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Correlation Analysis as a Thyroid Gland, Adrenal Glands, and Liver Relationship Tool for Correcting Hypothyroidism with Organic and Inorganic Iodine

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Abstract

The search for dependencies that exist between a plurality of state parameters of the constituent elements of a biological system is an important task for its diagnosis. An integral indicator of the body's status as a biosystem is the weight, the changes of which often correlate with the processes occurring in this organ. Using the Spearman's rank correlation coefficient in studying the effects of iodine-correction of model iodine deficiency has made it possible to establish that the weight of the adrenal glands and liver of rats is associated with the change in the weight of their thyroid glands. This proves the presence of a functional link between them and indicates the predominant role of the thyroid gland. In this case, the thyroid gland, adrenal glands and liver should be considered as a separate functional module. By this term, we propose denoting a set of several organs that may belong to different physiological systems, but have a mathematically proven functional link.

Keywords: correlation analysis ; mathematical transformations ; biomedical research ; thyroid gland ; adrenal glands ; liver ; hypothyroidism ; organic iodine ; inorganic iodine

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1. Introduction

The weight of the body/organ is an integrative indicator of its state [1-3]. Thus, an increase in the weight of the thyroid gland, which is observed in hypothyroidism, is a sign not only of its isolated pathology, but also indicates a deterioration of the state of the whole organism [4]. The basis of the existence of alimentary hypothyroidism is the biogeochemical feature of certain areas, which consists in the presence of areas with reduced iodine content in the objects of the environment; to cause and potentiate thyroid dysfunction may also be a series of anthropogenic, industrial and radiation contaminants, chemicals, and the like.

1. Related works

There are theoretical preconditions for the existence between the thyroid and adrenal glands and the liver of functional bonds. So, tyrosine is a common substrate for the formation of both thyroid and steroid hormones, while the liver is a target for thyroid hormones, the body in which they are metabolized and the place of enzymatic activation of steroid hormones. The interaction of the thyroid and adrenal glands and the role of the liver in the transformation of their hormones is indicated in works [5] and [6]. In the light of this study of the links between such related joint activities of organs like thyroid gland, adrenal glands and liver, has a scientific significance.

2. Proposal of the work

Investigation of the features of correlations between the indexes of thyroid, adrenal and liver weights in the regulation of medically potentiated alimentary hypothyroidism by the acceptance of iodine of organic and inorganic chemical nature.

3. Methods and Materials

3.1. The mathematical methods of investigation

The dependence of some quantitative variables on others was calculated by determining the Spirman rank coefficient, which assumes that the variance of a random member will either increase or decrease with increasing x, and therefore in the regression, which is estimated by using the Method of Least Squares, the absolute values of the residues and the values of x will be correlated. The data for x and the remainder are ordered, and the rank correlation coefficient is defined as:

$$r_{x,e} = 1\frac{6\sum D_i^2 - 2}{n(n^2 - 1)}, \tag{1}$$

where D - the difference between rank x and rank e; n - number of observations

Since his calculations were conducted on a small number of observations, the evaluation of its statistical significance was of great importance. In the case of observations of 10 or more, the significance assessment was carried out by using the the Student's t-test according to the formula:

$$t = p\frac{n-2}{1-p^2}, \tag{2}$$

where p - the coefficient of rank correlation.

Using the table of t-test values for degrees of freedom without two ($n^2 = n - 2$), the calculated values were compared with the table; the coefficient was considered significant, provided that the calculated $t > t_{0.05}$ tabular [7-9].

3.2. The materials of investigation

The experimental part of the study was conducted on nonlinear white male rats of 140-160 g body weight, which were in the model conditions of nutritional deficiency, potentiated with the administration of Mercazolil (INN – Thiamazole) in a dose of 3 mg per kg body weight. Correction of iodine deficiency was carried out by compounds of organic and inorganic iodine. Both iodine-containing substances were added to animal feed in quantities that consumed histologically verified minimal (21 µg iodine per kg body weight), moderate (50 µg iodine per kg body weight) and significant (100 µg iodine per kg body weight) iodine doses. The rats were divided into 9 groups of 10 animals in each. Rats of group 1 were on a full-fledged common vivarial diet; they were universal control (K_1) for animals of other groups. Group 2 rats consumed iodine deficient diet; they were controlled by K_2 in determining the effects of iodine deficiency and its potentiation with Mercazolil on the weight of the organs under study. Rats in group 3, which conditioned the state of malignant iodine deficiency, potentiated Mercazolil, were controlled by K_3 to determine the effectiveness of iodine-containing drugs. To the diet of the rats of groups 4, 5 and 6, respectively, 21, 50 and 100 µg of organic iodine were added, the rats of groups 7, 8 and 9 received the same amount of iodine of inorganic chemical nature. After 30 days, the rats were decapitated under ethereal anesthesia, the organs examined were weighed.

Digital results were averaged; their statistical processing was carried out by using the program Statistica 6.0 for Windows XP (Stat Soft). The results were compared with each other by comparing the weight indexes of the investigated organs with the consumption of identical doses of both iodine-containing compounds, with the consumption of increasing amounts of iodine of each iodine-containing substance, and comparing with the indices of controls K_1, K_2, K_3, considering the optimal approximation to the K_1 indices.

4. Results

The results of administration of rats with organic iodine are shown in Fig. 1. It has been established that the addition of iodine in feed of rats and the increase in the dose of iodine consumed by them was accompanied by a rapid decrease in the weight of thyroid glands, which may be due to intense activation of thyroid hormonopoiese. The weight of the adrenal glands in the consumption of 50 µg of organic iodine (group 5) decreased (relative to control and indicators in group 4), while the weight of the liver, as compared with the indications in group 4, slightly increased. We believe that the simultaneous reduction in the weight of thyroid and adrenal glands in the background of the increase in liver weight indicates consistency in the activities of these organs. With an increase in the dose of organic iodine to 100 µg (group 6) there was an increase in the weight of the adrenal glands and the liver; their parameters were greater than in the rats of the previous groups, with the weight of the liver was greater than in the control of K_3. It is logical to suppose that the increase in the weight of the adrenal glands and the liver due to the administration of a significant amount of 100 µg of organic iodine was due to a significant increase in the functional activity of the thyroid gland.

The results of consumption of similar doses of inorganic iodine are shown in Fig. 2. The weight of the thyroid glands of rats consuming 21 and 50 µg of inorganic iodine (groups 7 and 8) was lower than that of control of K_3, but its values greater than those of intact animals may indicate an inadequate effect of the studied doses of inorganic iodine on the functional state of the organ. Consumption of rats of group 9 of 100 µg of inorganic iodine resulted in a significant reduction in the weight of thyroid glands. When receiving inorganic iodine, the direction of change in the weight of adrenal glands coincided with the direction of change in the weight of thyroid glands. This may be a sign of activation of the "thyroid gland - sympathoadrenal system" functional axis. The weight of the liver of rats, which consumed different doses of inorganic iodine, changed little. At the same time, the obtained indices were higher than in intact animals, indicating the influence of inorganic iodine on the functional state of the liver.

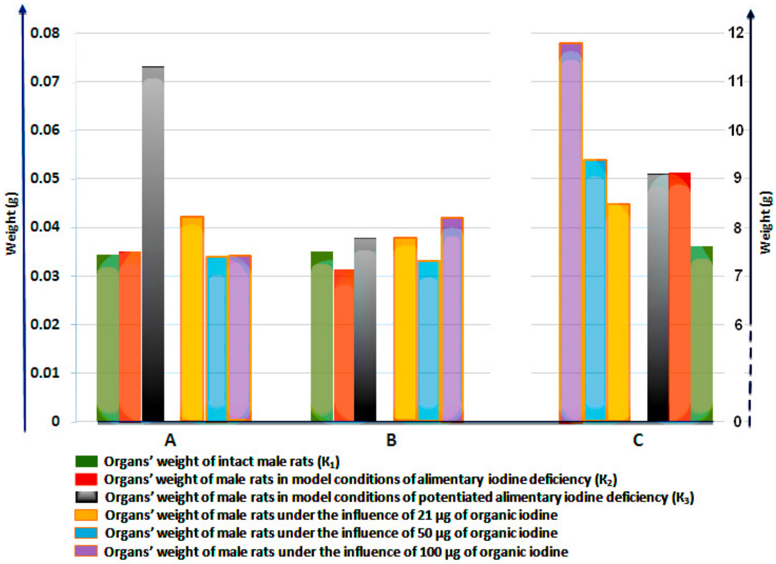

Fig 1. Organs' weight when receiving organic iodine under conditions of potentiated iodine deficiency: A - thyroid glands, B - adrenal glands, C - liver.

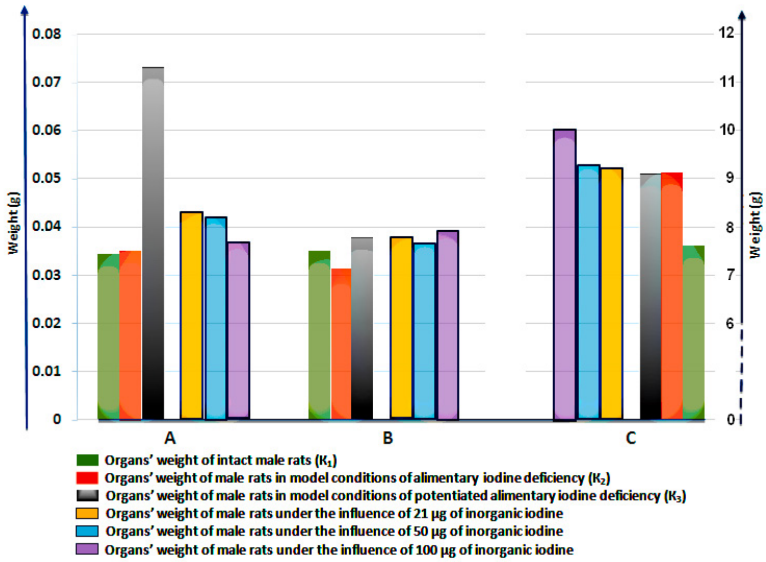

Fig. 2. Organs' weight when receiving inorganic iodine under conditions of potentiated iodine deficiency: A - thyroid glands, B - adrenal glands, C - liver.

5. Discussion

So, the weight of the thyroid and adrenal glands and the liver is largely due to the additional iodine intake, its chemical nature and dose. This made it possible to assume that there is a functional connection between the said authorities; with the role of the thyroid gland prevailing. Nowadays, more and more fields of science are using mathematical technologies to solve the tasks facing them [10-14]. Therefore examination proposed by us hypothesis was performed using the Spirman's rho with the checking of the results obtained following the *t*-test (see Table 1).

Table 1. Interdependence between the weight of thyroid glands, adrenal glands and liver.[1]

Study condition	$w_1 - w_2$	$w_1 - w_3$ Spearman's rho	$w_2 - w_3$	$w_1 - w_2$	$w_1 - w_3$ Student's *t*-test	$w_2 - w_3$
iodine deficiency in the diet	null	0.491	null	null	5.174	null
potentiated deficiency of iodine in the diet	null	null	-0.442	null	null	4.401
consume 21 μg of organic iodine	0.527	0.394	0.491	5.842	3.73	5.174
consume 50 μg of organic iodine	0.527	null	0.442	5.842	null	4.401
consume 100 μg of organic iodine	0.564	null	null	null	6.609	null
consume 21 μg of inorganic iodine	null	null	null	null	null	null
consume 50 μg of inorganic iodine	null	-0.309	0.370	null	2.734	3.426
consume 100 μg of inorganic iodine	0.467	null	0.564	4.773	null	6.609

Analysis of the data in the table showed that, in the deficit of iodine in the diet, there were no relationships between the thyroid and adrenal glands, as well as between the thyroid glands and the liver. Potentiation of iodine deficiency significantly impeded the interaction of the adrenal glands and the liver (r_s = -0.44), while the interconnections between the thyroid glands and other organs were not traced. Meanwhile, iodine supplementation affects the weight of thyroid and adrenal glands and liver, as well as contributing to the establishment of links between investigated organs (Fig. 3).

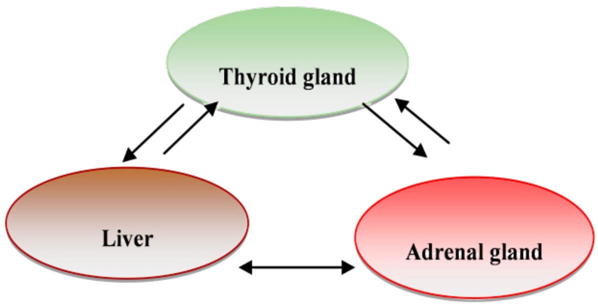

Fig. 3. Interconnections between thyroid gland, adrenal glands and liver in conditions of correction are potentiated hypothyroidism with different doses of organic and inorganic iodine.

Thus, our research confirms the information on the existence of certain functional effects of the thyroid gland on the liver [15,16] and regarding thyroid-adrenal bonds [17,18]. Established correlation analysis of the relationship between the weight of the thyroid, and adrenal glands, and the liver allows to distinguish these internal organs into a single functional module, the state of the constituent elements of which is determined by the activity of the thyroid gland.

6. Conclusion

It is expedient to consider a set of several organs as a functional module, which may belong mainly to different physiological systems, the connection between which is proved by means of mathematical analysis. The presence of correlation between the weight of thyroid and adrenal glands, thyroid glands and liver, adrenal glands and liver

[1] 1) The marks *w* indicate the weight: w_1 - thyroid glands, w_2 - adrenal glands, w_3 - liver. 2) The value r_s <0.300 was not entered in the table. 3) The critical value of the *t*-test was at 2.306 at a significance level of 0.05.

proves that there is a functional connection between these organs that meets the requirements for the concept of "functional module".

The absence of links between thyroid and adrenal glands in conditions of iodine deficiency and between thyroid glands and the liver under conditions of potentiated iodine deficiency indicates the prevalence of thyroid gland for the activity of the "thyroid gland - adrenal glands - liver" functional module.

The prospect of further research is seen in the study of the possibility of considering changes in the weight of the thyroid and adrenal glands and the liver as a sign of changes in the general state of the organism.

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