

PARAMETERS OF CENTRAL AND INTRACARDIAC HAEMODYNAMICS IN WOMEN WITH THYROID HYPERPLASIA AND ALCALCULOUS CHOLECYSTITIS

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ABSTRACT

Aim: The study aimed to investigate some parameters of functional status of central and intracardiac haemodynamics in women with thyroid hyperplasia and acalculous cholecystitis.

Materials and Methods: Functional changes of haemodynamic status in women with thyroid hyperplasia and acalculous cholecystitis were investigated. All data are obtained through general and special clinical methods, standard and special laboratory methods of examination, physiological, biochemical and statistical methods. Parameters of central and intracardiac haemodynamics have been recorded by the method of two-dimensional M-mode echocardiography in the echo chamber "Toshiba-140" (Japan) at the resting state.

Results: An increase in heart rate (by 45.6%) was observed in patients, which led to decreased duration of cardiac cycle and ejection time. Statistically significant ($p < 0.05$, 11.7% on average) increase in total peripheral vascular resistance was indicated. Dynamics of changes of parameters of central and intracardiac haemodynamics indicates different parallel existing pathways of secondary disturbances in the part of cardiovascular system. A significant increase in peripheral vascular resistance associated with decreased elasticity (increased vascular rigidity) of the arteries is the element of concentric type of left ventricular hypertrophy. The increase in volume in the absence of vasospastic reactions and increasing venous tone is an element of eccentric hypertrophy.

Conclusions: It is possible to talk about the presence of systolic dysfunction in patients, which, however, is predominantly of functional character. The revealed specific changes in homeostatic haemodynamic characteristics in the women's body with thyroid hyperplasia and acalculous cholecystitis require the development of new, more effective and preferably drug-free (due to liver pathology and detoxification dysfunction) approaches to medical treatment of such patients.

KEY WORDS: thyroid hyperplasia, acalculous cholecystitis, hypothyroidism, cardiovascular system, cardiac haemodynamics

INTRODUCTION

Endemic environmental iodine deficiency, as well as the absence or insufficiency of this microelement's dietary intake, which leads to hypersecretion of pituitary thyroid stimulating hormone, resulting into hypertrophy and hyperplasia of thyroid secretory epithelium [1], is a serious biomedical problem for Ukraine [2]. Especially – for Transcarpathian region [2].

The analysis of scientific literature on the issue allows us to conclude that thyroid hyperplasia is currently widespread pathology, especially among women. Structural changes in the gland may result in various types of disorders of body's hormonal status. That is, the presence of hyperplasia is not yet an indicator of the certain type of developing disease [3–7]. This statement becomes even more actual when liver pathology is added to thyroid dysfunction. In particular, cholecystitis, because it is the most common not only among liver diseases, but also among other types of somatic pathology. Women suffer from cholecystitis more often than men, so the problem of determining specific

features of the course of thyroid hyperplasia accompanied by cholecystitis should be given special attention [8–9].

Despite the prevalence of these pathologies and considerable number of works on their study, obtained information is still insufficient to give complete description and comprehensive explanation of the relationship and reciprocal effects between metabolic processes within thyroid gland and liver [10]. Such complexity of the matter is due to multifactorial impact of morphological structure and functional conditions of both glands on the overall hormonal status and functioning of most physiological systems of the body under the development of pathological processes [11–13].

The mechanisms of thyroid hormones' action on the cardiovascular system are multifactorial. The following are considered to be main ones: genomic effects and non-genomic direct actions on the myocardium. The latter includes influences on functional status of cardiomyocytes' plasma membrane, sarcoplasmic reticulum and mitochondria, and impact on the parameters of peripheral circulation [14–16].

Triiodothyronine and thyroxine actions on cardiomyocytes are implemented at the level of nuclei and extra-nuclear formations. Triiodothyronine has a direct effect on gene transcription level. It is indicated by changes in RNA amount and protein synthesis, showing direct nuclear-mediated effect on the heart [17–18]. Non-genomic, or non-nuclear, actions of thyroid hormones on the membrane include increased activity of sinoatrial pacemaker and enhanced transport of glucose, Na and Ca, based on the presence of Na-K-ATPases and Ca-ATPases within the inner side of cardiomyocytes' membrane and sarcoplasmic reticulum [17–20].

Due to these effects, patients with thyroid hyperplasia developing into hypothyroidism (in the areas with iodine deficiency) have decreased cardiac output, increased total peripheral vascular resistance in systemic circulation and increased diastolic blood pressure, which leads to a decrease in pulse pressure. Myocardial oxygen consumption also decreases. Disorders of lipid metabolism, which are inseparably related to metabolism of thyroid hormones, are also considered to be a direct cause of changes in functional status of cardiovascular system [17–20].

Although hypothyroidism has been identified as a risk factor for atherosclerosis and other cardiovascular diseases as early as 1938 by C. Smyth and A. Arbor, for a long time, especially in national medicine, such its aspect was not given appropriate attention. It can be explained by the fact that the risk of myocardial infarction in the case of hypothyroidism is not as high as could be expected – because of partial compensation of its negative effects by reduced myocardial oxygen demand. However, it must be noted that such results of the studies were obtained and analyzed mainly in patients with already diagnosed hypothyroidism, and in most cases on the background of replacement therapy.

In the national medical literature, there is practically no analysis of thyroid function studies in cardiological patients, in particular those with myocardial infarction. Nevertheless, only such analysis can objectify the significance of hypothyroidism as a factor in development of atherosclerosis, its complications and other cardiovascular pathologies. According to B.C. Tanis et al., among patients with myocardial infarction and dyslipidemia, elevated TSH levels have been detected in 27% of women over 60 years of age and in 6.7% of men under 50 years of age [21–26].

There is no doubt about the role of hypothyroidism, including subclinical hypothyroidism, in the development of cardiovascular diseases after the publication of the Rotterdam Study results [27]. The risks increase not only because of dyslipidemia and hypertension, but also due to abnormalities in microcirculation and coagulation homeostasis. In such patients hypercoagulation, increased platelet activity, increased concentration of coagulation factor VII and homocysteine level are observed. According to E.A. Hak, H.A. Pols, T.J. Visser et al., quite often in such patients, especially in the case of arrhythmia, and without previous clinical observation for hypothyroidism, hormonal studies show low levels of thyroid hormones and elevated

thyroid stimulating hormone levels [27]. In the myocardium, hypothyroidism causes serious edema within muscle fibers and interstitial tissue. These changes are diffuse by nature, but with prolonged course of hypothyroidism, local and then diffuse fibrosis develops. Objective examination reveals an increase in heart size and expansion of its walls, totally resulting in atrial and ventricular conduction violation [21–24].

AIM

The study aimed to investigate some parameters of functional status of central and intracardiac haemodynamics in women with thyroid hyperplasia and acalculous cholecystitis.

MATERIALS AND METHODS

PATIENT CHARACTERISTICS AND RESEARCH METHODS

87 women aged 22–54 years with chronic acalculous cholecystitis as the main diagnosis, and with thyroid hyperplasia, were chosen for examination. The control group, randomized by age, consisted of 20 healthy women.

All data are obtained through general and special clinical methods, standard and special laboratory methods of examination, physiological, biochemical and statistical methods [28]. Parameters of central and intracardiac haemodynamics have been recorded by the method of two-dimensional M-mode echocardiography in the echo chamber "Toshiba-140" (Japan) at the resting state.

CRITERIA

When analyzing the data obtained, the values of studied haemodynamic parameters in healthy women from the control group have been determined by us during clinical examination. These values, considering as normal, were used for comparison purposes.

STATISTICAL ANALYSIS

Statistical analyses were performed using the methods of variation statistics. Such statistical values as arithmetic mean, its average error, correlation coefficient and Student's reliability criterion were calculated. Statistical analysis was performed using Microsoft Excel 2003 software. Differences were considered significant at $p < 0.05$.

RESULTS

The characteristics of examined women are shown in Table 1.

During the study period, in all women having thyroid hyperplasia and acalculous cholecystitis certain features of central and intracardiac haemodynamics were found (Table 2).

According to the mechanism of thyroid hormones' action on cardiovascular system, in ill patients we have registered an increase in heart rate (by 45.6%), which leads to a decrease in duration of cardiac cycle and ejection time. Statistically significant ($p < 0.05$) increase of total peripheral vascular resistance (by 11.7% on average) has been observed. It is probably due to the non-nuclear effects of thyroid hormones

Table 1. Age composition of the groups of examined women

Examined groups	Number of examined women	
	abs.	%
Control (n=20):		
22-30 years	4	20.0
31-40 years	10	50.0
41-54 years	6	30.0
With thyroid hyperplasia (n=87):		
22-30 years	18	21,0
31-40 years	43	49,0
41-54 years	26	30,0

Table 2. Parameters of haemodynamics in examined groups of women

Parameters of haemodynamics	Control group	Patients with thyroid hyperplasia
HR, bpm	67.5±3.8	98.3±2.4*
Systolic AP, mm Hg	120±5	121±2
Diastolic AP, mm Hg	80±4	78±2
CO, L/m	5.00±0.30	4.92±0.22
Total peripheral vascular resistance, kPa×sec/m ²	14.5±0.5	16.2±0.8*
Duration of cardiac cycle, msec	950±21	893±30*
Ejection time, msec	305±9	283±5*
EDV, mL	97.5±2.4	125.1±3.0*
EDVI, mL/m ²	64.0±1.9	69.0±1.6*
ESV, mL	45.1±3.0	53.1±2.9*
ESVI, mL/m ²	23.5±2.2	28.9±1.2*
SV, mL	61.2±2.4	72.0±2.7*
SVI, mL/m ²	33.0±2.8	40.1±1.3*
Myocardial contractility index, kPa/sec	21.2±0.7	24.8±0.9*

Abbreviations: HR – heart rate; AP – arterial pressure; CO – cardiac output; EDV – end-diastolic volume; ESV – end-systolic volume; EDVI – end-diastolic volume index; ESVI – end-systolic volume index; SV – stroke volume; SVI – stroke volume index.

*Statistically significant difference in comparison to values of haemodynamic parameters in control group, $p < 0.05$.

and their influences on lipid metabolism disorders. At the same time, an increase in stroke volume (by 17.6%) and its index (by 21.5%) prevailed, which was provided by a certain raise of myocardial contractility index (by 17.5%) to some extent under greater peripheral vascular resistance.

In relation to the values of end-diastolic and end-systolic volumes and their corresponding indices, it must be noted that the latter increased to a greater or lesser extent in patients with thyroid hyperplasia and acalculous cholecystitis: EDV – by 28.3%, ESV – by 17.7%, EDVI – by 7.8%, and ESVI – by 23.0%. Such dynamics of changes indicates the presence of systolic dysfunction in examined patients. When the usual blood volume flowing from pulmonary veins is added to increased end-systolic volume, diastolic volume in heart chambers also raises up. Finally, the values of diastolic pressure and end-diastolic volume are above physiological normal state, too.

Despite the fact that such an increase in preload through Frank-Starling mechanism leads to the raise of stroke

volume, because of functional changes in contractility the end-systolic volume remains increased. Theoretically, this compensatory mechanism is aimed at maintaining the value of stroke volume in the case of dysfunction caused by decreased elasticity of cardiac muscle, which predominantly occurs due to non-nuclear effects of thyroid hormones in the studied pathology.

DISCUSSION

Thyroid hyperplasia, developing in either hyper- or hypothyroidism, is widespread and serious clinical pathology, especially when associated with liver and hepatobiliary dysfunctions, and particularly among women [8–9]. Scientific literature, especially national, is still lacking complete description and comprehensive explanation of functional interconnections between thyroid gland and liver and their common impact on overall hormonal status and functional conditions of physiological systems in the case of development of pathological process [11–13].

Our study revealed changes in parameters of central and intracardiac haemodynamics under the combination of hypothyroidism and cholecystitis. They are theoretically expected and based on both direct and indirect actions of thyroid hormones. In the first case such effects are implemented through hormonal actions on cardiac muscle. In the second case – through affecting lipid metabolism in association with hepatobiliary disorder [14-26].

In general, the dynamics of changes in central and intracardiac haemodynamics indicates different, parallel existing pathways of secondary disorders in cardiovascular system. Thus, a significant increase in total peripheral vascular resistance, associated with a decrease in vascular elasticity, which at the same time means increased rigidity of blood vessels' walls, is the component of concentric type of left ventricular hypertrophy. Increased stroke volume under the absence of vasospastic reactions and raised venous tone represent the element of eccentric hypertrophy [14, 21-24].

It should be emphasized that observed changes in cardiovascular system in examined women with thyroid hyperplasia and acalculous cholecystitis are predominantly functional (increased heart rate, myocardial contractility,

etc.). It is evidenced by the absence of significant changes in blood pressure, since with progression of pathological process, blood pressure stabilization at a high level takes place.

Based on the data obtained, it is also possible to talk about the presence of systolic dysfunction in patients, which, however, is predominantly functional.

CONCLUSIONS

The study confirmed that in women patients with thyroid hyperplasia and acalculous cholecystitis, changes in thyroid status and parameters of central and intracardiac haemodynamics in their pure form do not correspond to those typical for either thyroid hyperplasia of hypothyroid type, or acalculous cholecystitis. Revealed changes have mixed and predominantly functional character.

The revealed specific changes in homeostatic haemodynamic characteristics in the women's body with thyroid hyperplasia and acalculous cholecystitis require the development of new, more effective and preferably drug-free (due to liver pathology and detoxification dysfunction) approaches to medical treatment of such patients.

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CONFLICT OF INTEREST

The Author declares no conflict of interest

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