Features of the interpretation of the results of dynamic segmental diagnostics of patients with pathology of the central nervous system and psychovegetative sphere I.V. Boitsov1, T.E. Belousova2 (1LLC "Profdiag", Minsk, 2Nizhny Novgorod Medical Academy, Nizhny Novgorod)

> Features of interpretation of results of dynamic segmental diagnosis of patients with defects of the central nervous system and mental-vegetative activity IV Boitsov1, TE Belousova2 1Profdiag ltd. (Minsk, Belarus Republic), 2 Medical Academy (Nizhniy Novgorod, Russia)

# SUMMARY

The article discusses the possibilities of using the method of dynamic segmental diagnostics as a method for testing skin sympathetic reactions in the process of examining patients with a suprasegmental mechanism of impaired autonomic regulation of the body. It is proposed to calculate the asymmetry coefficients for interpreting the results of DSD testing of patients with such lesions of the autonomic nervous system, which give an idea of the presence and degree of imbalance between the indices of autonomic support for the activity of skin sympathetic reactions on the skin segments of the autonomic supply.

Key words: dynamic segmental diagnostics, skin sympatheticreactions, nervous system.

# RESUME

There are considered in the article the possibilities of dynamic segmental diagnostics (DSDtesting) method use as a way of skin sympathetic response 'testing in the process of examination of patients having the suprasegmental mechanism of the autonomic regulation's disorders of the body. It has been proposed to use the asymmetry coefficients for the interpretation of the DSD-testing of patients with similar disorders of autonomic nervous system. These coefficients give an indication of the presence and degree of imbalance between the vegetative provision of skin sympathetic responses in skin segments vegetative provision.

Keywords: dynamic segmental diagnosis, skin sympathetic response, nervous system.

#### Introduction

A promising direction in the study of the autonomic nervous system is the use of functional methods due to their dynamism, harmlessness and the possibility of early diagnosis of emerging pathology and control of ongoing therapy [1]. Dynamic segmental diagnostics (DSD-testing), reflecting functional shifts of the autonomic nervous system, meets these requirements. The high sensitivity and absolute safety of this diagnostic method makes this screening study indispensable at the first stage of preventive and diagnostic examinations, as a method of monitoring and controlling the effectiveness of treatment of many diseases [2–7].

The purpose of the study is to substantiate and develop a methodology for interpreting the results.dynamic segmental diagnostics as a way of testing skin sympathetic reactions when examining patients with pathology of the central nervous system and psycho-vegetative sphere.

Materials and research methods To achieve this goal, three groups of patients were examined and the control group, consisting of practically healthy people who do not present complaints, have undergone clinical, instrumental and laboratory examinations, and do not have pathology from the central, peripheral and autonomic nervous system - only 25 people (10 women and 15 men aged 18 to 29 years). The first observation group consisted of 25 patients with the consequences of an acute disturbance of the blood supply to the brain in the left carotid system as ischemic stroke and the presence of right-sided hemisyndrome with increased muscle tone of the flexors of the right arm and extensors of the right leg - 11 women and 14 men aged 47 to 69 years. with the duration of the recovery period from 6 months to 1 year. The second group consisted of 25 patients with revealed transient spinal cord ischemia against the background of a pausegmental type of blood supply to the spinal cord [8] - 19 men and 6 women in the age group from 31 to 43 years with a disease duration from 1 month to 4 years. The third observation group consisted of patients suffering from vegetative crises of the type of panic attacks - a total of 21 people (14 women and 7 men aged 19 to 37 years), with a disease duration from 3 months to 5 years.

The study of skin sympathetic reactions was carried out by the method of dynamic segmental diagnostics ("Method of dynamic segmental diagnostics" / Permission for the use of new medical technology No. FS 2011/336. - Federal Service for Surveillance in Healthcare and Social Development of the Russian Federation). Each subject underwent 3 tests with an interval of 1–3 days.

The survey was carried out on the device "POST-12.2" (Registration certificate of the Ministry of Health of the Russian Federation No. 29/23030700 / 2834-02). The basis of dynamic segmental diagnostics is the reflex response of the segmental division of the autonomic nervous system to stimulation of the skin nerve receptors by electric current in the area of application of the active electrode. During the examination, the testing current of the following parameters was used: voltage from 6 to 21 V; current strength from 150 to 250  $\mu$ A. The active electrode is of negative polarity, the area of contact with the skin is about 1 cm2. A cotton pad moistened with saline was placed between the skin and the metal contact of the active electrode. The patient held the passive electrode in his hand.

With normal sympathetic provision of the test area, the sympathetic skin reaction (CSR) goes through three stages [9]: 1) the stage of increasing the vegetative provision of the skin; 2) the stage of stabilization of the vegetative supply of the skin or the stage of "plateau"; 3) the stage of inhibition of the vegetative supply of the skin. The first stage of CSR begins from the moment of exposure of the testing current to the skin receptors and is characterized by a gradual decrease in skin electrical resistance in the testing area. In this case, the device, by stabilizing the voltage, records an increase in the current strength between the electrodes. The duration of the first stage is no more than 60 seconds. The beginning of the second stage is indicated by the stabilization of the current strength at maximum values. The duration of the second stage is is about 1-2 minutes. In the third stage, the cutaneous electrical resistance begins to increase,

In our study, the active electrode was installed in the area of the cutaneous segments of the autonomic supply (CSP) [10]. These skin segments are located on the distal extremities. On each limb, three segments are distinguished on the outer and inner surfaces. On the hands, the following CSVOs are distinguished: palmar-medial, palmar-median, palmar-lateral, dorsal-medial, dorsal-median and dorsal-lateral segments. On the legs, the following KSVO are distinguished: on the inner surface - the medial, dorsal-medial and posterior segments; on the outer surface - lateral, dorsal-lateral and dorsal-median segments. The reflex arc of skin sympathetic reactions initiated with CSWR has a central mechanism of formation involving the excitation of autonomic neurons in the lateral horns of the spinal cord at the level of C8L2 segments,

#### peripheral nerves.

Testing of skin sympathetic reactions was carried out up to the maximum values of the current strength, recorded by the device at the "plateau" stage. The intensity of skin sympathetic reactions was assessed by the indicator of autonomic support of activity (VOD), taking into account the correction factors, based on the indicator of the initial tone of the autonomic nervous system [11].

Statistical processing of the obtained digital data was carried out using a personal computer using the Statistica 6.0 software package. The statistical characteristics of sample distributions (sample size, skewness and kurtosis coefficients) are such that they allow the use of parametric statistics methods, while sample variances are approximately the same, therefore, to assess the reliability of sample means, the Student's t-test was used. Differences were considered statistically significant at  $p \le 0.05$ .

## **Research results**

Analysis of the results of DSD testing of the first group of patients with right-sided hemiparesis in the late recovery period after an ischemic stroke in the left carotid region of the brain revealed a characteristic feature of the distribution of skin sympathetic reactions according to their intensity on the skin segments of the upper and lower extremities: on the side of paresis, the prevalence of VOD parameters is observed DAC on three inner segments of the arm and three outer segments of the leg (Table 1). At the same time, on the left extremities, the intensity of skin sympathetic reactions is balanced, which can be seen when comparing the averaged indicators of the VOD DAC for the internal and external skin segments.

Table 1

Selective differences in the averaged values of the indices of vegetative support of the activity of skin sympathetic reactions for internal and external surfaces

extremities according to the results of DSD testing of the skin segments of the vegetative

Группы		Ручные	ксво	Ножные КСВО				
	Справа		Слева		Справа		Слева	
	Наруж.	Внутр.	Наруж.	Внутр.	Наруж.	Внутр.	Наруж.	Внутр.
1-ая, n = 25	$33,2 \pm 9,9$	$86,68 \pm 11,3^{1}$	$31,3 \pm 8,3$	$29,2 \pm 8,2$	$71,7 \pm 10,6^2$	$26,0 \pm 9,9$	$27,8 \pm 8,3$	$28,0 \pm 9,9$
2-ая, n = 25	$67,8 \pm 6,4$	$70,2 \pm 6,1$	$69,4 \pm 6,9$	$67,4 \pm 7,0$	$36,4 \pm 4,7^3$	$34,5\pm5,9^3$	$34,1 \pm 5,8^{3}$	$36,9 \pm 4,5^{3}$
3-я, n = 21	$123,6 \pm 11,1^4$	$78,2 \pm 19,4$	$123,5 \pm 10,1^4$	$63,4 \pm 17,7$	$125,4 \pm 10,5^{4}$	$69,7 \pm 22,7$	$125,9 \pm 9,4^4$	$71,6 \pm 22,2$
Контроль, n = 25	$89,9 \pm 8,1$	$89,5 \pm 8,4$	$87,6 \pm 7,0$	$89,5 \pm 7,3$	$88,4 \pm 7,7$	91,4 ± 6,8	89,0 ± 8,4	$87,1 \pm 7,6$

providing \*

\* Расчет усредненного значения ВОД КСР проводился с учетом поправочных коэффициентов. Данные представлены как M ± s, где M – средняя арифметическая величина; s – среднеквадратическое отклонение; n – количество пациентов в группах; КСВО – кожные сегменты вегетативного обеспечения.

Approx. 1. The reliability of the differences in the arithmetic mean values of the indicator of the VOD DAC in1st group

with other indicators in the same group. The calculation was carried out on the basis of the Student's t-test. The significance of the differences was proved for all comparison options ( $p \le 0.001$ ), except for the comparison with the indicator of the outer surface of the right leg;

Approx. 2. The reliability of the differences in the arithmetic mean of the VOD DAC in1st group with other indicators in the same group. The significance of the differences was proven for all comparison options (p  $\leq$  0.001), except for comparison with the index of the inner surface of the right hand; Approx. 3. Reliability of differences in the arithmetic mean values of the VOD DAC in2nd group with other indicators in the same group. The significance of the differences was proved for all comparison options (p  $\leq$  0.001), except for comparison of the differences was proved for all comparison options (p  $\leq$  0.001), except for comparison of the differences was proved for all comparison options (p  $\leq$  0.001), except for comparison with the indicators of the lower extremities;

Approx. 4. The reliability of the differences in the arithmetic mean of the VOD DAC in3rd group with

other indicators in the same group. The significance of the differences was proved for all comparison options (p  $\leq$  0.001), except for comparison with the indicators of the outer surfaces of the extremities.

Examination of patients with transient ischemia of the spinal cord (the second observation group) showed that the intensity of skin sympathetic reactions in all the studied segments was insignificant and did not exceed 42  $\mu$ A, while on the hand segments the VOD values of the CVR were almost 2 times higher (Table 1) ... Thus, the dynamic segmental diagnostics of this group of patients revealed the peculiarity of the distribution of skin sympathetic reactions according to their intensity, characteristic of diseases with lesions of the neurons of the thoracic spinal cord in a sufficiently large area along the long axis: insignificant activity on the lower extremities and comparative intact CSR activity on the upper ones.

Dynamic segmental diagnosis of patients with panic attacks (third observation group) was performed outside of the attacks. It drew attention to the fact that with an imbalance in the parameters of VOD CSR on individual CSVO, there is a predominance of CSR intensity on all outer skin segments of both upper and both lower extremities (Table 1), which was a characteristic feature of the results of testing skin sympathetic reactions in patients of this group. ... CSR testing in practically healthy people revealed a balance of VOD parameters between the skin segments of autonomic support without any imbalances between the averaged values of these indicators for the upper and lower extremities, right and left extremities, external and internal surfaces of the extremities (Table 1).

# Discussion of research results

As the results of this study have shown, the intensity of skin sympathetic reactions in patients in the observation groups depends not so much on intrasegmental interactions, but on the central influence of the higher centers of autonomic regulation. At the same time, for each type of pathology, a typical imbalance in the indices of autonomic support for the activity of CSW is determined. So, in hemisyndrome with right-sided spastic paresis of the flexors of the right arm and extensors of the right leg, the intensity of the sympathetic skin reactions is significantly increased on the right over the spastically altered muscles, which may be due to the central influence on the spinal cord segments that control the trophism of these muscle groups. Muscle spasticity is a static work of muscle fibers, which requires an increased vegetative supply of muscle tissue. In this regard, there is an activation of autonomic neurons at the corresponding segmental levels on the side of paresis, which we observed when testing skin sympathetic reactions on the skin segments located above the spastic muscles. Ischemia of the spinal cord along its longitudinal axis at the level of the thoracic segments leads to a decrease in the functional activity of all neuronal groups at this segmental level, including autonomic neurons. Therefore, in the second group, in patients with transient compression of A. Adamkevich with a pausegmental type of blood supply to the spinal cord and ischemia of the nervous tissue below Th.2 or Th.8 segments, we observed a decrease in the activity of skin sympathetic reactions precisely on the skin segments of the lower extremities simultaneously with the right left side.

We found a characteristic increase in the intensity of CSR on the outer segments of the extremities in patients of the third observation group with an increase in sympathetic influences in the body, which is due to an imbalance in the work of the suprasegmental level of the autonomic nervous system. From the theory of traditional oriental medicine, it is known that with the "general Yang syndrome", flowing in the body according to the type of sympathicotonia, the meridians are activated, the cutaneous course of which is localized precisely on the outer surface of the extremities. it is consistent with the data obtained during ADS testing of patients with autonomic sympathoadrenal crises. When interpreting the results of dynamic segmental diagnostics in order to identify the central mechanisms of violation of autonomic regulation of the skin in the area of skin segments of autonomic support, we propose, based on the indicators of vegetative support of the activity of skin sympathetic reactions, to calculate the following asymmetry coefficients:

1) CUD coefficient - gives an idea of the presence and degree of asymmetry of indicators WAT DAC on the hand and foot skin segments, while the sum of the indices of the skin segments of the arm (or both arms) is taken to calculate the CUD coefficient and compared with the sum of the indices of the leg (or both legs). If the intensity of DAC on manual KSVO is more pronounced, then the coefficient CUD is positive. This coefficient is negative if the intensity of sympathetic skin reactions on the lower extremities prevails.

2) CRL coefficient - gives an idea of the presence and degree of asymmetry of indicators VOD DAC between skin segments on the right and left extremities. In this case, to calculate the CRL coefficient, the sum of the indicators of the skin segments of the right hand is taken and compared with the sum of the indicators of the segments of the left hand. Similar calculations are carried out for the lower limbs. If the intensity of the CSR on the segments of the right extremities is more pronounced, then the CRL coefficient is positive. And this coefficient is negative if the intensity of sympathetic skin reactions on the left extremities prevails.

3) CEI coefficient - gives an idea of the presence and degree of asymmetry of indicators VOD DAC between skin segments on the outer and inner surfaces of the extremities. In this case, to calculate the CEI coefficient, the sum of the indicators of skin segments on the outer surface is taken and compared with the sum of the indicators of the segments on the inner surface of one, two or more limbs. If the intensity of the CSR on the outer segments is more pronounced, then the CEI coefficient is positive. And this coefficient is negative if the intensity of sympathetic skin reactions on the skin segments of the inner surfaces prevails.

$$\begin{split} CUD &= \frac{\overset{\circ}{\Sigma} U - \overset{\circ}{\Sigma} D}{\overset{\circ}{\Sigma} U + \overset{\circ}{\Sigma} D}, \ c\partial e \\ & \overset{\circ}{\Sigma} U + \overset{\circ}{\Sigma} D \\ CUD - коэффициент асимметрии между пока-зателями ВОД ручных и ножных КСВО; \\ & \overset{\circ}{\Sigma} U - совокупность значений показателей ВОД КСР ручных КСВО; \\ & \overset{\circ}{\Sigma} D - совокупность значений показателей ВОД КСР ножных КСВО; \\ & n - число наблюдений. \end{split}$$

The formulas for calculating the asymmetry coefficients are given below.

$$CRL = \frac{\sum\limits_{n=1}^{n} R - \sum\limits_{n=1}^{n} L}{\sum\limits_{n=1}^{n} R + \sum\limits_{n=1}^{n} L}$$
, где

CRL – коэффициент асимметрии между показателями ВОД КСР для КСВО правой и левой стороны;

∑ R – совокупность значений показателей ВОД КСР для КСВО правой конечности;

<sup>в</sup> L – совокупность значений показателей

ВОД КСР для КСВО левой конечности; n – число наблюдений.

$$CEI = -\frac{\sum\limits_{n=1}^{n} E - \sum\limits_{n=1}^{n} I}{\sum\limits_{n=1}^{n} E + \sum\limits_{n=1}^{n} I}, rge$$

СЕІ – коэффициент асимметрии между показателями ВОД КСР для КСВО наружных и внутренних поверхностей конечностей;

∑ Е – совокупность значений показателей ВОД КСР для КСВО наружных поверхностей конечностей;

∑І – совокупность значений показателей ВОД КСР для КСВО внутренних поверхностей конечностей;

n — число наблюдений.

As we have established, the values of the above coefficients in the range from -0.09 to +0.09 are physiological. A slight degree of imbalance corresponds to values from 0.1 to 0.13 and from -0.13 to -0.1, an average degree - from 0.14 to 0.18 and from -0.18 to -0.14, a severe degree - from 0.19 to 0.5 and from -0.5 to -0.19, a coefficient equal to 0.51 or more (-0.51 or less) indicates a severe degree of imbalance.

The results of calculating the asymmetry coefficients for patients in the observation groups and the control group are presented in table. 2, which shows the average values of all calculated coefficients and the reliability of their differences across groups. For patients of the first group with hemisyndrome, the CRL and CEI coefficients have the greatest deviations, which is characteristic of this pathology. Patients with spinal cord ischemia (second observation group) are characterized by a change in the CUD coefficient. For patients with vegetative crises - CEI coefficient.

#### Conclusion

Interpretation of the results of DSD testing with the calculation of asymmetry coefficients, which give an idea of the presence and degree of asymmetry of indicators of autonomic support for the activity of skin sympathetic reactions on the corresponding skin segments, from our point of view, more fully reflects the nature of the pathology of the suprasegmental part of the autonomic nervous system and is recommended for doctors using his practice, the method of dynamic segmental diagnostics.

table 2

Selective differences in the skewness coefficients calculated on the basis of indicators of autonomic support for the activity of skin sympathetic reactions for study groups \*

	Коэффициенты асимметрии									
Группы	(	CUD	CRL		CEI					
	Справа	Слева	Наруж.	Внутр.	Ручной	Ножной				
1-я, n = 25	$0,10 \pm 0,09$	$0,05 \pm 0,14$	$0,28 \pm 0,11^{1}$	$0,33 \pm 0,14^{4}$	$-0,29 \pm 0,12^{4}$	$0,30 \pm 0,12^{4}$				
2-я, n = 25	$0,32 \pm 0,06^2$	$0,32 \pm 0,08^2$	$0,01 \pm 0,05$	$0,01 \pm 0,05$	$-0,01 \pm 0,05$	$-0,01 \pm 0,06$				
3-я, n = 21	$0,02 \pm 0,09$	$-0,02 \pm 0,07$	$-0,01 \pm 0,05$	$0,04 \pm 0,15$	$0,26 \pm 0,09^3$	$0,30 \pm 0,11^3$				
Контроль, n = 25	$-0,01 \pm 0,03$	$0,01 \pm 0,03$	$0,01 \pm 0,03$	$0,01 \pm 0,03$	$-0.01 \pm 0.02$	$-0,01 \pm 0,02$				

\* Данные представлены как M ± s, где M – средняя арифметическая величина; s – среднеквадратическое отклонение; n – количество пациентов в группах.

Approx. 1. Reliability of differences when comparing the analyzed value of the coefficientasymmetries in the 1st group with the values of other coefficients in the same group according to the Student's t-test. The significance of the differences was proven ( $p \le 0.001$ ) when compared only with the values of the CUD coefficient;

Approx. 2. Reliability of differences when comparing the analyzed value of the coefficientasymmetry in the 2nd group with the values of other coefficients in the same group. The significance of the differences was proven ( $p \le 0.001$ ) when compared only with the values of the CRL and CEI coefficients;

Approx. 3. Reliability of differences when comparing the analyzed value of the coefficientasymmetries in the 3rd group with the values of other coefficients in the same group. The significance of the differences was proven ( $p \le 0.001$ ) when compared only with the values of the coefficients CUD and CRL.

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