ACTA SCIENTIFIC MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 3 Issue 12 December 2019

Research Article

Determination of the Thyroid Gland Density in the Differential Diagnosis of Functional Disorders in Patients with Autoimmune Thyroiditis

Ramchandra Sargar[1]*, Irina Kurnikova[1] and Igor Tomashevskiy[2]

[1]*RUDN-University, Moscow, Russia*

[2]*Central Clinical Hospital № 2 Named. N. A. Semashko Joint Stock Company Russian Railways, Moscow, Russia*

***Corresponding Author:** Ramchandra Sargar, RUDN-University, Moscow, Russia.

Received: October 30, 2019; **Published:** November 07, 2019

DOI: 10.31080/ASMS.2019.03.0466

Abstract

Background: primary diagnosis of the functional thyroid gland's state in various diseases is not very difficult, because the physician has the ability to determine the level of thyroid hormones. However, it is often necessary to assess the reserve capacity of the organ, the prognosis of the restoration of hormone secretion and the effectiveness of treatment on the administered (replacement or suppressive) therapy. Neither hormonal studies nor ultrasound diagnostic methods can provide such a possibility. One of the ways to solve this problem is to use the x-ray computed tomography with determination of the thyroid gland density by Hounsfield Unit (HU) [2,4].

Purpose of Study: to study the diagnostic possibilities of X-ray computed tomography (CT) with the determination of the thyroid gland density index in HU units in the diagnosis of functional disorders in patients with autoimmune diseases, both during the primary diagnosis and on the top of administered therapy.

Settings and Design: The study comprised 75 women, aging 43.3 ± 4.5 years. The parameters of healthy individuals (n = 30) were used as reference values.

Materials and Methods: Individuals were divided into five clinical groups depending on the stage of development of autoimmune process and thyroid functional status. Thyroid density parameters were compared in patients with autoimmune diseases of the thyroid gland on the background of euthyroidism and hypothyroidism with similar parameters in groups of patients without structural changes in the thyroid gland, but with suppression of hormone production or activation of antibody genesis.

Results: Thyroid density has been diminished in patients with thyroid autoimmune diseases. The decrease in density is remained regardless of the stage (subclinical or manifested) of hypothyroidism. Prolonged therapy with β-blockers causes similar changes in thyroid density and increases the risk of developing hypothyroidism.

Conclusions: The use of X-ray computed tomography to determine the density of the thyroid gland allows to predict the risk of hypothyroidism formation with high accuracy regardless of its genesis and also to monitor the effectiveness of treatment.

Keywords: X-Ray Computed Tomography; Autoimmune Thyroiditis; Hypothyroidism; Thyroid Density Index In HU Units

Introduction

An analysis of the scientific literature of recent decades indicates that the number of patients observed with postoperative hypothyroidism and hyperthyroidism resulting from the use of radioactive iodine for therapeutic purposes is reduced, and the number of patients with primary hypothyroidism, which has arisen against the background of autoimmune processes associated with the thyroid gland, is progressively increasing [1]. Currently, the number of autoimmune diseases of the thyroid gland can be classified into: autoimmune thyroiditis (AIT), several forms of diffuse toxic goiter

and thyroid manifestations of polyendocrine syndromes. Diagnosis of diseases is based, as a principle, on the results of functional thyroid tests, which are constantly being improved. In recent years elaborated sensitive laboratory methods allow to detect slight impairment in thyroid function and to diagnose thyroid diseases at an early stage [5]. Currently, the serum thyroid stimulating hormone (TSH) and thyroid hormones, which allow the physician to evaluate the level of thyroid hormones, availability of adequate relation with TSH. However, the convenient methods for doctors, in last decade, have been created to evaluate thyroid hormone formation and content of hormones in the thyroid gland [6,7]. The x-ray computed tomography with determination of the thyroid gland density by Hounsfield Unit is directly proportional to concentration of intrathyroidal stable iodine [4,7,8].

Purpose of study

To study the diagnostic capabilities of X-ray computed tomography with the determination of the thyroid density index in HU units in the diagnosis of functional disorders in patients with autoimmune diseases, both during the initial diagnosis and during therapy.

Materials and Methods

Design of study

The observational mono-centre study was prospective.

Eligibility criteria

Patients were received information and signed informed consent before including in the research.

The study comprised 75 women, aging 43.3 ± 4.5 years. Patients, who were suspicious of a volumetric formation in thyroid gland or sternal formations, were sent to perform X-ray computer tomography.

Exclusion Criteria:

- Lack of informed consent;
- The presence of nodular goiter;
- The age of patients younger than 30 and older than 50 years;
- The presence of acute diseases and exacerbation of chronic somatic diseases;
- Patients with severe somatic pathology and functional impairment.

Conditions

Central Clinical Hospital № 2 named. N. A. Semashko joint stock company Russian Railways, (Moscow, Russia). Patients were prohibited for 3 months to administer iodine, bromine, thyroid hormones, anti-thyroid drugs, adrenal hormones, β-blockers. Two groups of patients considered as an exceptions, who took levothyroxine 100 μg /day (group 3) and bisoprolol 5 mg / day (group 5).

Duration and research methods

The duration of the follow-up period for each patient ranged from 2 to 6 months during 2016 - 2018yrs. The thyroid status of the examined was determined by the endocrinologist on the basis of anamnesis, physical examination, USG of thyroid gland and serum level of TSH, fT4, fT3, antibodies to thyroid peroxidase and thyroglobulin. The determination of thyroid density was carried out in all patients by using a single-photon emission computed tomography scanner combined with a SymbiaT16 X-ray computed tomography scanner (SPECT / CT) (Siemens). The examination time was 7 - 10 minutes, and the local radiation stress was 0.4 - 1 mSv. The obtained values were recorded in arbitrary units, calculated separately for the right and left lobes, as well as the average value of HU.

Ethical consideration

The compliance of the study with the norms of biomedical ethics is confirmed by the conclusion of the Ethics Committee of the Medical Institute of RUDN University (Protocol №-30 by February 22. 2018).

Statistical analysis

To perform a statistical analysis of the results of the study, all the history, somatic status, laboratory and instrumental examination methods were entered into the Microsoft Excel program table and processed using the IBM SPSS Statistics 11.0 program. The construction of contingency tables with the calculation of the Pearson's consent criterion (χ^2 criterion), with a confidence interval of at least 95% ($p < 0.05$) was used to compare the medical characteristics of patients according to various grouping criteria.

Results

Patients were divided into five clinical groups depending on thyroid functional status (Table 1): Group 1 - patients without thyroid pathology (n = 30); Group 2 - patients with euthyroidism and the absence of structural changes in the thyroid gland, but with increased titers of antithyroid antibodies (AT-TPO) (n = 10); Group

3 - patients with autoimmune thyroiditis (AIT) and manifesting hypothyroidism (n = 9); Group 4 - patients with autoimmune thyroiditis and subclinical hypothyroidism (n = 22); Group 5 - patients with an euthyroid state and the absence of structural changes in the thyroid gland on ultrasound, but taking antihypertensive drugs that inhibit its functional activity (bisoprolol 5 mg per day for a month) (n = 4). The clinical characteristics of patients are presented in table 1.

Groups	N	Average Age	Duration Of Disease	Functional Status Of TG Euthyroidism/ Hypothyroidism
1	30	42,8 ± 3,4	1,2± 0,7	30/0
2	10	41,5 ± 1,8	3,5 ± 1,7	7/3
3	9	44,2 ± 3,4	4,6 ± 3,2	4/5
4	22	46,4 ± 2,4	12,3 ± 3,4	0/22
5	4	41,6 ± 1,2	10,4 ± 1,2	4/0

Table 1: Characteristics of clinical groups.

The average age of patients in all groups did not vary significantly and averaging 43.3 years.

Individuals (group 1), who did not have any pathology of thyroid gland (group 10, density of thyroid gland by computer tomography was 97.1 ± 10.4HU and these values were identified as reference values [3,4,8]. In patients (Group 2) with high titers of antithyroid antibodies, the density of the thyroid gland was reduced in the absence of structural changes according to ultrasound data and normal functional activity of the thyroid gland.

Group №	N	%	Density of thyroid gland (HU) M±δ	Volume of thyroid gland (cm^3) M±δ
1	30	40	97.1 ± 10.4	7,5 ± 3,0
2	10	12	75.3 ± 3.1	9,1 ± 2,8
3	9	10	57.8 ± 7.3	22,0 ± 1,7
4	22	30	66.4 ± 9.1	10,8 ± 3,9
5	4	8	60.8 ± 8.5	9,7 ± 3,9

Table 2: Morphological changes in the thyroid gland in the compared groups according to the CT.

In patients with AIT and manifesting hypothyroidism (Group-3), the average density values were even lower (57.8 ± 7.3). The identical data were observed in patients with subclinical hypothyroidism (group 4). In patients (group 5), who received beta blockers, were observed significant structural changes in thyroid gland.

Changes in thyroid gland volume were observed only in third group of patients ($p < 001$) as compare to first group who had no pathology (7.5 ± 3.0) (table 2).

Discussion

The changes in functional activity of gland have not been observed in individuals (group 1) with normal thyroid density during 1 year. In patients (Group 2) with high titers of antithyroid antibodies, the density of the thyroid gland was reduced in the absence of structural changes according to ultrasound data and normal functional activity of the thyroid gland, which indicates the initial changes and high resolution of the RCT, allowing for pre-nosological diagnosis. Subsequently, the structural changes and risk of hypothyroidism have been observed in group 2 patients during 9 - 12months ($r = 0.39$) and patients have been diagnosed as 'Subclinical Hypothyroidism'. In patients with AIT and manifesting hypothyroidism (Group-3), the average density values were even lower (57.8 ± 7.3), which confirmed a high correlation between thyroid density and dysfunction($r = 0.54$) [3]. Patients from group 3 and group 4 did not vary significantly according to density of thyroid gland. In patients (group 5), who received beta blockers, were observed significant structural changes in thyroid gland which in the future can lead to a decrease in the function of the organ.

It is important to emphasize that functional impairment of thyroid gland according to decreased density by CT does not always mean hypothyroidism, however, requires more serious attention to this patients. Destruction of thyroid follicular cell is accelerated while a progressed autoimmune process (due to lymphocytic and plasmocytic infiltration, oncocytic transformation of thyrocytes), which is associated with hyperplasia of gland.

Conclusions

The use of X-ray computed tomography to determine the density of the thyroid gland allows diagnosing not only the structural but functional impairments of thyroid gland at early stages of disease and predict the risk of hypothyroidism formation with high accuracy regardless of its genesis and also to monitor the effectiveness of treatment.

Authors' Contributions

Ramchandra Sargar is the main author of the manuscript, analyzed and interpreted the patients 39; data. Irina Kurnikova con-

tributed to the preparation of the manuscript. Igor Tomashevskiy participated in the collection of material and interpretation of these patients. All authors have read and approved the final manuscript.

Acknowledgments

Ministry of Education and Science of the Russian Federation on the program to improve the competitiveness of Peoples' Friendship University of Russia (RUDN University) among the leading research and education centers in the 2016 - 2020 financially supported this paper.

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