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Hormonal and other methods of thyroid gland examination: A literature review

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Abstract. The high frequency of thyroid gland disorders is currently being established, indicating that regular assessment of its condition and hormone levels may aid in the early detection of disease development. This study aimed to analyse current scientific data on methods for diagnosing the state of the thyroid gland. A randomised systematic review of 43 scientific sources published between 2015 and 2024 was conducted. The article provides an overview of traditional and modern methods of thyroid gland examination. It has been established that modern diagnostic methods are used to determine the condition of the thyroid gland and to characterise formations. Among them, thyroid ultrasound examination is the main non-radiation diagnostic tool for establishing diseases and monitoring observation. The advantages of ultrasound examination include speed, availability, and information content of the method. In addition, an important role is played by the physical examination of the patient and laboratory tests. Currently, fine-needle aspiration biopsy is considered the gold standard for the study of thyroid nodules. Positron emission tomography combined with computed tomography is used to assess tumour response and for the diagnosis, prognosis, and staging of thyroid cancer. To determine the functional state of the thyroid gland, the level of thyroid hormones in the blood serum is established: triiodothyronine, thyroxine, thyroid-stimulating hormone, thyroid peroxidase antibody, thyroglobulin antibodies, thyroid stimulating hormone receptor antibodies, thyroglobulin, and calcitonin. Thus, various clinical, instrumental, and laboratory research methods are used to determine the state of the thyroid gland

Keywords: hormones; diagnostic methods; structure; functional state; ultrasound examination

INTRODUCTION

Over 200 million people worldwide have thyroid gland pathology [1, 2]. It has been established that in developed countries of the world, the incidence of newly diagnosed thyroid diseases has increased by 52% in women and by 17% in men [3]. According to the Ministry of Health, from 2015 to 2020, the incidence of the disease in Ukraine

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increased fivefold [3]. These changes depend on the state of the environment, iodine deficiency, a person's lifestyle, stress, nutrition, and concomitant diseases.

Thyroid gland pathologies include autoimmune thyroiditis (enlarged thyroid gland due to inflammation); hypothyroidism (hormone deficiency); hyperthyroidism (excess hormones); and thyroid gland neoplasms. For accurate diagnosis, instrumental (ultrasound examination and laboratory methods (hormone tests, tumour markers) are currently used. For a more accurate diagnosis, computed tomography (CT), magnetic resonance imaging (MRI) and biopsy of thyroid nodules are used [4].

Ultrasound is of great importance in the early detection of structural changes and thyroid cancer [4, 5]. The modern level of ultrasound technology and the improvement of the standard of living gradually increase the level of detection of thyroid nodules. This type of study can detect from 30% to 67% of thyroid nodules [4]. In most cases, due to the subjective assessment of ultrasound images by radiologists and their use of different classifications, there are difficulties in the visual differentiation of benign and malignant thyroid nodules [6, 7]. L. Yang *et al.* [4] indicate that the effectiveness of ultrasound assessment of thyroid nodules differs in different approaches to determining risk groups, which leads to the appearance of different data on the level of diagnostic specificity and sensitivity of methods. This indicates that this type of study does not allow for an accurate diagnosis of the malignancy of thyroid tumours due to the dependence on individual visualisation features, which requires the creation of detailed evaluation criteria. Currently, fine-needle aspiration biopsy allows differentiation of benign and malignant from 5% to 96% of cases. This method is effective and accurate in cases of suspected malignant neoplasms [8]. However, in about 25% of cases, the cytological result is inconclusive. In such cases, molecular tests are proposed. They help to carry out a more accurate preoperative diagnosis, which allows to reduce the number of diagnostic operations. The high cost of these molecular markers and their unavailability in all medical centres make their use in clinical practice impractical.

T.L.M. Barbosa *et al.* [8] emphasise the importance of acknowledging the strengths of various diagnostic features in current ultrasound examination programs and guidelines. Combining these features will allow the development of effective diagnostic criteria. Additionally, standardising the parameters for evaluating the thyroid gland across different hospitals will assist in multicentre validation of clinical trials and enhance diagnostic effectiveness.

A wide range of clinical, instrumental, and laboratory research methods are used to diagnose the functional and structural state of the thyroid gland. These methods allow for the detection of thyroid gland pathologies and the determination of the effectiveness (dynamics) of treatment. The aim of the study was to analyse modern scientific data on methods for diagnosing the state of the thyroid gland.

To search for publications from 2019 to 2024 in the scientometric databases PubMed, Web of Science, Scopus, and Google Scholar, the keywords "hormones", "diagnostic methods", "structure", "functional state", and "ultrasound examination" were used. A randomised systematic review of 43 scientific sources was conducted. The inclusion criteria were the study and analysis of scientific publications in Ukrainian and English. The theoretical search for publications was aimed at analysing, comparing, and summarising data from modern scientific research on effective methods for diagnosing the state of the thyroid gland. The process of selecting publications included screening and quality assessment stages, where each article was carefully analysed in terms of its scientific content and methodological aspects. This approach helps to systematically summarise the literature data and allows for a deeper consideration of the literature data and allows for a deeper consideration of the publications selected for the study.

CLINICAL METHODS OF THYROID GLAND EXAMINATION

A family history of thyroid gland pathology is a predictor of its development. The presence of malignant thyroid neoplasms in first-degree relatives increases the risk of thyroid cancer by nine times [1]. Additionally, the presence of comorbidities plays a crucial role. Often, chronic diseases and severe forms of illness lead to iron deficiency anaemia, in which thyroid nodules are more frequently detected. Common signs of thyroid gland disease include changes in body weight, mood swings, elevated body temperature, dry skin, discomfort when swallowing, changes in heart function, somnolence, and muscle pain [2].

A crucial diagnostic method is the physical examination of the thyroid gland. Palpation of the thyroid gland can be performed in various ways, including with one or both hands from the anterior or posterior approach. During the examination of the thyroid gland, the placement, shape, size, symmetry, surface condition, and degree of gland movement during swallowing are assessed. The size of the gland is crucial during the examination; if changes are detected, the nature of the enlargement needs to be determined (diffuse, nodular, or mixed); the surface condition – smooth or covered with tubercles; consistency (soft-elastic or firm); mobility; adhesions to surrounding tissues; and the patient's sensations during palpation [9].

Thyroiditis is an inflammatory process associated with the damage to the thyroid gland. It is characterised by elevated serum concentrations of thyroid antibodies, such as thyroid peroxidase antibodies (TPOAb) and thyroglobulin antibodies (Tg Ab). Autoimmune thyroiditis (Hashimoto's thyroiditis) is one of the most common autoimmune diseases of the thyroid gland. Researchers by O. Gąsiorowski *et al*. [10] have found that it is diagnosed five times more often in women than in men. Autoimmune thyroiditis is found in 7% of men and 27% of women, with prevalence increasing with age. Additionally, it is estimated that approximately 1% of men and 5% of women have altered thyroid gland structure. The pathological features of autoimmune thyroiditis include lymphocytic infiltration and fibrosis, which lead to stiffness of the thyroid parenchyma [10].

The prevalence of hypothyroidism depends on iodine availability, sex, and age. In 4.70% of cases, hypothyroidism is undiagnosed, while 4.11% have subclinical hypothyroidism and 0.65% have overt hypothyroidism [11, 12]. Patients with hypothyroidism typically present with a range of nonspecific symptoms that overlap with other conditions. These include low mood, feeling cold, weight gain, muscle aches/cramps, weakness, dry skin, brittle hair and nails, carpal tunnel syndrome, or dysmenorrhea. Inevitably, many people continue to struggle with these nonspecific symptoms, possibly attributing them to other causes without discussing them with their general practitioner. This may be particularly relevant for subclinical hypothyroidism, where the severity of thyroid symptoms is likely to be less than in a person with overt clinical hypothyroidism. The diagnosis of hypothyroidism is biochemical and is established based on changes in thyroid-stimulating hormone (TSH) levels above the normal range [11]. The study by S.P. Fitzgerald *et al.* [13] found that clinical hypothyroid symptoms have correlational links with thyroid hormone levels (particularly free T4 or T3) rather than TSH. In the future, this could form the basis for recommendations and aid in better identification of patients with hypothyroidism.

Another common thyroid condition is goitre [12]. Depending on the aetiology of the disease and the presence of cancerous tissues in patients, various clinical manifestations and levels of thyroid hormones are observed. In 15% of patients with goitre, cancer is diagnosed, indicating the need for screening of patients with goitre for thyroid cancer [1].

Thyroid nodules are defined as lesions that can be differentiated from normal thyroid parenchyma through physical examination or imaging methods [1, 9]. Thyroid nodules detected by palpation are a common occurrence, affecting approximately 7% of patients, with 20% of these being cancerous [1]. The detection rate of thyroid nodules is estimated to be 2-6% on physical examination, 19-67% on ultrasound, and 8-65% in autopsy series. Thyroid lesions that are not identified during physical examination can be detected using radiological imaging methods [14]. Micronodules may increase in size over time and are more frequently found in elderly women [15]. M.A. Al-Shammari *et al*. [1] found that the presence of an enlarged thyroid gland increased the risk of thyroiditis detected by ultrasound. Meanwhile, iron deficiency anaemia, vitamin D deficiency, other autoimmune diseases, and hypertension were associated with an increased risk of thyroid nodules. Among endocrine neoplasms, thyroid cancer occupies one of the top positions and is diagnosed in 2.1% of all neoplasms worldwide (excluding carcinoma in situ and skin cancer). It should be noted that from 2000 to 2023, the incidence of thyroid cancer has been rapidly increasing [10].

Thus, the first step in the timely and high-quality diagnosis of the thyroid gland is clinical methods, which include collecting anamnestic data to determine the patient's complaints and physical examination of the thyroid gland. If necessary, further laboratory and instrumental research methods are carried out to determine the thyroid hormone spectrum, possible autoimmunity, metabolic disturbances, and assess pathomorphological changes in the thyroid gland. In addition, it is necessary to find out whether other family members (parents, brothers and sisters) had malignant neoplasms or other diseases to stratify the risk and timely carry out the prevention and diagnosis of thyroid gland diseases.

INSTRUMENTAL METHODS FOR THYROID GLAND EXAMINATION

Ultrasound is one of the main methods for visualising the thyroid gland, detecting its pathology, and monitoring dynamic changes. Moreover, this method is accessible and safe [6, 15]. When the results of ultrasound are insufficient to determine organ dysfunction, other research methods are used: MRI, CT, and PET/CT based on fluorine-18 fluorodeoxyglucose (18F-FDG). These methods are insensitive to microlesions of the thyroid gland and are more expensive and radioactive.

Currently, radioisotope studies (radionuclide scanning and scintigraphy) are necessary for patients with hyperthyroidism, in the diagnosis of various forms of goitre, and for the determination of iodine-dependent tissue following surgical intervention in thyroid cancer. Radionuclide scanning and scintigraphy are methods for obtaining gamma-topographic two-dimensional images of the gland, which determine the distribution of the radionuclide iodine-133 or 99 mTc-pertchnetate in the thyroid gland. This allows for a more accurate determination of the places where radioactive iodine or other nucleotides accumulate and are processed, as well as determining the necessity and strategy for surgical intervention. It has been established that cancer cells concentrate less radioactive iodine than healthy ones [15]. While other studies have shown the low effectiveness of these methods, it has been established that the tissues of benign formations also poorly accumulate radioactive iodine [15, 16]. The high resolution of ultrasound, its simplicity, and the absence of the need to introduce radioisotopes have been shown. This diagnostic method has high sensitivity, specificity, and diagnostic accuracy for diagnosing thyroid swellings, with values of 86.66%, 91.66%, and 90.66%, respectively [17].

Heterogeneous hypoechoic echogenicity and a lobed contour are specific grayscale features. Shear-wave elastography (SWE) is a new real-time non-invasive imaging technology for the thyroid gland that quantitatively assesses tissue stiffness. To increase the sensitivity of determining the degree of the disease and the activity of the process, B-mode ultrasound is used [18]. A direct relationship was found between SWE indicators and AT-TG levels, gland volume, between Tg Ab and TPOAb levels, and an inverse relationship between SWE and echogenicity. In addition, T. Kara *et al.* [19] established specific numerical ranges for determining thyroid gland pathology, namely, 29.45 kPa was proposed as a sensitive-specific cut-off value for determining Hashimoto's thyroiditis. However, SWE is better and more practical than other ultrasound methods for determining disease progression, as SWE allows quantitative assessment of the degree of fibrosis.

Currently, the gold standard for early diagnosis of thyroid tumours is fine-needle aspiration biopsy of nodules under ultrasound guidance with subsequent cytological examination. The results of cytological studies, together with the clinical picture and laboratory data, can help in complex and difficult cases. This method is simple, safe, requires minimal costs, and has high diagnostic accuracy [20-22]. Studies have shown that this method has 83% sensitivity and 92% specificity, and has 1 to 21% failures, which occur due to the technique and experience [23]. In another study, the authors P. Singh *et al.* [22] showed its 83.3% sensitivity and 100% specificity. Y.K. Lee *et al.* [23] established a correlation between the number of thyroid FNA and the number of thyroid cancer diagnoses.

Another method is sonography, which allows for the detection of micronodules (incidentalomas) in the thyroid gland. While sonography can provide very important information about the nature of the thyroid lesion, it does not allow for the differentiation of benign lesions from cancer [15, 24]. To address this issue, the non-invasive diagnostic and visualisation method ^{18}F-FDG PET/CT has been proposed. PET allows for obtaining data on the quantitative parameters of the metabolic activity of tissues. 18F is a radioisotope of fluorine produced by a cyclotron, which emits positrons and has a short half-life of about 109.7 minutes [25]. This allows the labelling of numerous molecular indicators, the images of which can be obtained within a few hours after injection. FDG is a glucose analogy and is taken up by living cells through glucose transporters on the cell membrane, then incorporated into the first step of the normal glycolytic pathway. The accumulation of FDG in tissues is proportional to the amount of glucose utilisation. Increased glucose consumption is characteristic of most cancers and is partially associated with overexpression of glucose transporters and increased hexokinase activity. It has been shown that FDG PET/CT is a sensitive visualisation method for the detection, tumour volume determination, staging, and assessment of treatment response in oncology [25]. In a study by A. Akbas *et al.* [14], it was found that the frequency of malignant neoplasms with increased focal 18F-FDG uptake, accidentally detected on PET/CT, was 18.8%. It was determined that ^{18}F-FDG PET/CT uptake of the thyroid gland can be diffuse or nodular. Diffuse uptake does not require additional examination, as it is usually accompanied by benign thyroid diseases. Patients with nodular uptake with a satisfactory general condition require additional examination due to the high rates of malignancy [14].

Recent studies have allowed the identification of cancer-associated fibroblasts, which have been proposed for low-molecular-weight nuclear diagnostics. In these fibroblasts, fibroblast activation protein (FAP) is overexpressed, while it is not found in normal tissues. It has been shown that FAP is highly expressed on the membrane of cancer-associated fibroblasts in approximately 90% of epithelial tumours, which is observed in cases of tissue damage, remodelling or chronic inflammation, as well as in benign conditions [26, 27].

A new class of radiopharmaceuticals based on the FAP-specific inhibitor (FAPI) based on quinoline has been developed, which have been recognised as preclinically promising as molecular targeting imaging probes [28, 29]. FAPI PET/CT is a new diagnostic method in the imaging of oncology patients. In contrast to 18F-FDG, no diet or fasting is required before the examination, and image acquisition can potentially be started within a few minutes after the indicator application. The tumour-to-background contrast ratios were the same or even better than those of 18F-FDG. In direct comparison, 68Ga-FAPI PET/CT surpasses 18F-FDG PET/CT in sensitivity and specificity for the characterisation of primary, nodular, and metastatic lesions of various types of thyroid tumours [26, 29].

H. Liu *et al.* [30] found that diffusely increased 68Ga-FAPI uptake in the thyroid gland is mostly related to chronic lymphocytic (Hashimoto's) thyroiditis. 68Ga-FAPI uptake level correlated neither with the degree of hypothyroidism nor with the TPOAb content. Immune-related thyroiditis with immune checkpoint inhibitors may be accidentally found on 68Ga-FAPI [30]. Therefore, modern imaging methods such as ultrasound, MRI, CT, and PET/CT are used to determine the structure and size of the thyroid gland and its nodules. Additional studies of the thyroid gland are needed for more accurate diagnosis and treatment planning.

LABORATORY MARKERS FOR THYROID GLAND EXAMINATION

The thyroid gland produces the hormones triiodothyronine (T3), thyroxine (T4), and calcitonin. These hormones regulate basal metabolism, protein synthesis, and several other processes, including development [31]. Thyroid function is assessed and monitored by measuring TSH levels. Euthyroidism (normal TSH and thyroid hormone levels), overt thyroid dysfunction (abnormal TSH and thyroid hormone levels), subclinical thyroid dysfunction (abnormal TSH/normal thyroid hormone levels), and isolated hyper/hypothyroxinemia (normal TSH/abnormal thyroid hormone levels) are determined [13].

S.P. Fitzgerald *et al.* [13] believe that thyroid hormone levels are associated with clinical parameters. In their research, K. Inoue *et al.* [32] found that low levels of thyroid hormones are linked to various cardiovascular disease risk factors, including diastolic hypertension, weight gain, insulin resistance, hypercholesterolemia, and dyslipidemia. Hypothyroidism with a serum TSH level greater than 10 mIU/L is associated with a higher risk of heart failure.

Studies have shown problems that arise when interpreting laboratory data. The number of results is influenced by various physiological factors such as pregnancy, metabolic status, obesity, and the presence of comorbidities. These factors affect hormone metabolism and regulation [33]. Research by Y.C. Zhou *et al.* [34] indicates a connection between TSH and metabolic syndrome. Thyroid hormone levels influence metabolic state and energy balance. Changes in hormone levels (whether an increase or decrease) lead to insulin resistance, glucose metabolism disturbances, and alterations in lipid levels, which in turn affect the patient's metabolic parameters.

In the study conducted by A. Punda *et al.* [35], an association was found between TSH and the development of insulin resistance; a reciprocal relationship between free T3 and T4 concentrations and insulin resistance; and a reciprocal relationship between free T3 and T4 levels and cholesterol levels. Additionally, hypo- and hyperthyroidism may influence the development of atherosclerotic cardiovascular diseases, which is related to the impact of hormones on lipid metabolism and increased blood pressure [36]. TSH is associated with lipid metabolism and its seasonal fluctuations are established [37]. O. Ustinov [2] notes that an increase in hormone levels leads to weight loss, while a decrease results in weight gain.

Testing the hormonal spectrum constitutes a significant portion of the workload in laboratories worldwide. For screening, diagnosing, and monitoring thyroid diseases of various aetiologies across all age groups, different test systems for *in vitro* diagnostics and measurement devices are used. These range from classical radioimmunoassay to modern highly sensitive immunochemiluminescent methods for determining thyroid hormones and TSH levels in human serum. Identifying deviations in the hormonal spectrum allows for the assessment of thyroid gland functional status, which complements the diagnosis of thyroid diseases. Radioimmunoassay methods for measuring thyroid hormone levels have low sensitivity. To improve sensitivity, new non-isotopic immunological analysis technologies have been developed: enzyme-linked immunosorbent assay (ELISA), chemiluminescent assays, and immunofluorescent assays. These methods are used to determine: markers of thyroid gland functional status (TSH, total and free T3, total and free T4); markers of autoimmune pathology (Tg Ab, TPOAb, thyroid stimulating hormone receptor antibodies (TSHR-Ab)); and markers of oncological pathology (thyroglobulin and calcitonin).

Many factors (population, health status, applied technology, and timing) can affect the assessment of the measured parameter. The rhythmic variations described for thyroid hormones imply that differences in sample collection timing and the duration of the study can lead to variations in the results. All these factors need to be considered during analysis. Additionally, the standardisation and effectiveness of the analytical method in terms of accuracy and specificity also impact the values obtained [33, 34]. It is evident that technological advancements will lead to changes in generations of analytical systems, meaning that over time, such analytical characteristics will significantly improve [37-39]. Therefore, laboratory marker results should be interpreted only in conjunction with the clinical picture of the disease, as well as with data from other diagnostic methods (ultrasound, CT, MRI, SWE, PET/CT).

Currently, there is progress in technological tools within medical science. Machine learning algorithms are actively being introduced into visualisation programs, which will help reduce diagnostic time and increase the diagnostic accuracy of fine-needle aspiration biopsy of the thyroid gland [40-42]. Recent research by D.D.E. Range *et al*. [43] has demonstrated the high effectiveness of machine learning in predicting malignant thyroid neoplasms. Machine learning-based diagnosis using digital imaging of biopsy samples is comparable to the effectiveness of a cytopathologist. Specifically, the machine learning algorithm for detecting malignancy achieved a sensitivity of 92.0% and a specificity of 90.5%. The area under the curve for predicting malignancy was 0.931 for cytopathologists and 0.932 for machine learning. Machine learning effectively distinguished between benign and malignant nodules in cases with indeterminate diagnoses [40]. However, machine learning-based diagnostic tools for fine-needle aspiration biopsy of the thyroid gland have not yet been implemented in practice, so further research is needed before they can be applied in clinical settings.

CONCLUSIONS

In the course of analysing the literature, the objectives of the study were achieved and contemporary scientific data on methods for diagnosing the structural and functional state of the thyroid gland were highlighted. It was determined that in the first stage of diagnosis, a thorough clinical examination of the patient and the collection of medical history are of great importance. It is essential to clearly identify the patient's complaints and their duration, the presence of other diseases, perform a physical examination (palpation) of the organ and adjust further investigations accordingly. Attention should be paid to changes in body weight, mood swings, elevated body temperature, dry skin, discomfort during swallowing, changes in heart function, somnolence, and muscle pain. In the next stage, the structural characteristics of the thyroid gland are assessed. Instrumental diagnostics are used to evaluate the structure, size, and presence of nodules or thyroid cancer. Modern imaging methods in endocrinology include ultrasound examination of the thyroid gland and its nodules, magnetic resonance imaging, computed tomography, and positron emission tomography. Additionally, determining the functional state of the thyroid gland is of significant importance. Blood laboratory tests are used to measure hormone levels (triiodothyronine, thyroxine, thyroid-stimulating hormone), thyroid-stimulating hormone receptor antibodies, thyroid peroxidase antibodies, thyroglobulin antibodies, thyroglobulin, and calcitonin. To assess the state of the thyroid gland, it is necessary to comprehensively analyse data from clinical, instrumental, and laboratory research methods. These methods and indicators are used to determine the dynamics of changes and the effectiveness of treatment. The analysis of scientific research has shown that currently there is no single method or device for accurately diagnosing changes and determining their nature. Therefore, ongoing efforts are being made to find effective markers. The implementation of artificial intelligence through machine learning algorithms for the effective diagnosis of thyroid gland pathologies is promising. It has been shown that both the structural and functional states of the thyroid gland need to be assessed. Timely detection of changes in the thyroid gland contributes to the establishment of effective treatment and prevention of thyroid diseases. The analysis conducted highlights the need for a differentiated approach to diagnosing, treating, and preventing thyroid gland diseases in patients with various pathologies. A prospective area for further research is determining the algorithm for diagnosing thyroid gland diseases using artificial intelligence.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Гормональні та інші методи дослідження щитоподібної залози: огляд літератури

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Анотація. Наразі встановлюється висока частота виявлення захворювань щитоподібної залози і це означає, що регулярне дослідження її стану та визначення гормонів може допомогти ранньому виявленню розвитку захворювання. Метою роботи було проведення аналізу сучасних наукових даних щодо методів діагностики стану щитоподібної залози. В ході роботи було проведено рандомізований систематичний огляд 43 наукових джерел, які опубліковані в період з 2015 по 2024 роки. У статті надано загальну інформацію щодо традиційних та сучасних методів дослідження щитоподібної залози. Було встановлено, що для визначення стану щитоподібної залози та характеристики утворень використовують сучасні діагностичні методи. Серед яких ультразвукове дослідження щитоподібної залози є головним безрадіаційним діагностичним інструментом при встановленні захворювань та моніторингу спостереження. До переваг ультразвукового дослідження можна віднести швидкість, доступність, інформативність методу. Крім того, важливу роль відводять фізикальному огляду пацієнта та проведенню лабораторних тестів. Наразі тонкоголкова аспіраційна біопсія вважається золотим стандартом дослідження вузлів щитоподібної залози. Позитронно-емісійна томографія разом із комп'ютерною томографією використовується для оцінки відповіді пухлини, а також для діагностики, прогнозу та визначення стадії раку щитоподібної залози. Для визначення функціонального стану щитоподібної залози в сироватці крові встановлюють рівень гормонів щитоподібної залози: трийодтиронін, тироксин, тиреотропний гормон, антитіла до тиреопероксидази, антитіла до тиреоглобуліну, антитіла до тіреотропного гормону, тиреоглобулін та кальцитонін. Отже, різноманітні клінічні, інструментальні та лабораторні методи дослідження застосовуються для визначення стану щитоподібної залози

Ключові слова: гормони; методи діагностики; структура; функціональний стан; ультразвукове дослідження