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The Importance of Morphological Study of the Thyroid Gland

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Annotation: In an experiment, morphological research is key to substantiate the results of scientific work; photographs represent the best demonstration material, and data from calculations and analysis of quantitative parameters are the evidence base. In the clinic, morphology is the key to substantiating the diagnosis, determining the stage of the disease, treatment tactics, endocrinological and oncological monitoring, and prognosis. The thyroid gland (TG) is an accessible organ for morphological research; a variety of methods have been proposed, among which the researcher can choose a successful combination to solve scientific problems [1-5]. This article analyzes the importance of morphological examination of the thyroid gland.

Key words: thyroid gland, method, morphology, follicles, microslide.

Relevance. The thyroid gland (TG) is extremely important for the normal functioning of the body [1, 4, 5]. Being extremely sensitive to the influence of factors of the natural and social environment, it serves as one of the central links in the hormonal regulation of adaptive processes in humans [1, 2, 3]. Iodine-containing thyroid hormones - thyroxine (T4) and triiodothyronine (T3) - are responsible for various and numerous functions of almost all organs and tissues; influence their morphology, as well as the growth and development of the entire organism; control all types of metabolism, the activity of enzyme systems, thermoregulation processes, functions of the central and autonomic nervous system; enhance higher nervous activity; take part in the regulation of the work of other endocrine glands and in adaptive reactions under stress [11, 12,14]. Their synthesis is regulated by the hypothalamus and pituitary gland, which together with the thyroid gland form the hypothalamic-pituitary-thyroid axis [14, 15, 17]. Neurons of the hypothalamus produce thyrotropin-releasing hormone, the so-called "thyrotropin releasing factor," which stimulates the production of thyroid-stimulating hormone by the adenopituitary gland, which, in turn, regulates the synthesis of T4 and T3 [2, 5, 9, 10, 13]. These hormones are constantly produced in the thyroid gland, accumulate in it and are released into the bloodstream as needed [21, 25, 30], that is, in its structure and function, the thyroid gland is a "reserve gland" [13, 15]. This mechanism of hormone formation is unique to the endocrine system [13, 20] and is ensured by the unique structure of the thyroid tissue, which differs from that of other endocrine glands. The secretory parenchyma, expressing T4 and T3, has a follicular structure. Follicles are formed by follicular (thyroid) epithelium lying on the basement membrane - the so-called "A-cells" [13, 27, 35]. Inside the follicles there is a colloid, which is a structureless material containing a special protein - thyroglobulin, which first undergoes a process of iodization and then splitting, after which thyroid hormones are released and released into the blood [17, 20, 21, 25, 30, 34, 35]. The sizes of follicles are extremely variable [13, 25, 30], so the thyroid gland can have a different structure - from microfollicular (the so-called "parenchymal" type), when the follicular structure is determined only with special stains of the basement membrane (PAS reaction and/or silver impregnation) , and the thyroid epithelium undergoes desquamation and completely fills the lumen of follicles deprived of colloid; to macrofollicular (colloid type), in which giant follicles with a flattened lining epithelium are stretched by a thick basophilic colloid without signs of resorption [29, 30, 34, 35]. The first of these types determines the most pronounced functional activity of the thyroid gland, when iodine-containing hormones are quickly released into the blood, and their reserves are not created in the intrafollicular colloid. On the contrary, the colloidal type of thyroid tissue structure is characteristic of glands with a low level of functioning [12, 21, 30]. Between the marginal types considered, there are many intermediate ones, reflecting the different functional activity of the thyroid gland. The noted correlation of the degree of expression of the secretory function of the thyroid parenchyma with the characteristics of its histological structure led to the development of a number of morphological criteria that reliably characterize the functional state of the thyroid gland [9, 12, 13, 19, 36-38]. A significant part of these morphofunctional criteria was obtained using the morphometric research method [2-4, 12, 32, 34, 38, 39], which meets modern requirements of evidence-based medicine [15, 20] and allows us to objectify the results obtained and the conclusions drawn, since the final data have a quantitative expression and are easily amenable to statistical analysis [2-4, 17]. It is appropriate to note here that the functional morphology of the thyroid gland has been studied most fully in comparison with other organs of the endocrine system. At the same time, such studies of the thyroid gland encounter many and, often, significant difficulties due to the fact that, due to the participation of thyroid hormones in almost all physiological processes in the body, the glandular parenchyma turns out to be very sensitive to the effects of an immense number of damaging factors, such as endo- and exogenous nature, which determines the extreme diversity of its structure depending on the individual's environment, his age and gender, circadian rhythms, etc. [19, 23, 26, 27]. A special place among these factors is occupied by the influence of geographical and geochemical natural conditions, in particular, iodine deficiency in soil and water [29, 30, 31, 37, 38]. The results of studying such effects on the thyroid gland led to the emergence and development of such a branch of pathomorphology as geographic (regional) pathology [5, 7, 29, 34]. According to the data obtained in this direction, it is advisable in each area, characterized by some unfavorable features of natural conditions, to determine the macro- and microstructure of the thyroid gland in the population of the indigenous local population, taking it as its own regional conditional norm (CN) for a given biogeochemical region [24]. Various aspects of the age-related morphology of the thyroid gland, both within the framework of the classical descriptive method and from the standpoint of the functional morphological approach, were studied in sufficient detail in the last century [13, 29, 30, 33, 34], although they continue to attract the attention of modern researchers [1, 10, 25]. At the same time, ideas about unidirectional age-related involution of the thyroid gland with a decrease in its function [18, 33] were replaced by the concept of adaptive processes in this organ associated with a decrease in general metabolism in an aging body and aimed at equalizing the age-related activity of the endocrine glands as an integral endocrine system [22].

Indicators of normal morphological parameters of the thyroid gland have been widely studied and standardized [4-5], characterized by structural and functional asymmetry: the right lobe is larger and more active; therefore, it is important to examine both lobes. When studying the thyroid gland in small rodents after decapitation under ether anesthesia, the skin is dissected in the regio cervicalis anterior, the superficial muscles of the median group are separated, the area of the larynx and the upper part of the trachea are prepared from the muscles, tissue and esophagus, and a section of airways 8-12 mm long is cut off. Having fixed the trachea with a dissecting needle, the right and left lobes are cut off from the cartilage of the larynx and trachea. The lobes are ellipsoidal in shape, located on the sides, caudal to the larynx to the level of the 4-5 gotracheal rings, rich brown-red color; the isthmus is thin, often not visible, located on the ventral surface of the trachea. It is advisable to determine the linear dimensions of the thyroid lobes before cutting it off from the trachea in order to avoid deformation. Volume can be calculated using the formula VABC6, where V is volume, A is length, B is width, C is thickness; or by liquid displacement method. To determine the asymmetry of the shares, a study is carried out where Ka is the asymmetry coefficient, F1 is the larger parameter, F2 is the smaller one. As rats grow, an increase in the size and volume of the gland is detected. The length of the lobes increases to a maximum. The size of the thyroid gland in postnatal ontogenesis does not have gender characteristics. The high functional activity of the thyroid gland in females, associated with the reproductive cycle, leads to the fact that it is not inferior in volume to the gland of larger males. The birth of rat pups and lactation increase the volume of the gland, but the increase is statistically insignificant [1]. For histological examination, the lobes are cut off with a scalpel and placed in 10% neutral formalin for 18 hours of fixation for light-optical techniques and subsequent impregnation with paraffin. When performing immunomorphological techniques in experiments with small animals, during embedding it is advisable to manually mount the multiblock for subsequent production of serial paraffin sections 4 µm thick. For electron microscopy examination of semi-thin sections embedded in resin, it is necessary to immediately place part of the right lobe in a solution of glutaraldehyde in phosphate buffer for standard sample preparation of this technique. Morphometric studies are optimal on paraffin sections. The structures are measured in the central section of the maximum frontal section of the right lobe at a magnification of 400x. Taking into account the elongated shape of the follicles, the larger and smaller diameters and the height of thyrocytes are measured in different areas - in the center of the larger and smaller semicircles; follicle area. The areas of the colloid and stroma (including blood vessels) are measured; the epithelial area is calculated as the difference between the total area and the sum of the areas of the colloid and stroma. When studying the sizes of follicles and thyrocytes, the 6 largest follicles in the field of view are studied, and when studying planar parameters, the field of view is studied. It is recommended to carry out these studies in a program where calibration is possible, for example, in the accessible IMAGEJ. Based on these parameters, it is convenient to calculate indices: where FCI is the follicular-colloid index (an indicator of gland maturity), IS is the sclerosis index (the ratio of stromal-vascular and parenchymal components), Se is the relative area of the epithelium, Sc is the colloid, Sc is the stroma; Brown index (colloid accumulation) according to the formula: where IB is the Brown index (shows functional activity), Df is the average diameter of the follicle, Ht is the average height of the thyrocyte. In female rats, in periods of 30-60,60-90,90-180 days, an increase in the height of thyrocytes, diameter and area of follicles is detected. The growth of indicators occurs synchronously, the changes are not accompanied by significant dynamics in the relative content of parenchymal and stromal components, as well as functional indices when comparing adjacent age groups. Differences in thyroid parameters in females with different reproductive status: fertile females – decreased IS due to active vascularization; in lactating women – stroma growth, reduction in epithelial area and FCI. In males, starting from the 60th day, colloid synthesis occurs so intensively that changes in its relative content, as well as the corresponding dynamics of indices (decrease in FCI and increase in IB) are significant between neighboring age groups.

From the 180th day, the condition of the gland stabilizes, the area of the epithelium and FCI increase.

There are two ideas about interfollicular islets: 1) they are independent formations; 2) they appear when the cut passes through the wall of the follicle, without capturing its cavity or with minimal coverage of the cavity (they are described as microfollicles). The second point of view is valid and is confirmed by a number of electron microscopy data. From any point of view, an increase in the area of IFE (or epithelium not in contact with the colloid) is an indicator of growth, proliferative activity and low differentiation of gland tissue. The cytological method is also an effective element in the study of the thyroid gland from material obtained by fine-needle aspiration biopsy (FNA), it is described in detail in specialized manuals [2]. And it is optimal at the preoperative stage in the clinic. The use of a unified classification of gland pathology according to the Bethesda system (2010) helps determine the tactics of conservative or surgical treatment.

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