

## Ultrasound characteristics of tonsils in children with tonsillitis

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The problem of acute and chronic inflammatory diseases of the lymphopharyngeal apparatus of the pharynx is one of the most urgent in modern clinical medicine. The prevalence of pathology in the world is from 2 to 15 % of the entire population. The disease is especially common among children: 50 % of patients are between the ages of 5 and 15, and the majority of them are of early school age. Patients with newly discovered diseases of the tonsils and adenoids constitute a significant proportion of outpatients of both otolaryngologists and pediatricians, and the diagnosis of the lymphopharyngeal pharynx apparatus diseases is 19-20 % of the cases among the twenty diagnoses most often established by otorhinolaryngologists [1]. Up today, tonsillitis (T) is a widespread disease that is observed in all age groups, has a tendency to become chronic and is accompanied by periodic exacerbations of the inflammatory process. Most often, acute disease manifestations are observed in patients aged 1 to 3 years. This very process, thanks to viral and bacterial inflammation, can be the trigger for many complications from the cardiovascular system, connective tissue and kidneys. It is known that the tonsils have a structure similar to other lymphatic organs and perform two important functions hematopoietic (lymphopoiesis) and protective (barrier). The follicular apparatus, which is located in tonsils, is the main lymphatic barrier that neutralizes infectious agents that enter the mucous membranes from the external environment. Although T usually begins superficially as an acute bacterial or viral infection, it can progress to the development of

a life-threatening abscess [2]. However, when infectious agents are neutralized in tonsils, an immunobiological restructuring of the body and the development of active immunity occur. This is due to the point of view that it is undesirable to perform a tonsillectomy before the age of 6 years, because the main phase of the body's immune defense mechanism occurs precisely in this period of the child's life, when the palatine tonsils are in a physiologically hyperplastic stage [8].

One of the important reasons for studying tonsils is also that enlarged palatine and adenoid Ts represent the most common cause of obstructive sleep apnea in children, which is present in 12 % to 15 % of children worldwide and especially in preschool patients (3-5 years) [3, 5]. The attention of doctors to this pathology is explained by the fact that obstructive sleep apnea in children can cause such clinical manifestations as: excessive daytime sleepiness, hyperactivity, attention during learning, hearing loss, inharmonious physical development. This substantiates the necessity and importance of monitoring the condition of tonsils in children older than 3 years. Therefore, for the completeness of the characterization of T clinical manifestations, it is important to study the morpho-functional state of tonsils with the involvement of non-invasive methods of radiation diagnostics, in particular, ultrasound.

Of course, like any inflammation, T is accompanied by a reaction of the lymph nodes (submandibular and cervical). The morphological characteristic of their condition also characterizes the level of spread of inflammation.

The purpose is to determine the ultrasound criteria of the tonsils structure in normal children and with T with percutaneous high-frequency ultrasound.

## Material and Methods

67 children aged 6 to 18 years were investigated. Of them, 19 children were in the control group (CG) and 48 were children with T. Distribution by gender: 34 boys and 33 girls. All patients were consulted by an otorhinolaryngologist and a pediatrician. If necessary, a laboratory examination was carried out.

Sonograms were obtained with real-time Aplio 500 (Cannon Medical Systems) and MyLab Twice (Esaote) diagnostic systems, linear transducers with a frequency greater than 8 MHz.

The investigations were carried out by 3 doctors of ultrasound diagnostics with experience in their specialty of more than 5 years. Patients were examined in supine position; they did not need special training. Percutaneous approach was applied [7].

Scanning of the neck submandibular region was performed in the coronal and sagittal planes to obtain transverse and longitudinal images of the tonsils. The state of vascularization of the capsule and, directly, the tonsils tissue was assessed with Color Doppler mapping (CDM) by the number of colored pixels.

Statistical processing of quantitative indicators was carried out with Microsoft Excel 2010

(license number 02260-018-0000106-48794) and Statistica 6.1 (serial number AGAR909E-415822FA) with the determination of the arithmetic mean (M), standard error (m), Student's test [1].

All patients entered the study after informed written consent for planned clinical, radiological, laboratory and therapeutic measures. The study was conducted in accordance with the principles of bioethics set forth in the World Medical Association's Helsinki Declaration – "Ethical Principles of Medical Research Involving Human Subjects" and "Universal Declaration on Bioethics and Human Rights" (UNESCO).

## Results and their discussion

The main results of the study are presented in Table 1. In CG, the ultrasound structure of the tonsils was characterized by clear contours, "striped" structure (86.9 %) – alternating hypoechoic and isoechoic layers (thickness – no more than 1.5 mm each). In addition, isolated small (up to 1.5 mm) echo-positive structures were identified against the background of the organ tissue in the CG, which represented the contents of lacunae – so-called "crusts" or tonsillar stones (15.8%) (Fig. 1).

Single colored loci (as a manifestation of increased blood flow, which is a typical mani-

**Table 1.**  
*Ultrasound characteristics of tonsils in tonsillitis structure.*

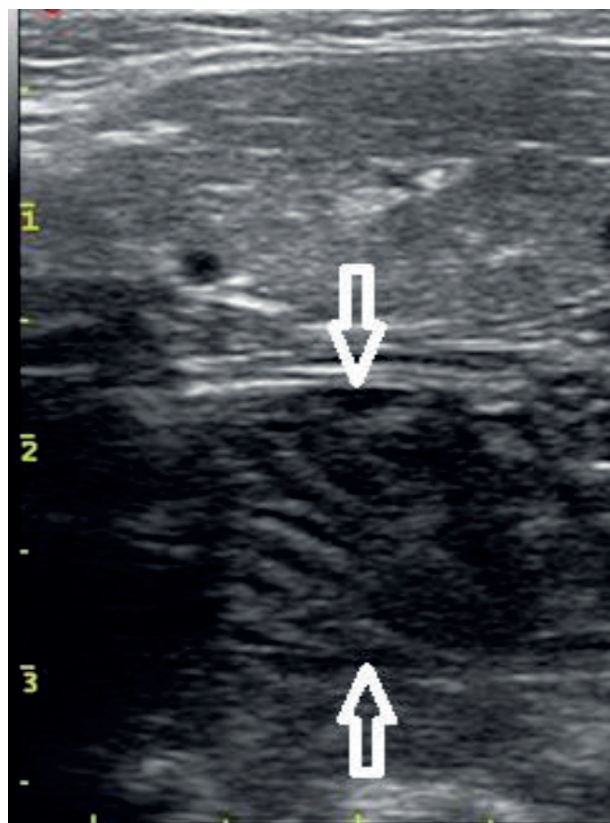
US indicators		Control Groups		Patients with T	
		abs	%	abs	%
Structure	striped	17	89,4	23	47,9
	hypoechoic	1	5,2	11	23
	hyperechoic	1	5,2	14	29,1
Hyperechoic inclusions		3	15,8	20	86,9
Capsule state	thickened	3	15,8	35	72,9
	not changed	16	84,2	13	27,1
Capsule vascularization	increased	5	26,3	40	83,3
	not changed	14	73,7	8	16,7
Increased size of submandibular lymph nodes		4	21	42	87,5

festation of inflammation) were registered with CDM, which were observed mainly around the capsule (fig. 2). Submandibular lymph nodes were enlarged ( $13.6 \pm 2.4 \times 6.5 \pm 1.3$  mm) in only 21 % of CG children, but they had no structural changes (Fig. 3, 4).

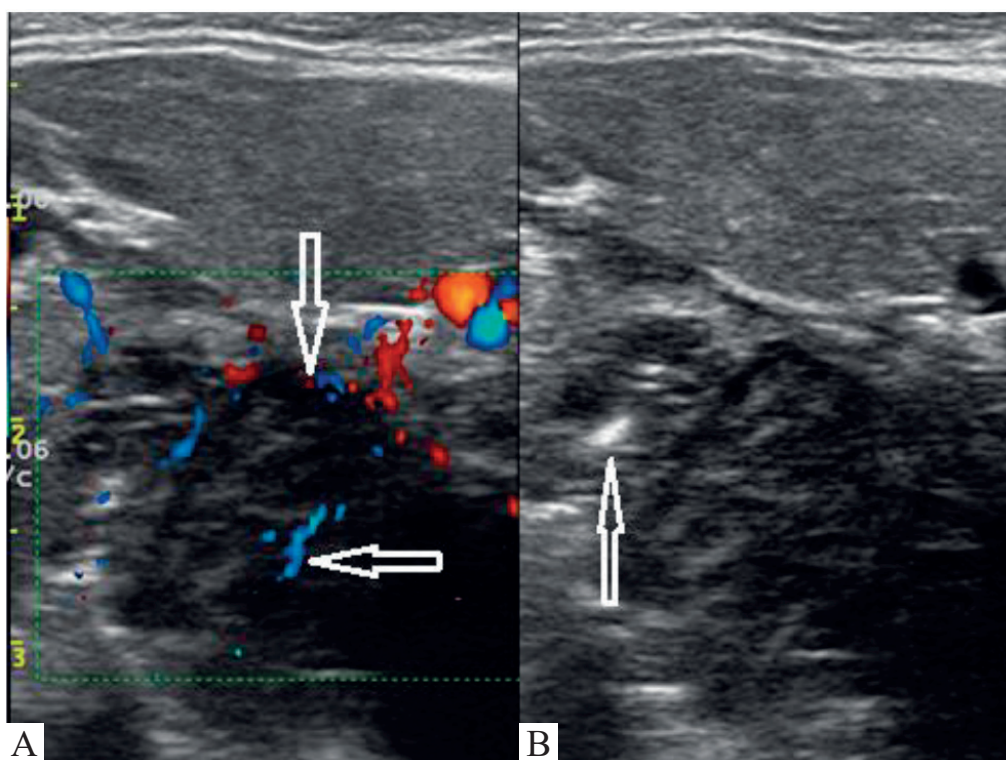
At T, the echographic changes were more pronounced, which is explained by repeated acute inflammation of tonsils in patients in the anamnesis.

Primarily, this concerned the changes in the echographic structure of tonsils, namely: a decrease in “striping” (47.9 %), an increase in the percentage of hypoechoic (23 %) and hyperechoic according to the structure of tonsils (29.1 %), the presence of a greater number of echopositive inclusions (86.9 %) and increased vascularization of the capsule (83.3 %).

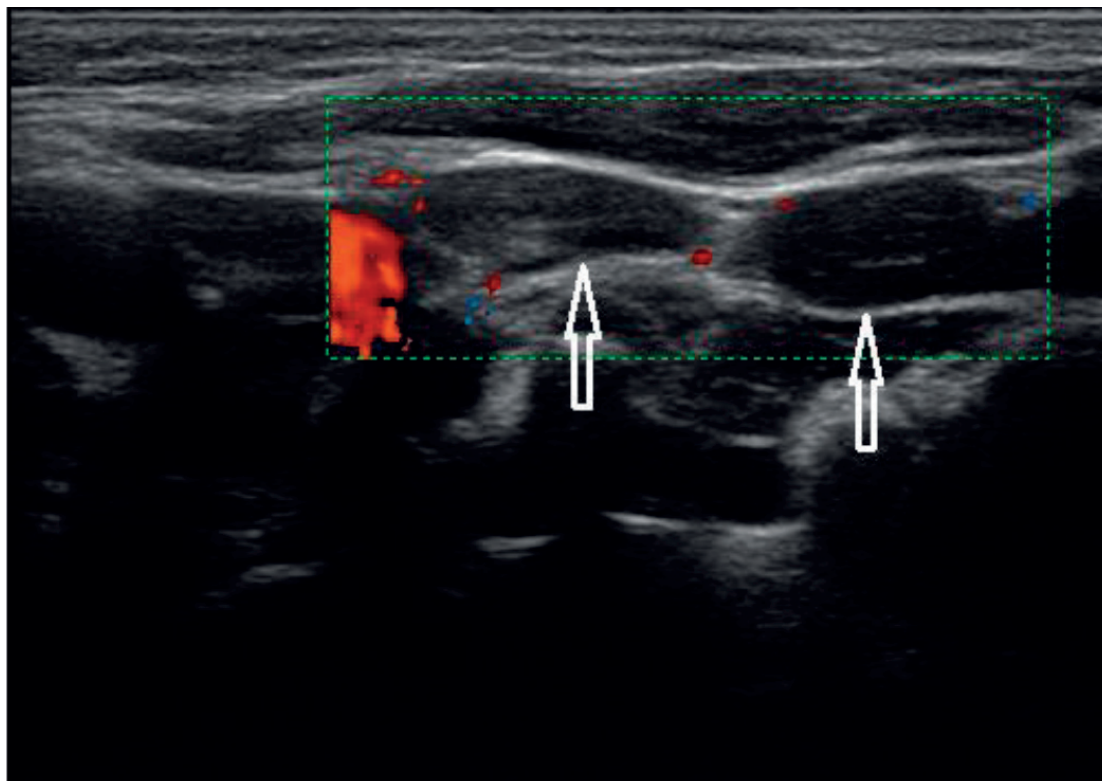
At T, the echographic dimensions of the tonsils increased ( $17.6 \pm 2.8$  mm longitudinal and  $15.4 \pm 1.9$  mm transverse dimensions) in 87.5 % of patients. An increase in size and increased vascularization of the submandibular lymph nodes (87.5 %) was also typical. At the same time, there was no change in their anatomical ultrasound structure.



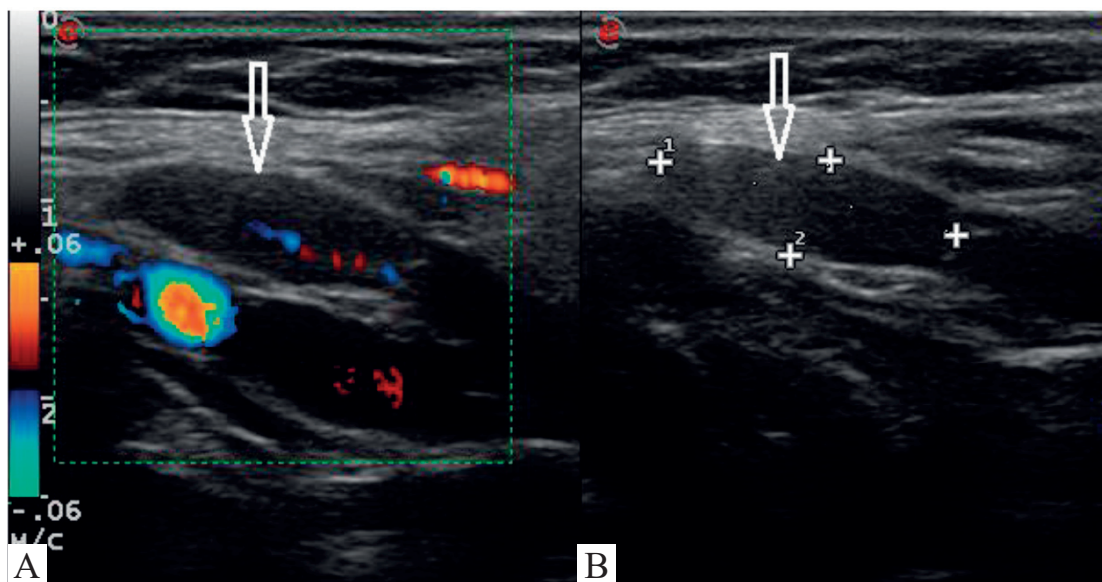
**Fig. 1.** *Ultrasound structure of a healthy child tonsil (the borders of the organ are indicated by arrows).*



**Fig. 2.** *Echogram of the tonsil with T. A – increased vascularization of the capsule and tissue of the tonsil (arrows); B – the presence of an echo-positive structure in the tonsil crypt.*



**Fig. 3.** Echogram of normal submandibular lymph nodes; at CDM – the absence of colored pixels (arrows).



**Fig. 4.** Echogram of submandibular lymph nodes in tonsillitis (indicated by arrows): A – with CDM – single colored pixels; B – during B-scanning.

Regarding the size of tonsils, there is the commonly applied by clinicians classification according to Brodsky L. [4], which is based on the visual assessment of the tonsils volume in percentages relative to the oropharyngeal airway: 1st degree

$\leq 25\%$ ; 2d degree – 26-50%; 3rd degree – 51-75%; 4th degree  $> 75\%$ . There are attempts to objectify this classification with the help of ultrasound examination [9], which, to some extent, supplements the information about tonsils condition.

It is worth noting that the use of high-frequency ultrasound to determine the size of tonsils correlates with postoperative measurement data, which indicates the objectivity of the ultrasound examination method [7]. Also, the lifetime study of tonsils can provide a more detailed picture of their structural changes at T. Thus, chronic T is also diagnosed by histological materials obtained during tonsillectomy based on the following criteria, which were observed in almost all patients with chronic T, namely: the presence of light or moderate lymphocytic infiltration in the surface epithelium; the presence of abscess, which leads to the surface epithelium defect (Ugras abscess); diffuse lymphocytic infiltration, which leads to a defect of the surface epithelium. These phenomena are observed in 97 and 93 vs 25 and 5 % in chronic T and chronic adenotonsillar hypertrophy, respectively [11]. That is, histological structural changes in T are also confirmed by echography, which was demonstrated in our study.

Clinicians, focusing on the measurements of tonsils sizes, pay more attention to their structure, mostly in acute inflammatory processes and tumor lesions [6, 9, 10], unfortunately ignoring the radiological diagnostic changes at T.

**Conclusions.** Sonographic signs of T in children are characterized not only by an increase in the size of the tonsils, but also by significant changes in their internal structure.

The method of transcutaneous high-frequency ultrasound can be the method of choice for the diagnosis of T and the supplement in investigation of children with this pathology.

**Conflict of interest information.** The authors declare no conflict of interest related to the publication of this article.

### УЛЬТРАЗВУКОВІ ОСОБЛИВОСТІ СТАНУ МИГДАЛИКІВ У ДІТЕЙ ПРИ ТОНЗИЛІТІ

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**Мета** – визначити ультразвукові критерії будови мигдаликів у дітей в нормі та при Т за допомогою черезшкірної високочастотної ехографії.

Обстежено 67 дітей віком від 6 до 18 років. З них 19 дітей – група контролю (ГК) та 48 – що мали тонзиліт (Т) Сонограми було отримано за допомогою діагностичних систем Aplio 500 (Cannon Medical Systems) та MyLab Twice (Esaote) у реальному час, лінійними датчиками з частотою більшою за 8 МГц. Сканування підщелепної ділянки ший проводилося у коронарних та сагітальних площинах для отримання поперечних та поздовжніх зображень мигдаликів(М).

При Т ехографічні зміни були більш вираженими. В першу чергу це стосувалося змінами ехографічної будови М, а саме: зменшенням «смугастості» (47.9 %), збільшенням відсотка гіпоехогенних (23 %) та гіперехогенних за структурою М (29.1 %), наявністю більшої кількості ехопозитивних включень (86.9 %) та підвищенням васкуляризації капсули (83.3 %). При Т ехографічні розміри мигдаликів збільшувалися (17.6±2.8 поздовжній та 15.4±1.9мм поперечний розміри) у 87.5 % пацієнтів. Типовим також було збільшення розмірів та підсилення васкуляризації підщелепних лімфатичних вузлів (87.5 %).

Таким чином, сонографічні ознаки тонзиліту у дітей характеризуються не лише збільшенням розмірів мигдаликів, але й значними змінами їх внутрішньої структури.

Метод черезшкірної високочастотної ехографії може бути методом вибору щодо діагностики тонзилітів і доповненням при обстеженні дітей з даною патологією.

### ULTRASOUND CHARACTERISTICS OF TONSILS IN CHILDREN WITH TONSILLITIS

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The goal is to determine the ultrasound criteria of the structure of the tonsils in healthy children and with T using percutaneous high-frequency ultrasound.

67 children aged from 6 to 18 were examined. 19 children were the control group (CG) and 48– with tonsillitis (T). Linear probe scan-

ning of the submandibular area of the neck was performed in the coronal and sagittal planes to obtain transverse and longitudinal images of the tonsils.

There were more echographic changes in children with T. First of all, this was related to changes in the echographic structure of tonsils, as following: a decrease in “striation” (47.9 %), an increase in the percentage of hypoechoic (23 %) and hyperechoic according to the structure of tonsils (29.1 %), the presence of a larger number of echopositive inclusions (86.9 %) and an increase capsule vascularization (83.3 %). In patients with T, the echographic dimensions of the tonsils increased ( $17.6 \pm 2.8$  longitudinal and  $15.4 \pm 1.9$  mm transverse dimensions) in 87.5 % of patients. An increase in the size and increased vascularization of the submandibular lymph nodes (87.5 %) was also typical.

So, sonographic signs of T in children are characterized not only by an increase in the size of the tonsils, but also by significant changes in their internal structure.

The method of percutaneous high-frequency ultrasound can be the method of choice for the diagnosis of tonsillitis and a supplement when examining children with this pathology.

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