Middle-East Journal of Scientific Research 20 (10): 1302-1305, 2014
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2014.20.10.21069

Chaotic Dynamics of Autonomic Nervous System Parameters in Patients with Postherpetic Neuralgia on Hirudoreflexotherapy in Conditions of the North of the russian Federation

Raise N. Zhivoglyad, Natalia V. Zhivaeva, Olga A. Bondarenko and Alexey G. Danilov

"Surgut State University at Khanty-Mansi Autonomous Okrug", Yugra, Surgut, pr. Lenina, 1, Russia

Abstract: The purpose of the study is to establish the behavioral patterns of quasi-attractors of autonomic nervous system in inhabitants of Yugra suffering from postherpetic neuralgia living in conditions of the North of the Russian Federation. Material and methods. 60 patients at the age of 54.5 ± 2.8 were examined. Patients were divided into 3 groups: 30 women before and 30 after applying of hirudoreflexotherapy and a control group consisting of 30 women. Results and discussion. Method of identification of quasi-attractor's behavioral parameters of the state vector of the human body in a multidimensional phase space of states of women's organism suffering from neuralgia objectively reflects the state of neurovasomotor cluster in the pathogenesis of post-herpes zoster complications. Conclusion. New methods for studying mechanisms of functional state of the human body can be used to assess the adequacy and effectiveness of homeostasis system in population.

Key words: Functional state of the human body · Quasi-attractor · System analysis · State vector of the human body · Pulse oximetry

INTRODUCTION

Given the fact that the number of people leaving from the South to the North of Russia increases, health problems of inhabitants of the northern regions will acquire special importance and urgency. These movements are related to the climatic and geographical extremity [1], which causes various pathologies in newcomers of the north. Extremity of northern territories includes many factors including weather and climate combined with anthropogenic pollution in industrial regions. In this regard, the Russian North is a typical example of extreme natural zone.

The purpose of this research is to study and comparatively evaluate physiological parameters of the autonomic nervous system in the group of women with a history of neuralgia caused by herpes zoster before and after the course of rehabilitation treatment (hirudoreflexotherapy).

Estimation of the parameters was carried out within the system analysis and synthesis [2, 3, 4, 5] by defining the parameters of the state of behavioral quasi-attractors vector of the human body state (VHBS) before and after the course of hirudoreflexotherapy. The obtained data were compared with VHBS value of the control group.

System analysis and synthesis during violations in the homeostasis system in people of Yugra living in extreme environments allows to analyze the behavior of the vector of the human body state (VHBS) under compartmental-cluster approach [6-8].

The urgency of studying the key pathogenetic mechanisms of herpes infection and the development of effective therapies for the disease is caused by the steady growth of the number of herpetic diseases in adults and children. According to Gilden D.H. Cohrs R.J. Mahalingam R. 2003 [9] immunization against the Varicella zoster virus was found in almost 99% of adults. Herpes Zoster can occur at any age, but in most cases the disease occurs in people older than 50 years, according to Gross G. Schufer N. Wassilew S *et al*. 1999. The greatest threats to health are neurological complications such as postherpetic neuralgia and ophthalmic herpes (Ramsay-Hunt syndrome). These complications often cause personality changes and depression. According to study of Cunningham A.L. Breuer J. Dwyer D.E, *et al*. 2008 [9, 10] delayed treatment of ophthalmic herpes can even lead to blindness.

Hirudotherapy or bdellotherapy is a method of treatment with Hirudo medicinalis known for a long time. Therapeutic effects of hirudotherapy are associated with

Corresponding Author: Zhivaeva, "Surgut State University at Khanty-Mansi Autonomous Okrug", Yugra, Surgut, pr. Lenina, 1, Russia.

the action of biologically active substances released into the bloodstream of the donor on blood-sucking of the leech. Together with the study of the mechanisms of therapeutic action of the medicinal leech in the last 15-20 years, the interest in this type of treatment has grown again. The issue of studying the scientific bases and opportunities of hirudotherapy is considered as being timely made.

MATERIALS AND METHODS

The study used a non-invasive technique of pulse oximeter device "Elox-01S2". The device used optical finger sensor (in the form of pegs), which registered the pulse wave of the thumb. This enabled continuous recording of hemoglobin saturation with oxygen (%, SpO2) as well as heart rate (HR) and cardiointervals. Later cardiointervals were analyzed, integrative indicators of the sympathetic and parasympathetic departments of autonomic nervous system (SIM, PAR) were determined. The frequency spectrum of cardiointervals was analyzed by calculating the standard values of cardiointervals (VLF mc^2, LF mc^2, HF mc^2, Total mc^2, LF norm%, HF norm%, the ratio LF/HF). Also the blood level of oxyhemoglobin (SpO_2) was determined. According to the analysis results, the VHBS dynamics was analyzed for groups of women with post-herpetic neuralgia, before and after applying of hirudoreflexotherapy in m-dimensional phase space of state conditions.

Parameters of the vector of the groups' body state in the phase space of state conditions were assessed by methods of the theory of chaos and self-organization. This allowed to identify parameters of quasi-attractors using the software "Parameter identification of behavioral attractor parameters of the vector of the state in biosystems in m-dimensional phase space" (Eskov V.M. Certificate for the official registration of computer software No. 2009616012.-Rospatent, 2009). The method is based on a comparison of the parameters of various clusters representing biological dynamical systems (BDS), which may include the same BDS, being in different physiological states. Using this method researchers calculated a total volume of m-dimensional parallelepipeds (vX) restricting movement of quasi-attractor of the vector of the system state and the distance between the geometric (chaotic) and statistical (stochastic) centers (rX) of these parallelepipeds.

The following components of the heart rate variability were found to be the most considerable: SIM, PAR, SDNN, MI, LF, HF, Total. 60 women were examined in the current study: 30 patients before and 30 after applying of hirudoreflexotherapy and 30 women in the control group. Mean age of the patients suffering from neuralgia was 54.5 ± 2.8 years. All the studied parameters were recorded prior to restorative treatment and at the end of the course of rehabilitation treatment (at the 30th session).

Main Part of the Study: According to the results obtained during the statistical processing of the parameters of the autonomic nervous system and cardiorespiratory system, it was revealed that the value of the activity index of sympathetic autonomic nervous system link (SIM) decreased after a course of rehabilitation treatment to 5.57 ± 0.87 compared with the initial state equal to 7.98 ± 1.6 before applying the external control action (ECA) on the body of patients with neuropathy. The parameter of parasympathetic department of autonomic nervous system (ANS) - PAR, by contrast, was increased after the full course of treatment from the value of 8.76 ± 1.57 to the value of 9.6 ± 1.28 (Table 1).

Clinical picture in terms of stress index Baevsky was completely changed: anxiety index (INB) before the treatment was 95.69 ± 21.2 and after the rehabilitation therapy it was decreased by 1/3 to the value of 66.36 ± 10.2. The value of heart rate on the background of the conducted treatment has changed insignificantly: HR before the treatment was 80.32 ± 2.4 and after the treatment - 78.2 ± 1.95. Oxygen saturation of arterial remained virtually unchanged (Table 1).

According to the brain phasatone theory all methods of recovery treatment, in particular hirudoreflexotherapy, cause typical changes to the parameters of autonomic nervous system, in particular changes to the level of activity of sympathetic and parasympathetic parts of regulation.

So, the General asymmetry value decreased from the value rX = 3 913.49 before the restorative treatment to the value rX = 2 606.07 - after treatment. There's a decrease in the general volume value $vX = 1.44 \times 10^{24}$ to the general volume value $vX = 8.27 \times 10^{24}$ - after treatment (Table 2).

Reducing the amount of quasi-attractors in phase spaces (by an order) in women after applying hirudoreflexotherapy and reducing asymmetry indicates that there's changing in the dynamics of quasi-attractors, i.e. ANS indicators transit from the phasic area (fast, with the adrenergic system) to the tonic area (slow, with the cholinergic system). Lowering of the asymmetrical indicators characterizing randomness of the system reflects a sharp decrease in the degree of dispersion (variability) in the phase space of states for finding VHBS group for the surveyed women group.

Table 1: Average values of the autonomic nervous system and blood oxygenation in groups of women suffering from post-herpes zoster neuralgia before and after hirudoreflexotherapy compared with the control group, *M ± ó (0.05; 0.95)*

The parameter of HRV	Group 1- women before the treatment	Group 2- women after the treatment	Group 3 Control group	Kruskal-Wall is test (P <0.05)	Dunnett's criterion (p <0.05)
SIM, conventional units (cu)	7.98 ± 1,6 (1;19)	5.57 ± 0.87(1;11.1)	5.75 ± 0.54(1.1; 14.5)	0.006	0.003
PAR, cu	8.76 ± 1,57(0.9; 16.3)	9,6 ± 1,28(4; 16.3)	10.23 ± 0.56 (4; 19)	0.02	0.02
HRbpm	80.32 ± 2,4(66.5; 97)	78.2 ± 1,95(62; 88.2)	81,51 ± 1,29(69; 102.8)	0.936	0.83
INB, cu	95.69 ± 21,2(19.8; 275)	66.36 ± 10.2(19.8; 119.4)	71,6 ± 7.52(18.4; 141.9)	0.004	0.004
$SpO_{2\%}$	97.5 ± 0.29(95; 99)	97.4 ± 0.33(95; 99)	97.55 ± 0.11(96; 99)	0.93	0.95
SDNN mc.	37.93 ± 4,69(17; 65.8)	40.02 ± 4,3(24; 65.8)	41,86 ± 1,76(24.1; 69.8)	0.009	0.007
HF mc2	1123.76 ± 367.61(85; 5112.5)	1080.73 ± 329,9(126; 3514.1)	1120.75 ± 162,21(87.1; 4798.1)	0.002	0.004
LF mc2	2250.86 ± 559,94(256.9; 6668.6)	2473.6 ± 551,9(543.3; 6668.6)	2400.56 ± 224,33 (399.9; 8660.5)	0.021	0.034
VLF mc2	1746.69 ± 497.44(215; 5547.5)	1727.02 ± 441,47(526.8; 4708.7)	2195.296 ± 214,47(508.3; 4905)	0.622	0.72
TOTAL, ms^2	5121,3 ± 1269,71(826; 12629.1)	5281,3 ± 1191,8(1534.8; 12629.1)	5716.53 ± 460.62(1764.2; 14942.8)	0.004	0.004
LF/HF,%	26035.21 ± 4254,7(0.9; 46062.8)	26868.1 ± 3939,3(0.928; 46113)	6767.2 ± 1552.26(0.8125; 7.898)	0.17	0.25

Table 2: Bioinformatic analysis of neurovegetative status in patients with postherpetic neuralgia before and after the reducing treatment, in comparison with the control group (m = 7)

Group 1 of the patients (neuralgia) before treatment	Group 2 of the patients (neuralgia) after treatment	Group 3 women (control)
General asymmetry value rX = 3 913.49	General asymmetry value rX = 2 606.07	General asymmetry value rX = 7 180.79
General V value $vX = 1.44 \times 10^{24}$	General V value $vX = 8.27 \times 10^{22}$	General V value $vX = 5.05 \times 10^{24}$

Bioinformatic analysis of VHBS parameters allowed to determine differences in the dynamics of the parameters controlling autonomic homeostasis. Conducted control action of hirudoreflexotherapy method showed a tendency in the dynamics of quasi-attractors parameters in patients with neuralgia towards reducing quantitative asymmetry index (Rx) (approximately 2-fold reducing), which characterizes the measure of randomness of the system. This indicates that hirudoreflexotherapy is able to restore an optimal homeostasis.

At the same time, according to the observed variability in the heart rate there's transition to parasympathotony and reducing the influence of the sympathetic nervous system following hirudotherapy. A similar pattern of reduction parameters of vector of the body state in this group of women shows the ability to adapt their functional state to external influences.

After three courses of hirudoreflexotherapy women were consulted by a neurologist in the clinic at the place of residence. Their complaints were considered, as well as the clinical data. There were no clinical signs of the disease in more than 80% of patients with previously diagnosed post-herpetic neuralgia. The number of the recovered women exceeded the expected results.

CONCLUSIONS

- Method of identification of quasi-attractors behavior parameter of the vector of the human body state in a multidimensional phase space of state conditions of the women's organism suffering from neuralgia objectively reflects the state of neurovasomot cluster in the pathogenesis of post-herpes zoster complications. This results in dramatic decrease in the general asymmetry and the general volume of quasi-attractor in a phase space and change of the wave characteristics in spectrum of such patients. Hence the use of bioinformatic analysis shows that one of the mechanisms of adaptation to extreme environmental conditions is impairment of the neurovasomotor cluster caused by the year impact of severe climatic factors.
- The method of multidimensional phase spaces of state conditions makes it possible to determine the trajectory of the quasi-attractor displacement of the vector of the body organism state of patients. Also it allows to evaluate the features of the pathogenesis and the treatment efficacy in patients being in the environmental conditions of the northern urbanized biological ecosystem.
- Method of multidimensional phase spaces allows to improve the program of rehabilitation treatment in patients with post-herpetic neuralgia, aimed at normalization of vegetative homeostasis, which considerably increased the direct therapeutic effect and contributed to the correction of associated maladaptive manifestations.
- The method of restorative treatment where hirudoreflexotherapy plays a great role in women suffering from post-herpetic neuralgia allows doctor to control homeostasis, causing changes to the regulatory processes of the autonomic nervous

system with the ability to adapt the functional state of the organism in the specific area.

REFERENCES

1. Eskov, V.M., A.A. Khadartsev, O.E. Filatova and KA. Hadartseva, 2012. Circadian Rhythms of Cardiorespiratory System and Biological Age of the Human. Therapist, 8: 36-43.
2. Eskov, V.M., Y.M. Popov and O.E. Filatova, 2012. Third Paradigm and a Stand Point of Prigogin I.R. and Haken G. with Regard to the Complexity and Special Properties of Biosystems. Herald of New Medical Technologies, Vol. XVIII, 2: 416-418.
3. Konrath, O.N., V.M. Eskov, V.F. Ushakov and O.V. Efimova, 2013. Matrices of Interattract Distances to Evaluate the Efficacy of Treatment of Patients with Mixed Pathologies Constantly Living in the North Region. Complexity. Mind. Postneoclassics, 2: 13-21.
4. Eskov, V.M., V.V. Eskov, O.E. Filatova and M.A. Filatov, 2012. Two Types of Systems and Three Types of Paradigms in Philosophical Systems and System of the Science. Journal of Biomedical Science and Engineering, Vol. 5, 10: 602.
5. Eskov, V.M., A.A. Khadartsev, V.V. Eskov, O.E. Filatova and D.U. Filatova, 2013. Chaotic Approach in Biomedicine: Individualized Medical Treatment. Journal of Biomedical Science and Engineering, 6: 847-853.
6. Eskov, V.M., A.A. Khadartsev, V.V. Eskov and O.E. Filatova, 2013. Quantitative Registration of the Degree of the Voluntariness and Involuntariness (of the Chaos) in Biomedical Systems. Journal of Analytical Sciences, Methods and Instrumentation, VI. 3: 67-74.
7. Eskov, V.M., V.V. Eskov, M. Ya. Braginskii and A.S. Pashnin, 2011. Determination of the Degree of Synergism of the Human Cardiorespiratory System under Conditions of Physical Effort. Measurement Techniques, 54(7): 832-837.
8. Gilbert, G.J., 1974. Herpes zoster ophthalmicus and delayed contralateral hemiparesis. Relationships of the syndrome in central nervous system granulomatous angiitis. JAMA. 229: 302-04.
9. Breuer, J., 2007. Varicella Zoster Virus: Natural History and Current Therapies of Varicella and Herpes Zoster. Eds. Breuer, J. and R. Whitley. Herpes, 14(Supplement 2): 25-29.
10. Gilden, D.H., 2003. Clinical and Molecular Pathogenesis of Varicella Virus Infection. Eds. Gilden, D.H. R.J. Cohrs and R. Mahalingam. Viral Immunol, 16(3): 243-258.