variability analysis according to R.M. Bayevsky, was accompanied with the decrease in the EC skin average value. The measurement of the skin conductivity is relatively simple and low-cost method. It can be applied to
objectivize the integral changes of the vegetative innervation state and in combination with other methods to identify their primary sympathetic or parasympathetic orientation.

While researching the above mentioned indicators three weeks after the stop of the essential oils’ complex “Polynol” action and the physical loads stop there were registered the values similar to the ones, obtained immediately after the end of the experiment.

5. Conclusions
1. There was registered a trustworthy change of the vegetative regulation mechanisms towards their optimization both under the influence of combination of the physical load with a prolonged contact with the essential oils, and during the use of only essential oils; besides, more pronounced differences were registered in the first case. All the registered changes had a relatively prolonged character.
2. The decrease in the parasympathetic influence on the heart, based on the heart rate variability analysis according to R.M.Bayevsky, was accompanied with the decrease in the EC skin average value.
3. The combination of the physical load with the prolonged contact with the essential oils leads to the reliable EC values’ decrease in the BHS of the heart meridian, characterizing the myocardium and endocardium on the right.
4. The measurement of the skin electroconductivity is a relatively simple and low-coast method. It can be applied to objectivize the integral changes of the vegetative innervation state and in combination with other methods to identify their primary sympathetic or parasympathetic orientation.

6. References
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