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## **THE RESULTS OF ULTRASOUND EXAMINATION OF THE THYROID GLAND IN CHILDREN WITH HYPOTHYROIDISM**

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Abbreviation

TG - thyroid gland

TSH - Thyroid stimulating hormone

### **Abstract**

Diseases of thyroid gland (TG) rank first among all endocrine pathologies and remain one of the most difficult problems. According to the statistics of Ministry of Health of Ukraine, the prevalence of hypothyroidism in children does not exceed 0.035%. However, the

relatively low rate can be explained by the low level of detection and diagnosis of this pathological condition due to the variability and low specificity of its symptoms. More acceptable for practice are methods of ultrasound diagnosis of the thyroid gland and laboratory examination of the content of thyroid-stimulating hormone in the serum.

**Aim.** To evaluate the results of ultrasound examination of the thyroid gland in children with hypothyroidism.

**Methods.** The results are based on a survey of 94 children with hypothyroidism living in the Chernivtsi region aged 2 to 10 years. An ultrasound examination of the thyroid gland, determination of the level of thyroid hormones (thyroid stimulating hormone (TSH), free thyroxine (fT4) was performed. Statistical analysis was performed using standard methods using the StatSoft software package © Statistica® 6.0 for Microsoft® Windows XP.

**Results.** Analysis of the results of the study showed that in 59.6% of cases (56 out of 94) the diagnosis was made by screening for congenital hypothyroidism, and in 40.4% of cases (38 out of 94) the disease was diagnosed outside the screening. According to the results of our ultrasound, it was found that in 29 patients the thyroid tissue was not visualized in a typical place or its total volume was much less than normal. Of these, in 12 individuals, thyroid tissue was not reliably visualized at the site of TG projection, and in 17 cases was hypoplasia. In 65 patients, the TG was in a typical place, and its volume corresponded to the norm on the surface area of the body. In 85 people, regardless of the state of functional activity of the TG had a heterogeneous echostructure of the thyroid parenchyma), in 9 people the echostructure of the thyroid parenchyma was homogeneous. In thyroid hypoplasia, the level of TSH was at lower values ( $p < 0.05$ ) compared with thyroid dystopia.

**Conclusion.** Sonographic examination of the thyroid gland has a high level of information. In cases of malformations of the thyroid gland there is a more pronounced degree of thyroid insufficiency.

**Key words: children; hypothyroidism; ultrasound examination of the thyroid gland.**

Almost every second-third person on Earth has one or another pathology of the thyroid gland (TG), in the structure of which hypothyroidism in frequency and social significance occupies one of the leading places [1]. Analysis of the literature suggests that thyroid disease ranks first among all endocrine pathologies, and still remain one of the most difficult

problems of practical medicine [2]. This is confirmed by the steadily increasing incidence rate, as well as consistently high rates of disability in this pathology.

Hypothyroidism is a chronic disease associated with deficiency in the thyroid hormones, thyroxine (T4) and triiodothyronine (T3) [3]. The full implications of hypothyroidism in the population are not completely appreciated or defined. Hypothyroidism affects up to 5% of the population according to European prevalence estimates [4], while as many as 5% of the population may have undiagnosed thyroid failure [5]. Of patients who are treated, up to one-third are not receiving adequate treatment. The economic impact of undiagnosed, untreated or undertreated hypothyroidism is therefore not inconsequential, especially with regard to costs associated with maternal and congenital hypothyroidism, or with hypothyroid patients having comorbid conditions such as diabetes mellitus [6]. Hypothyroidism is also associated with decreased quality of life [7], increased number of sick leave days, and even increased mortality [8].

Normal thyroid status depends on the chemical/elemental composition of body fluids and tissues, which changes depending on physiological state, lifestyle and environment. Certain levels of elements in tissues and body fluids are considered to be normal [9]. Deficiencies or excess amounts of these elements, disrupting their physiological levels in the body, adversely affect the functioning of the cells and tissues, which can lead to the development of disease. Another important consideration is the presence of toxic chemical elements in the body, which can compete with essential elements even at low exposure levels. Heavy metals tend to accumulate in the body [10]. This paper is a summary of current studies based on measurement of the concentrations of selected trace elements, i.e., Se, Zn, Mn, Cr, Fe, F, Cd and Pb, in patients with primary or secondary hypothyroidism. Current literature on this subject emphasizes and provides evidence that exposure to certain chemical elements (e.g., heavy metals), contributes to the etiopathogenesis of hypothyroidism and the autoimmune process.

In the last decade, there have been many studies on the problem of hypothyroidism in children, which have changed our views on the entire pathology of the TG [11-14]. This is primarily due to the introduction into clinical practice of modern diagnostic methods and drugs of thyroid hormones. It should be noted that so far the only possible approach to the treatment of hypothyroidism is the use of thyroid hormones.

According to a large population-based NHANES-III study in the United States, the prevalence of overt hypothyroidism among individuals over 12 years of age is 0.3% and that

of subclinical hypothyroidism is 4.3%. [16]. During the year, 5-10% of cases of latent hypothyroidism turn into manifest, and its frequency increases with increasing age of the subjects and in the elderly population can reach 7-26% [17]. From a prognostic point of view, it seems appropriate to be able to distinguish between nosological variants of hypothyroidism. More acceptable for practice are methods of ultrasound diagnosis of the body (ultrasound) and laboratory examination of the content of thyroid-stimulating hormone (TSH) in the serum.

According to the statistics of the Ministry of Health of Ukraine, the prevalence of hypothyroidism in children does not exceed 0.035%. However, the relatively low rate can be explained by the low level of detection and diagnosis of this pathological condition due to the variability and low specificity of its symptoms [1, 2, 3].

**Aim.** To evaluate the results of ultrasound diagnosis of the thyroid gland in children with hypothyroidism.

**Methods.** The results are based on a survey of 94 children with hypothyroidism, whose age at the time of inclusion in the study ranged from 2 to 10 years (41 boys and 53 girls). Depending on the ultrasound results, the children were divided into two groups. The first group (I group) - 33 children with dysgenesis (dystopia + hypoplasia) of the TG, the second group (II group) consisted of 61 children with TG in a typical place.

Ultrasound of the TG was performed according to the conventional method of the device Aloka prosound 5500 (Japan) using a linear sensor with a frequency of 10-12 MHz. The sonogram was evaluated for the following features: 1. absence or presence of the thyroid gland in usual anatomical location, 2. absence or presence of the thyroid lobes and isthmus and 3. presence of thyroid in ectopic localization. Agenesis is characterized by a complete absence of thyroid tissue. Thyroid ectopia was defined as thyroid tissue localization other than in the lower part of the neck. The anterior cervical area was systematically studied for the presence of thyroglossal duct remnants from the foramen caecum to the normal anatomic position of the thyroid gland and even lower, above the sternal manubrium. Based on the ultrasonographic, patients were classified into two main categories: 1. normal gland in usual location and 2. abnormal results which contains agenesis, ectopia and hypoplasia.

Determination of the level of thyroid hormones (TSH, fT4) and TG was performed in the morning, on an empty stomach, using venipuncture of the ulnar vein using an automated system Architect company Abbot (USA). The TG level study was performed using the automated Elecsys 2010 system from Roche (Switzerland).

Statistical analysis of the obtained results was performed using standard methods using the application package StatSoft © Statistica® 6.0 for Microsoft® Windows XP. Verification of normal distribution of quantitative characteristics was performed using the Kolmogorov - Smirnov criterion. Normally distributed quantitative characteristics of the groups are presented as mean  $\pm$  standard deviation. Comparison of groups by qualitative characteristics was performed using the chi-square criterion with the Yates correction. The Mann-Whitney test was used to compare unrelated quantitative traits. Analysis of the correlation and establishment of the strength of the connection between the two traits was performed by the Spearman method. The significance level  $p < 0.05$  was considered probable.

The authors assert that all procedures contributing to this study comply with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by the Bukovinian State Medical University.

**Results.** Analysis of the results of the study showed that in 59.6% of cases (56 out of 94) the diagnosis was made by screening for congenital hypothyroidism, and in 40.4% of cases (38 out of 94) the disease was diagnosed outside the screening. According to the results of our ultrasound, it was found that in 29 patients the thyroid tissue was not visualized in a typical place or its total volume was much less than normal. Of these, in 12 individuals the thyroid tissue was not reliably visualized at the site of thyroid projection, and in 17 cases was hypoplasia. In 65 patients, the thyroid gland was in a typical place, and its volume corresponded to the norm on the surface area of the body (Fig. 1).

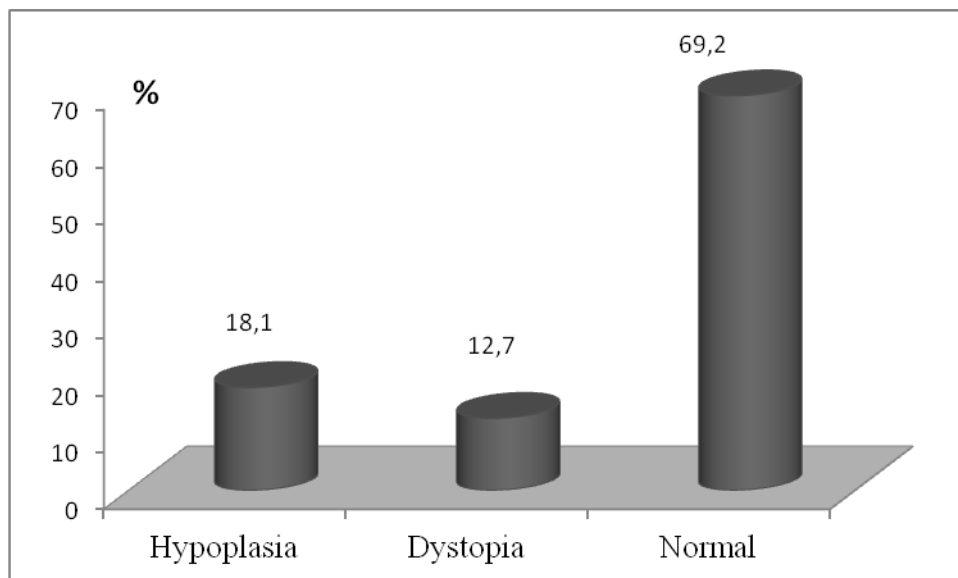


Fig.1 The results of ultrasound examination of the thyroid gland

In 12 patients we observed, thyroid tissue was not clearly defined at the typical site, but hyperechogenic tissue in the form of connective tissue strands was visualized at the site of thyroid projection. In this group of children, the results of ultrasonography suggested that hypothyroidism may have been due to either a violation of the migration of the thyroid bookmark (dystopia), or a defect in organ development (agenesis). In the remaining patients, the thyroid tissue was in a typical location, but they had changes in its basic ultrasound parameters against the background of a sharp decrease in total volume.

We found that 85 people, regardless of the state of functional activity of the TG had a heterogeneous echostructure of the thyroid parenchyma. And only in 9 people the echostructure of the parenchyma of the TG was homogeneous (Fig. 2).

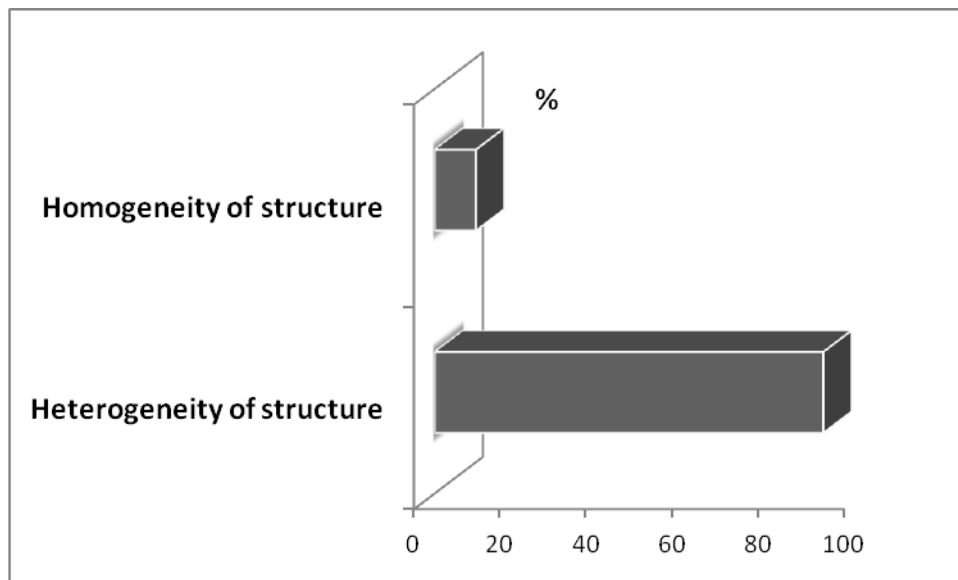


Fig.2 Distribution of children depending on the echostructure of the thyroid gland

Our data showed that 55.6% of children had cystic structures according to ultrasound. At the same time, in 56% of cases cysts were detected in children with dystopia of the gland, in 44% of cases - in thyroid hypoplasia. Moreover, in 63% these signs were single in nature, and only in 37% were multiple (2 or more cysts).

All of them were located paratracheally: on the left - in 66.7%, on the right - in 13.3%, in 20% - on both sides. These formations, according to ultrasound, had a hypoechoic homogeneous structure, the size ranged from 2.0 to 15 mm, oval or round, with a thin well-defined capsule. Thus, according to our data, in more than half of the cases, the presence of cystic formations with predominant localization to the left of the trachea was determined in patients at the site of thyroid projection.

It is believed that in general, patients with thyroid dysgenesis have a deeper degree of thyroid insufficiency than patients with morphologically preserved thyroid. According to the results of our hormonal study (against the background of 5-day cancellation of replacement therapy) there was a more pronounced degree of thyroid insufficiency in patients with glandular defects. However, in thyroid hypoplasia, the level of TSH was at lower values ( $p < 0.05$ ) compared with thyroid dystopia (Table), which indicates a less severe severity of hormonal insufficiency in this defect.

Table

Indicators of hormonal status of children with hypothyroidism ( $M \pm m$ ; Me; min – max)

Groups of children (n = 94)	TGG, mIU / l	fT4, pmol / l	TГ, mkg / l
TG dystopia (n = 12)	84,16±3,1 55,23 [41,1 - 51,6]	2,09±0,77 2,41 [0,4 - 3,9]	0,54±0,18 0,48 [0 - 1,1]
TG hypoplasia (n = 17)	36,42 ± 9,41 28,81 [5,9 - 82,4]	6,65 ± 2,52 5,85 [2,2 - 12,7]	11,13 ± 2,27 9,65 [7,5 - 17,7]
Typical location of the TG (n = 65)	9,15 ± 1,3 6,77 [2,8 - 15,6]	12,15 ± 1,10 8,85 [4,2 - 19,6]	16,17 ± 1,25 11,41 [8,5 - 20,4]

**Discussion.** The findings of this study, likewise other studies, showed that ultrasonography could reflect the anatomical status of the thyroid gland. However, ultrasonography had some weaknesses in diagnosing ectopic thyroid gland [20]. In this study, only 33% of ectopic thyroid glands were diagnosed by ultrasonography. In another similar study which was performed among 54 CH patients, only 5 out of 26 cases with ectopic thyroid gland were diagnosed by ultrasonography [21]. In a similar recent study in Korea, discordant cases of CH according to the comparison of findings of ultrasonography and scintigraphy were investigated; in 6/300 patients, ultrasonography was not able to detect the ectopic thyroid gland and its sensitivity in this field was 78%. The specificity of ultrasonography in this field was 100%, which was similar to our results [22].

The European Thyroid Association (ETA) in the latest update of the guidelines for subclinical hypothyroidism in pregnant women and children indicates the possible negative impact of high TSH on the growth, development and health of the child [23-24]. Elevated TSH levels in young children over 5.0–5.5 mIU / l, and in children older than 12 years - more than 4.0 mIU / l at normal values of free T4 indicates the presence of subclinical hypothyroidism and requires careful monitoring of the clinical picture and biochemical

constants (every 2–4 weeks) until the final verification of the diagnosis. An increase in TSH, accompanied by a decrease in serum T4 and T3 concentrations, should be considered as manifest hypothyroidism.

Thus, the study of the features of the clinical course of hypothyroidism in children and the improvement of methods of early diagnosis, treatment and development of rehabilitation measures are promising scientific and practical areas.

### **Conclusions**

1. Sonographic examination of the thyroid gland is very informative.
2. In cases of malformations of the thyroid gland there is a more pronounced degree of thyroid insufficiency.

### **Literature**

1. van Trotsenburg P, Stoupa A, Léger J, et al. Congenital Hypothyroidism: A 2020-2021 Consensus Guidelines Update-An ENDO-European Reference Network Initiative Endorsed by the European Society for Pediatric Endocrinology and the European Society for Endocrinology. *Thyroid*. 2021;31(3):387-419. doi:10.1089/thy.2020.0333
2. Alzahrani AS, Al Mourad M, Hafez K, et al. Diagnosis and Management of Hypothyroidism in Gulf Cooperation Council (GCC) Countries. *Adv Ther*. 2020;37(7):3097-3111. doi:10.1007/s12325-020-01382-2
3. Guglielmi R, Grimaldi F, Negro R, et al. Shift from levothyroxine tablets to liquid formulation at breakfast improves quality of life of hypothyroid patients. *Endocr Metab Immune Disord Drug Targets*. 2018;18:235–240.
4. Garmendia Madariaga A, Santos Palacios S, Guillen-Grima F, Galofre JC. The incidence and prevalence of thyroid dysfunction in Europe: a meta-analysis. *J Clin Endocrinol Metab*. 2014;99:923–931.
5. Kraut E, Farahani P. A systematic review of clinical practice guidelines' recommendations on levothyroxine therapy alone versus combination therapy (LT4 plus LT3) for hypothyroidism. *Clin Invest Med*. 2015;38:E305–E313.
6. Raval AD, Sambamoorthi U. Incremental healthcare expenditures associated with thyroid disorders among individuals with diabetes. *J Thyroid Res*. 2012;2012:418345.
7. Vigario Pdos S, Vaisman F, Coeli CM, et al. Inadequate levothyroxine replacement for primary hypothyroidism is associated with poor health-related quality of life-a Brazilian multicentre study. *Endocrine*. 2013;44:434–440.
8. Vigone MC, Capalbo D, Weber G, Salerno M. Mild Hypothyroidism in Childhood:



Who, When, and How Should Be Treated?. *J Endocr Soc.* 2018;2(9):1024-1039. Published 2018 Jul 25. doi:10.1210/js.2017-00471

9. Mayo Clinic Laboratories. [(accessed on 10 June 2021)]. Available online: <https://www.mayocliniclabs.com/>

10. Błażewicz A., Dolliver W., Sivsammeye S., Deol A., Randhawa R., Orlicz-Szczesna G., Błażewicz R. Determination of Cadmium, Cobalt, Copper, Iron, Manganese, and Zinc in Thyroid Glands of Patients with Diagnosed Nodular Goitre Using Ion Chromatography. *J. Chromatogr. B Anal. Technol. Biomed. Life Sci.* 2009;878:34–38. doi: 10.1016/j.jchromb.2009.11.014.

11. Sparling DP, Fabian K, Harik L [et al.]. Congenital hypothyroidism and thyroid dyshormonogenesis: a case report of siblings with a newly identified mutation in thyroperoxidase. *J. Pediatr Endocrinol. Metab.* 2016; №1:23-28. doi: 10.1515/jpem-2015-0253.

12. Malaty W. Primary hypothyroidism. 2017. <https://bestpractice.bmj.com/topics/en-us/535/pdf/535.pdf>. Accessed 4 Jan 2017.

13. Chaker L, Bianco AC, Jonklaas J, Peeters RP. Hypothyroidism. *Lancet.* 2017;390:1550–1562.

14. Dew R, Okosieme O, Dayan C, et al. Clinical, behavioural and pharmacogenomic factors influencing the response to levothyroxine therapy in patients with primary hypothyroidism-protocol for a systematic review. *Syst Rev.* 2017;6:60.

15. World Health Organization. WHO model list of essential medicines. 2017. <http://apps.who.int/iris/bitstream/handle/10665/273826/EML-20-eng.pdf?ua=1>. Accessed 4 Jan 2019.

16. Bougma K, Aboud FE, Harding KB, Marquis GS. Iodine and mental development of children 5 years old and under: a systematic review and meta-analysis. *Nutrients.* 2013;5:1384–1416.

17. Carle A, Pedersen IB, Knudsen N, et al. Gender differences in symptoms of hypothyroidism: a population-based DanThyr study. *Clin Endocrinol (Oxf)* 2015;83:717–725.

18. European Thyroid Association Guidelines for the Management of Subclinical Hypothyroidism in Pregnancy and in Children / Lazarus J., Brown R. S., Daumerie C. [et al.]. — 2014to

19. Abstracts from the 9th Biennial Scientific Meeting of the Asia Pacific Paediatric Endocrine Society (APPEs) and the 50th Annual Meeting of the Japanese Society for Pediatric Endocrinology (JSPE): Tokyo, Japan. 17-20 November 2016. *Int J Pediatr Endocrinol.* 2017;2017(Suppl 1):15. doi:10.1186/s13633-017-0054-x
20. Hoseini M, Hekmatnia A, Hashemipour M, Basiratnia R, Omidifar N, Rezazade A, et al. Sonographic assessment of congenitally hypothyroid children in Iran. *Endokrynol Pol.* 2010;61(6):665–70.
21. Chang YW, Lee DH, Hong YH, Hong HS, Choi DL, Seo DY. Congenital hypothyroidism: analysis of discordant US and scintigraphic findings. *Radiology.* 2011;258(3):872–9
22. Hashemipour M, Rostampour N, Nasry P, et al. The role of ultrasonography in primary congenital hypothyroidism. *J Res Med Sci.* 2011;16(9):1122-1128.
23. Pradeep PV, Jayashree B. Thyroglossal cysts in a pediatric population: apparent differences from adult thyroglossal cysts. *Ann Saudi Med.* 2013;33(1):45-48. doi:10.5144/0256-4947.2013.45
24. Tian L, Shao F, Qin Y, Guo Q, Gao C. Hypothyroidism and related diseases: a methodological quality assessment of meta-analysis. *BMJ Open.* 2019;9(3):e024111. Published 2019 Mar 30. doi:10.1136/bmjopen-2018-024111

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