DOI 10.26724/2079-8334-2018-3-65-179-185
UDC 51-7:[616.441-008.64-085.326:546.15]

O. I. Ryabukha
Lviv Medical Institute, Lviv, Ukraine

SEARCH FOR MARKERS OF CHANGES OF THE SYNTHETIC ACTIVITY OF THYROCYTE UNDER THE INFLUENCE OF IODINE RECEPTION IN IODINE DEFICIENCY CONDITIONS

E-mail: oriabuha@ukr.net

An indispensable condition for the activity of a cell is the variety of its states, each of which has its own characteristic – markers, which, according to the degree of completeness of the transformation of one state into another, are divided into markers of primary changes, markers of the majority of changes and markers of final changes. The presented work is devoted to the establishment of those ultrastructural constituents of follicular thyrocyte elements, which when exposed to its synthetic activity by iodine of organic and inorganic chemical nature acquire the signs of markers of the prevailing majority of changes. Qualitative information on the number and condition of thyrocyte organelles associated with the synthesis of thyroid hormones was obtained by viewing the electron diffraction patterns of the thyroid glands of white male rats. After its transformation into quantitative indicators and the subsequent correlation analysis, the revealed correlation connections between organelles were visualized by the construction of correlation portraits, which were analyzed from the positions of cytophysiology. It was established that the synthetic activity of follicular thyrocytes adequately reflects the degree of electron density of their cytoplasm. The most pronounced changes in the state of the cytoplasm are traced after the onset of changes in the number of free ribosomes; the established changes precede the changes in the number of ribosomes bound. This gives grounds to consider the degree of cytoplasm electron density of follicular thyrocytes as a marker of the prevailing majority of changes in their synthetic activity.

Keywords: mathematical technologies in medicine, thyroid gland, thyrocyte, cytophysiology, markers of state changes.

The paper is a fragment of the research project of the Family Medicine, Dermatology and Venereology Department of Danylo Halytsky Lviv National Medical University "Development of prognostic and diagnostic criteria, creation of experimental models, improvement of the metabolic processes disorders treatment at some diseases of internal organs and skin", state registration number 01164004506.

Any biological system is characterized by the following basic features: 1) the defined properties of the constituent elements; 2) the components intensity manifestations; 3) the type of connections between the elements; 4) the density of connections between the components of the system. During the study of the biological system, the properties of its elements and the types of connections between them can be described by means of certain parameters and variables and to reflect them in the form of functional dependencies. At the same time, each of the elements of the biological system can successively be in a state of normal life activity, excitation, functional stress, emergency regulation, functional changes, organic changes. Then the main task of diagnosing the state of the biological system is to establish the relationship between the set of detected signs and a certain state of the system, taking into account informativity of each sign and their combinations.

According to the conditions in which the biological system may occur during its activities, characteristic signs of each state are formed, i.e. markers. To characterize and predict the possibilities of the studied biological system's functioning, markers should be divided into several groups. Markers of primary changes occur at the initial stages of any changes and indicate a disorder of the primary functional balance. As the duration of the change process increases, the number of biological system parameters, which came out of the balance, is growing. Disorder of the system's adaptation to the conditions of existence is manifested by the emergence of signs of dissociation between its constituent elements. When disorders in the system are quantitatively exceeding the state of the primary functional balance, it is advisable to determine the markers of the prevailing majority of changes. Markers of the final changes in the state of the biological system appear at the stage of irreversible changes and the completion of the process. We have previously determined [3, 4] that under conditions of alimentary hypothyroidism, the marker of initial changes in the synthetic activity of follicular thyrocytes is the number of free ribosomes in the cytoplasm, and the marker of final changes is the number of ribosomes located on the granular cytoplasmic reticulum membranes. At the same time, the issue of markers for the majority of changes remained unclear.

The purpose of the study was to establish those ultrastructural elements of the follicular thyrocyte, which in the conditions of alimentary iodine deficiency correction with iodine-containing drugs of organic and inorganic nature, acquire signs of the majority changes markers of the thyrocyte's synthetic activity.

Materials and methods. Subacute study, which lasted 30 days, was carried out on 80 non-linear white male rats, which formed 8 groups with 10 animals in each one. The rats of group 0, which were universal control for animals of other groups, were kept on a complete, commonly-vivarium feed; rats of groups 1 - 7 were on an isocaloric starch-casein synthetic food diet, deficient in iodine content. Rats of group 2 consumed histologically verified minimal (21 μg iodine per kg body weight), dose of organic iodine, the rats of groups 3 and 4 consumed, respectively, moderate (50 μg iodine per kg body weight) and significant (100 μg iodine per kg body weight) doses of organic iodine, the rats of groups 5, 6, 7 consumed similar amounts of inorganic iodine. Animals of group 1 did not additionally consume iodine and served as a control to determine the degree of the consumed iodine-containing drugs effect. The source of organic iodine was iodine-protein preparation obtained at O.V. Bogatsky Physical-Chemical Institute, NAS of Ukraine, Odessa, from the Black Sea industrial red algae Phyllophora crispa (*Phyllophora nervosa*), a source of inorganic iodine, i.e. potassium iodide. After the experiment, the rats were decapitated under ethereal anesthesia, their thyroid glands were thoroughly separated from the connective tissue, fixed in osmium tetroxide and dehydrated in ascending alcohols and acetone, followed by polymerization in epoxy resins. UTTP-3 ultramicrotome produced ultrathin glands sections with the thickness of 4-6 μm were further contrasted with the salts of uranyl acetate and lead citrate and studied under TESLA BS-500 electron microscope. At all stages of the study, international requirements for the humane treatment of vertebrate animals were observed in accordance with the "Guidelines for Accomodation and Care of Animals" (Strasbourg, 2006, Annex 4) and Helsinki Declaration on humane endpoints to experiment animals. The follicular epithelium cells of the thyroid gland were considered by us as a complex negentropy system, which subsystem was their synthetic capacity profile. The ultrastructural elements of the profile were cytoplasm, granular cytoplasmic reticulum, Golgi complex, free ribosomes and polysomes. The research was carried out by methods for semi-quantitative analysis of electron diffraction patterns and determination of hormonopoietic cells special possibilities profiles with applying the phase interval method, statistical and correlation analyzes, used in our previous studies [2, 3, 4].

The state of the profile ultrastructural elements was determined using two standards: their state in normal conditions and under the untreated iodine deficiency conditions. Transformation of quality indices into quantitative ones was performed by the state/number assessment of each element in digital equivalents according to the severity of the sign within the range from 0 to 4 points. Absence of the sign was marked as 0 points; insignificant severity - 1-2 points; moderate - 3 points. The normal value was scored 4 points. The results were processed by means of the correlation analysis using the Microsoft Excel of Microsoft Office 2010 software.

To clarify the existence of connections between constituent elements of the profile the pair correlation coefficients were determined, which were calculated by the Pearson formula. Study of correlation connections was performed taking into account their strength, quantity and the link's sign. The positive value of the pair correlation coefficient indicated the same direction of change in the studied indices, and the negative value meant that with the increase in one of the indices, another index associated with it decreases; the value of $r_{xy} = 1.0$ indicated the existence of a direct proportion between the x and y, $r_{xy} = -1.0$ meant inverse proportion. In the structural organization of the relationship between the indices, the most significant were considered very strong and strong connections, which on the Chaddok correlation scale were respectively within $0.91 < r_{xy} < 1.0$ and $0.71 < r_{xy} < 0.9$; in the absence of such connections, noticeable connections ($0.51 < r_{xy} < 0.7$) were taken into account.

The term "intra-system correlation portrait", which is a variant of correlation nets, denoted the structural organization of relations between all elements of the studied profile based on the calculated array of the pair correlation coefficients values. The construction of correlation portraits was carried out based on their "factual elements": those ultrastructures of the profile, between which significant correlations were established by the correlation analysis. The correlation portrait analysis was performed taking into account the connections traced between its "factual elements" and the filling of "nodal points" as places of connections aggregation; interpretation of the established correlations was carried out based on the principles of cytophysiology, taking into account the functional significance of each ultrastructural cell element [1].

Results of the study and their discussion. Taking into account the importance of the cytoplasm in the activity of hormone-producing cells, it was decided to pay in-depth attention to the features of correlations, which, together with other components of the synthetic ability profile, are formed by electron density of the thyrocyte cytoplasm (table 1). The study showed that with administering 21 μg of organic iodine (fig. 1a), strong direct connections were observed, with a small degree of the cytoplasm

electron density (B_1) with extended substructures of granular cytoplasmic reticulum (J_3) and a moderate number of ribosomes on its membranes (J_5).

Table 1

Constituent elements of follicular thyrocytes synthetic capacity profile

Ultrastructural element	Studied feature of the ultrastructural element	State of the studied sign of the ultrastructural element examined
cytoplasm	electron density	insignificant (B_1)
		moderate (B_2)
		significant (B_3)
granular cytoplasmic reticulum	structure	constricted (J_1)
		normal (J_2)
		enlarged (J_3)
	number of ribosomes on membranes	reduced (J_4)
		moderate (J_5)
		enlarged (J_6)
free ribosomes and polysomes	number	reduced (K_1)
		moderate (K_2)
		enlarged (K_3)
Golgi complex	structure	constricted (L_1)
		normal (L_2)
		enlarged (L_3)

Such a nature of correlations with a high probability can indicate the presence of functional changes in the thyrocyte. This can be confirmed by an indirect strong correlation, with a small degree of the cytoplasm electron density (B_1) with a small number of ribosomes bound (J_4), as well as direct strong connections between moderate electron density of the cytoplasm (B_2) and insignificant (K_1) and moderate (K_2) number of free ribosomes and polysomes. When receiving a similar amount (21 μg) of inorganic iodine (fig. 1b), direct strong connections between B_2 and K_1 and K_2 indicate a certain similarity in the minor doses effects of organic and inorganic iodine on synthetic processes in the thyrocyte.

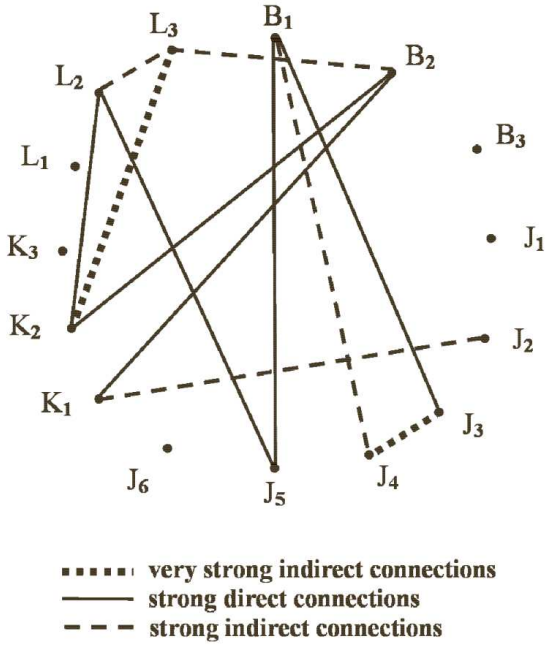

Fig. 1a. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 21 μg of organic chemical nature iodine under the model conditions of alimentary iodine deficiency.

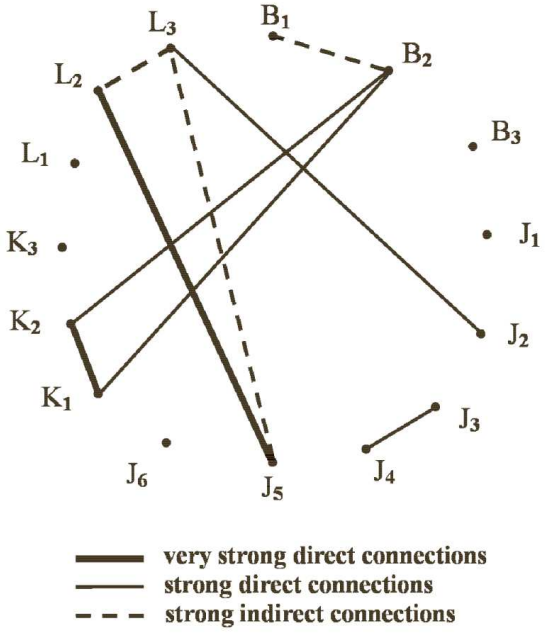

Fig. 1b. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 21 μg of inorganic chemical nature iodine under the model conditions of alimentary iodine deficiency.

When consuming 50 μg of organic iodine (fig. 2a), the small electron density of the cytoplasm (B_1) had a strong correlation with the moderate number of bound ribosomes (J_5), which may indicate some strain in the synthetic activity of the thyrocyte. At the same time, strong connections that have a moderate electron density of the cytoplasm (B_2) formed with B_1 (indirect link) and a significant number of free ribosomes K_3 (direct link), in our opinion, indicate an active course of hormonopoiesis. It is interesting to note that when receiving 50 μg of inorganic iodine (fig. 2b), no correlations between the

insignificant electron density of the cytoplasm (B_1) and other ultrastructures of the profile were traced, whereas the moderate electron density of the cytoplasm (B_2) had very strong connections to the normal substructures of the granular cytoplasmic reticulum (J_2) and the extended substructures of the Golgi complex (L_3). In our opinion, this kind of correlation may indicate both violation of the primary equilibrium in the course of the synthetic process, and the presence of intensive specific activity.

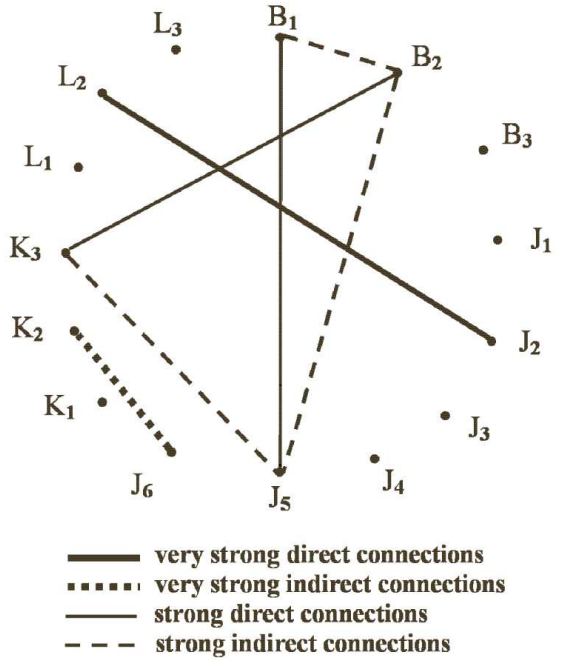

Fig. 2a. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 50 μg of organic chemical nature iodine under the model conditions of alimentary iodine deficiency.

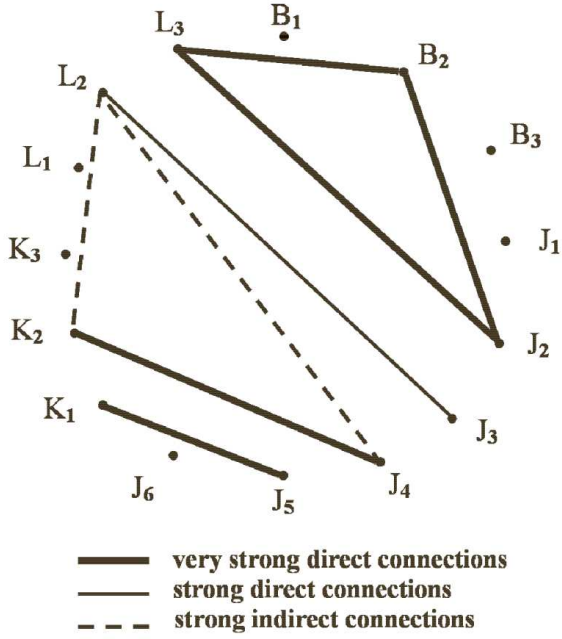

Fig. 2b. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 50 μg of inorganic chemical nature iodine under the model conditions of alimentary iodine deficiency.

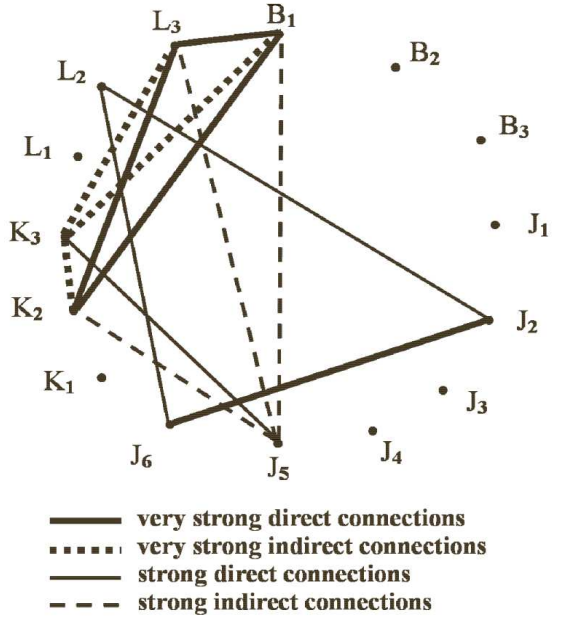

Fig. 3a. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 100 μg of organic chemical nature iodine under the model conditions of alimentary iodine deficiency.

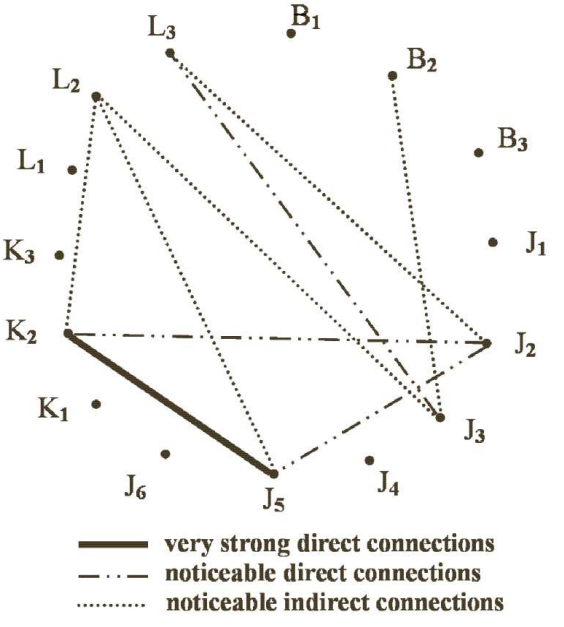

Fig. 3b. Graphic representation of the follicular thyroid's synthetic possibilities profile structure and correlation portrait of the thyroid glands in rats, having received 100 μg of inorganic chemical nature iodine under the model conditions of alimentary iodine deficiency.

When consuming 100 μg of the studied iodine-containing drugs, the number of correlations that the cytoplasm electron density had with other ultrastructural elements of the profile, was limited. Thus, when consuming the discussed dose within the inorganic iodine composition (fig. 3b), there is only one noticeable indirect relationship between the moderate electron density of the cytoplasm (B_2) and the expanded substructures of the granular cytoplasmic reticulum (J_3). When consuming 100 μg of organic

iodine (fig. 3a), significant correlations between B_2 and other ultrastructures are not traced. This can be a sign of both, acquiring by "the follicular thyrocyte synthetic possibility profile" system new qualities and a significant initial balance violation in this system. We are more inclined to the latter. The reason for this can be considered the existing correlations of insignificant cytoplasm electron density (B_1) as a "nodal point" with other ultrastructures of the profile: very strong direct correlations - with the extended Golgi complex substructures (L_3), very strong direct and indirect ones - with a moderate and significant amount of free ribosomes (K_2, K_3), a strong indirect correlation - with a moderate number of ribosomes placed on the granular cytoplasmic reticulum membranes (J_2). Thus, when a small (21 μg) amount of organic iodine was administered with expanded substructural elements of the granular cytoplasmic reticulum and a moderate (normal) number of ribosomes bound, a decrease in the cytoplasmic electron density degree was observed (in both cases r = 0.79). Whereas the moderate degree of electron density of the cytoplasm was similarly firmly associated with a moderate and reduced number of free ribosomes, both when receiving organic and inorganic iodine. The above established data permit to consider these correlations to be a sign of the initial response of the thyrocyte specific synthetic capacity system to administering a small amount of iodine, regardless of its chemical nature.

With an increase in the dose of iodine consumed up to 50 μg, among the studied signs of the cytoplasm state, its moderate electron density (B_2) was the most important. At the same time, the nomenclature of its correlations and their functional significance were determined by the chemical nature of the consumed iodine. Thus, a strong indirect dependency between B_2 and a moderate number of ribosomes on the granular cytoplasmic reticulum membranes (J_5) may indicate a lack of the thyrocyte functional activity under the conditions of organic iodine consumption.

However, a direct link of the same strength traced between B_2 and an increased number of free ribosomes in the cytoplasm (K_3), with a high probability is a sign of the hormonopoiesis harmonization. To a large extent, this assumption can be confirmed by very strong connections established between moderate electron density of the cytoplasm (B_2), moderately expressed substructures of the granular cytoplasmic reticulum (J_2), and extended substructures of the Golgi complex (L_3), which was observed at receiving the discussed dose of iodine in the composition of its inorganic compound.

Consumption of a significant dose (100 μg) of organic iodine violated the previously achieved equilibrium in the thyrocyte synthetic activity. This is illustrated by the few correlations of the cytoplasmic electron density with other profile ultrastructures. Thus, when receiving organic iodine, correlations between the moderate electron density of the cytoplasm (B_2) and other constituent elements of the studied capacity profile were not traced. Whereas the connections established between the insignificant electron density of the cytoplasm (B_1) and the hormone-synthesizing organelles indicate that there is a functional strain. In particular, very strong connections B_1 with the extended substructures of the Golgi complex (L_3) and a sufficient number of free ribosomes in the cytoplasm (K_2) can be considered as such signs.

Particularly evident dissociation in the state of the thyrocyte protein-synthesizing ultrastructures was manifested at receiving the amount of inorganic iodine discussed, when no significant correlations were traced between the insignificant electron density of the cytoplasm (B_1) and other ultrastructures of the profile. Meanwhile, an indirect link of noticeable strength (r = -0.6), which the moderate electron density of the cytoplasm B_2 had with the extended substructures of the granular cytoplasmic reticulum (J_3), indicates the thyrocyte's adaptation to activity under the functional stress conditions due to administering the discussed amount of inorganic iodine on the iodine deficiency background.

Summarizing the results obtained, it should be noted that they provide an opportunity to further explore the organization of the "follicular thyrocyte" biological system and to identify its potential and reserve capacities. In this dimention, our approach to studying the state of a hormonopoietic cell, particularly determining its cytological markers, is a variant of the hybrid expert system, which is entirely consistent with the current practice of studying biological objects and systems, in particular, with the needs of medical diagnostics [6]. Other authors [9] point out to the need of using expert systems in the conditions of uncertainty for performing various forensic tests, including medical ones; they emphasize that now there is a certain array of research on improving modeling in management, healthcare and various branches of medicine, namely endocrinology, oncology, etc., that should be carried out viewed from uncertainty, using qualitative data. The similar opinion is expressed [8] when the expediency of using qualitative (linguistic) information in cardiology is substantiated.

Significant opportunities and research prospects based on the use of qualitative information for the needs of medical diagnosis are also emphasized by the authors [7], who believe that estimation of the linguistic data about the patient's condition should be carried out at the beginning of the diagnostication.

The most clearly expressed opinion on this subject was expressed by [5], who mentioned that the process of any diagnosing, particularly medical one, is always based on some uncertainty. That is why we consider medical diagnostics, which can operate with quantitative data [10], to be one of its best types.

Conclusion

The state of the follicular thyrocytes' cytoplasm electronic density sufficiently reflects the activity level of the synthetic processes occuring in the cell. We believe that the presented studies have proved the electronic density degree of the thyrocyte cytoplasm to be a marker of the prevailing majority of changes occurring in it during etiopathogenetic correction of iodine deficiency.

We see prospects for further research in the adaptation of the suggested mathematical approaches for application in cytomorphology and cytophysiology.

References

1. Lutsenko MT. Tsitofiziologiya: monografiya. Novosibirsk – Blagoveshchensk: SB RAMS. 2011; 216 s. [in Russian].
2. Plashchevaya EV, Smirnov VA, Nigej NV, Lysak VA. Osnovnyye vidy vrachebnoy logiki. In: Posobiye dlya prakticheskikh zanyatiy po meditsinskoy informatike. Blagoveshchensk: AGMA. 2014; 176 s. [in Russian].
3. Ryabukha OI. Ultrastrukturni osoblyvosti syntetychnoyi diyalnosti folikulyarnykh tyrotsytiv pry pryymanni orhanichnoho yodu v umovakh alimentarnoho yododefitsytu. Visnyk problem biolohiyi i medytsyny. 2017; 2(140):134-139. [in Ukrainian].
4. Ryabukha OI. Doslidzhennya syntetychnoyi diyalnosti folikulyarnykh tyrotsytiv pry pryymanni neorhanichnoho yodu v umovakh alimentarnoho yododefitsytu. Visnyk problem biolohiyi i medytsyny. 2017; 3(141):218-223. [in Ukrainian].
5. Ahmadi H, Gholamzadeh M, Shahmoradi L, Nilashi M, Rashvand P. Diseases diagnosis using fuzzy logic methods: A systematic and meta-analysis review. Computer Methods and Programs in Biomedicine. 2018; 161:145-72.
6. Amigó JM, Small M. Mathematical methods in medicine: neuroscience, cardiology and pathology [Internet]. Phil. Trans. R. Soc. 2017; A375. Available from: http://dx.doi.org/10.1098/rsta.2017.0016.
7. Das S, Guha D, Dutta B. Medical diagnosis with the aid of using fuzzy logic and intuitionistic fuzzy logic. Applied Intelligence. 2016; 45(3):850-67.
8. Mirams GR, Pathmanathan P, Gray RA, Challenor P, Clayton RH. Uncertainty and variability in computational and mathematical models of cardiac physiology. The Jornal of Physiology. 2016; 594(23):6833-47.
9. Mishra N, Jha P. Fuzzy expert system and its utility in various field. Recent Research in Science and Technology. 2014; 6(1):41-5.
10. Zadeh LA. Can Mathematics Deal with Computational Problems Which Are Stated in a Natural Language? Logic Colloquium, UC Berkeley. 2011, September 30. Available from: http://philosophy.berkeley.edu/events/detail/793.

Реферати

ПОШУК МАРКЕРІВ ЗМІН СИНТЕТИЧНОЇ ДІЯЛЬНОСТІ ТИРОЦИТА ПІД ВПЛИВОМ ПРИЙМАННЯ ЙОДУ В УМОВАХ ЙОДНОГО ДЕФІЦИТУ

Рябуха О. І.

Обов'язковою передумовою діяльності клітини є різноманітність її станів, кожен з яких має притаманні тільки йому ознаки – маркери, які за ступенем завершеності трансформування одного стану в інший поділяють на маркери первинних змін, маркери переважаючою більшості змін та маркери остаточних змін. Репрезентована робота присвячена встановленню тих ультраструктурних складових елементів фолікулярного тироциту, які при впливі на його синтетичну активність йодом органічної і неорганічної хімічної природи набувають ознак маркерів переважаючої більшості змін. Якісну інформацію щодо кількості і стану органел тироцита, пов'язаних із синтезом тиреоїдних гормонів, отримували під час огляду електронограм щитоподібних залоз білих щурів-самців. Після її трансформування у кількісні показники і наступного проведення кореляційного аналізу, простежені кореляційні зв'язки між органелами візуалізовували шляхом побудови кореляційних портретів, які аналізували з позицій цитофізіології. Установлено, що синтетичну активність фолікулярних тироцитів достатньою мірою відображає ступінь електронної щільності їх цитоплазми. Найбільш виражені зміни в стані цитоплазми простежуються після зміни кількості вільних рибосом; встановлені зміни передують змінам кількості зв'язаних рибосом. Зазначене дає підстави розглядати ступінь електронної щільності

ПОИСК МАРКЕРОВ ИЗМЕНЕНИЙ СИНТЕТИЧЕСКОЙ ДЕЯТЕЛЬНОСТИ ТИРОЦИТА ПОД ВЛИЯНИЕМ ПРИЁМА ЙОДА В УСЛОВИЯХ ЙОДНОГО ДЕФИЦИТА

Рябуха О. И.

Обязательным условием деятельности клетки является разнообразие её состояний, каждое из которых имеет присущие только ему признаки – маркеры, которые по степени завершённости трансформации одного состояния в другое разделяют на маркеры первичных изменений, маркеры преобладающего большинства изменений и маркеры окончательных изменений. Представленная работа посвящена установлению тех ультраструктурных составляющих элементов фолликулярного тироцита, которые при воздействии на его синтетическую активность йодом органической и неорганической химической природы приобретают признаки маркеров преобладающего большинства изменений. Качественную информацию о количестве и состоянии органелл тироцита, связанных с синтезом тиреоидных гормонов, получали при просмотре электроннограмм щитовидных желёз белых крыс-самцов. После её трансформации в количественные показатели и последующего проведения корреляционного анализа, установленные корреляционные связи между органеллами визуализировали путём построения корреляционных портретов, которые анализировали с позиций цитофизиологии. Установлено, что синтетическую активность фолликулярных тироцитов в достаточной мере отображает степень электронной плотности их цитоплазмы. Наиболее выраженные изменения в состоянии цитоплазмы прослеживаются после изменения количества свободных рибосом; установленные изменения предшествуют изменениям количества связанных рибосом. Указанное даёт основания рассматривать степень электронной плотности

цитоплазми фолікулярних тироцитів як маркер переважаючої більшості змін їх синтетичної активності.

Ключові слова: математичні технології в медицині, щитоподібна залоза, тироцит, цитофізіологія, маркери змін стану.

Стаття надійшла 15.07.18р.

цитоплазмы фолликулярных тироцитов в качестве маркера преобладающего большинства изменений их синтетической активности.

Ключевые слова: математические технологии в медицине, щитовидная железа, тироцит, цитофизиология, маркеры изменений состояния.

Рецензент Шепітько В.І.

DOI 10.26724/2079-8334-2018-3-65-185-189
UDC 611.12

[1]A.P. Stepanchuk, [1]N.V. Royko, [1]B.M. Fylenko, [2]A.M. Pryshlyak
[1]HSEE "Ukrainian Medical Stomatological Academy", Poltava
[2]I. Horbachevsky Ternopil State Medical University, Ternopil

MORPHOFUNCTIONAL PURPOSE OF HUMAN ATRIAL AURICLES

E-mail: borius007filenko@ukr.net

The paper is aimed at the topography study of the normal human atrial auricles. Specimens of 24 human hearts of both gender aged 55 to 76 years old with no cardiovascular lesions in the history have been studied. The analysis of the findings has shown that the right atrial auricle area, due to the presence of pectineal muscles and fossae between them, is a special adaptation which, in systole, results in the formation of turbulent streams, overlapping the main blood flow from the right atrium in the ventricles, giving it some turbulence. The longitudinal axis of the left atrial auricle is oriented perpendicular to the axial flow of blood from the left atrium into the ventricle. Generally, this is similar to a special attachment, the purpose of which is to transform the rhythmic reductions of the pectineal muscles of the atrial auricle into the force necessary for lateral shifting of blood flow layers through the atrium to the left ventricle and giving it a turbulent movement. The interior topography of the right and left atrial auricles is irregular and such scalloped surface is formed by the pectineal muscles, trabecules, multiple fossae and rare diverticula-like cavities. The extra and intracorporal models of the artificial heart must have a topography of the plains as close as possible to the human heart to avoid cardiovascular complications. The size of the auricle and its orifice should be considered during surgery on the cardiac valves.

Keywords : atrial auricles, orifice, heart, pectineal muscles, trabeculae.

The study is a fragment of the research project "Age-related aspects of the structural organization of the human immune system organs, glands of gastrointestinal and urogenital system in normal condition and pathology". State registration number: 0106U004192, prolonged for the period of 2016-2020.

Circulatory system diseases take the leading place among the causes of mortality in most industrialized countries [7, 8]. The prevalence of the cardiovascular pathology is constantly increasing worldwide [3, 6]. According to the experts ' predictions, the number of deaths from cardiovascular diseases will rise due to increasing mortality among the male population from 18,1 million people in 2010 to 24,2 million in 2030 worldwide [5]. As a result, there is an increase in the formation of thrombi in the heart, leading to fatal outcomes [1]. According to the publications, they are most frequently formed in the left atrial auricle [4]. In addition, while creating the artificial heart models, cardial cavities should be taken into account to further reduce multiple complications in the contact with the blood flow [10].

The purpose of the work was to study the topography of the normal human atrial auricles.

Materials and methods. Specimens of 24 human hearts of both gender aged 55 to 76 years old with no cardiovascular lesions in the history have been studied.

The methods of anatomic dissection and morphometry have been applied. Morphometric studies of the hearts, fixed in 10% formalin solution have been carried out using the flexible ruler and caliper as the measuring tools. The following measurements were used as morphometric indicators: the length and width of the atrial auricles (the length was determined by the distance from the midpoint of their base to the top, and the width by the mean diameter of its body); the diameter of the atrial auricles orifice. In addition, a count of the number of pectineal muscles on the medial and lateral walls of the left and right atrial auricles.

The resulting metric data has been statistically processed by the Microsoft Office Excel 2003 software and medical morphometry.

The study was performed in compliance with the requirements of major bioethical principals of the "European Convention for Human Rights and Biomedicine" (04.04.1997), Helsinki Declaration of the World Medical Association on Ethical Principles for Medical Research Involving Human Subjects (1964–2008), as well as the MOH of Ukraine Order No. 690 dated 23.09.2009.

Results of the study and their discussion. It has been found that on the anatomical wet