THE ALGORITHM FOR ESTIMATION OF THE CHAOS OF PATIENTS WITH GASTRIC CANCER: MAGNETIC RESONANCE IMAGING AND MECHANOEMISSON IN BLOOD

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The known physical principles of medical diagnosis provide limited information on the interrelation between visualized information of the electromagnetic field in magnetic resonance imaging (MRI) and the quantum chaos of electromagnetic mechanoemission (ME) processes reflecting conformational and configurational changes in biological macromolecules. Taking into consideration the fact that the kinetics of the changes in theses events is due to physiological and pathophysiological processes in the host we developed a computed system for detection and spectral analysis by original algorithm of ME from biological cells and liquids in the radio ranges of electromagnetic emission.

METHODOLOGY

We studied of ME in two groups of patients. Group 1 included patients with gastric cancer (22 persons), Group 2 - healthy subjects (n = 21). Cancer patients were evaluated at Stage II-IV with the diagnosis confirmation in terms of morphology and histology. All groups consisted of male aged 45-60.

Blood at 0.02 ml was layered onto FN-2 chromatographic paper (Filtrak, Germany), which was placed in the slide frame. A sample of whole blood dried to 45 % relative humidity was triboelectrified using a rotating electret probe at 1400 ± 50 rpm with enhanced mode of 1.2 N in the atmosphere of highly purified gaseous nitrogen under excessive pressure of 1 kPa at 37 ± 0.5 °C. Correlation analysis was made to evaluate the quantitative pattern of periodic values in whole blood electromagnetic ME amplitude within 12.5 ms.

A radiosensor of tribogeneration employs an electret probe made of teflon as a roll measuring 30 mm in diameter. The rolling unit is installed on axis and is rotated with an electric motor. The sample frame is moved to the electret probe using a pressing device. The receiver aerial for recording electromagnetic ME generated by electret probe and sample friction is located directly in the vicinity of the sample contact zone and rotating probe. Electrical signals enter the input of the aerial amplifier and after amplification in the frequency range of 1 Hz to 0.1 MHz are transmitted to the input of the analogue-digital converter. MR images were acquired using a 0,5T mafnet (GE Medical Systems).

The pseudophase space method was used for the analysis of the spatial chaos of MR images and the quantum chaos of ME of blood. Let I_0, I_1, …, I_N be the ME value being measured at discrete time moments t_0, t_1, …, t_N, $t_i = t_0 + i\tau$, $i = 1, 2, \ldots, N$ in the case of quantum chaos estimating, or let I_0, I_1, …, I_N be the optical density of MR image pixels t_0, t_1, …, t_N, $t_i = i$, $i = 1, 2, \ldots, N$ ordered in a

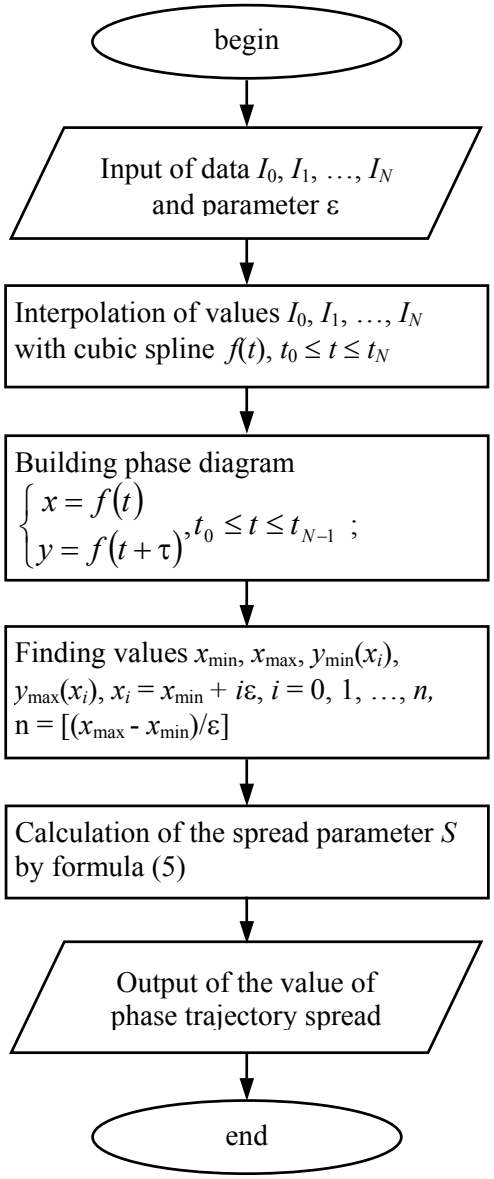

Fig. 1. The block diagram of algorithm for calculation of phase trajectory spread parameter.

certain manner in the case of spatial chaos estimating. In order to build a continuous phase trajectory, let us interpolate values I_0, I_1, …, I_N with a cubic spline $f(t)$, $t_0 \le t \le t_N$ of defect 1.

The phase trajectory is defined as the multitude $\{(x, y) | x = f(t+\tau), \quad y = f(t), \quad t_0 \le t \le t_{N+1}\}$. Let $\Phi = \{(x, y) | x = \varphi(t), y = \psi(t), t \in [\theta_1, \theta_2]\}$ be the phase diagram of a certain process, functions φ and ψ being continuously differentiable on segment $[\theta_1, \theta_2]$. Let $x_{min} = \min_{t \in [\theta_1, \theta_2]} \varphi(t)$, $x_{max} = \max_{t \in [\theta_1, \theta_2]} \varphi(t)$, $y_{min}(x) = \min_{t \in \varphi^{-1}(x) \cap [\theta_1, \theta_2]} \psi(t)$, $y_{max}(x) = \max_{t \in \varphi^{-1}(x) \cap [\theta_1, \theta_2]} \psi(t)$.

Let us define spread parameter $S(\Phi)$ of phase diagram Φ as

$$S(\Phi) = \int_{x_{min}}^{x_{max}} (y_{max}(x) - y_{min}(x)) dx . \qquad (1)$$

To approximately calculate the integral on the right in the formula (4), let us use the quadrature rectangles formula:

$$S(\Phi) \approx S_\varepsilon(\Phi) = \sum_{i=0}^{n-1} (y_{max}(x_i) - y_{min}(x_i)) \cdot \varepsilon , \quad (2)$$

where $n = [(x_{max} - x_{min})/\varepsilon]$, $x_i = x_{min} + i\varepsilon$, $i = 0, 1, \ldots, n$.

A special algorithm is developed for calculation of the blood ME phase trajectory spread parameter *S*. The block diagram of the algorithm of estimation of the phase trajectory spread parameter is shown in Fig. 1.

CONCLUSION

Analysis of the research results of T1-weighted MR images has shown. As compared with the cancer patients exhibited higher values within the spread parameter *S* range healthy individuals. These results permit us to consider oncogenesis as a kind of a impairment of a homeostatic deterministic chaos at the organ level.

Analysis of the phase diagrams of ME of blood shows that cancer patients have greater spread parameter *S* than healthy individual patients. Our findings allow viewing oncogenesis as an expression of impairments of molecular determined chaos of homeostasis.

The effect of marked unbalanced ME of blood and MR imaging by algorithm of estimation of the chaos in cancer patients testifies to the particular features of oncogenesis chaos, which may find application in the development of new medical diagnostic equipment. A formalized description utilizing the algorithm of estimation of the quantum chaos of blood ME parameters and spatial chaos of MR imaging shows promises for the possibility of estimation and prognosis of treatment efficiency of patients with gastric cancer.