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ULTRASOUND INVESTIGATION DIAGNOSTIC POTENTIAL IN LARYNGEAL SOFT TISSUE CONDITION DETERMINATION AND VOCAL APPARATUS DISORDERS AFTER THYROID SURGERY

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The purpose of the study was to assess the clinical reasonability of laryngeal organs ultrasound examination to recognize complications or transient functional disorders occurring after the neck organs surgical operations. 12 patients with disorders of phonation, swallowing and breathing after neck organs surgery were under observation. 12 practically healthy individuals without pathological changes in neck organs consisted the control group. The "Kontron" ultrasound system for all patients' larynx and neighboring soft tissues ultrasound examination in static and dynamic modes was used to objectify the clinical symptoms during the 7-day period after the operation. The data obtained allowed us to consider the technique of thyroid tissue ultrasound examination as the most sensitive tool for diagnosing possible lesions of its parenchyma and laryngeal organs functions. The method of ultrasound investigation was shown to be an appropriate and objective tool of laryngeal organs condition and functional disorders postoperative monitoring. Postoperative ultrasound examination of the larynx is a means of differential diagnosis between recurrent laryngeal nerve mechanical damage and functional transient disorders associated with laryngeal mucosa edema. The authors suppose that combined use of larynx ultrasound with commonly used means of direct and indirect laryngoscopy increases the reliability of laryngeal functions probable disorders differential diagnosis and allows for more rational determination of prognostic criteria and further treatment tactics.

Key words: thyroid gland, neck, surgical operations, larynx, vocal apparatus, phonation disorders, ultrasound examination, diagnostics.

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ДІАГНОСТИЧНІ МОЖЛИВОСТІ УЛЬТРАЗВУКОВОГО ДОСЛІДЖЕННЯ У ВИЗНАЧЕННІ СТАНУ М'ЯКИХ ТКАНИН ГОРТАНІ ТА ПОРУШЕНЬ ГОЛОСОВОГО АПАРАТУ ПІСЛЯ ОПЕРАЦІЙ НА ЩИТОВИДНІЙ ЗАЛОЗІ

Метою дослідження була оцінка клінічної доцільності використання ультразвукового дослідження органів гортані для інтерпретації ускладнень або транзиторних функціональних порушень, які виникають після операцій на органах ший. Під наглядом знаходилося 12 пацієнтів із порушеннями фонації, ковтання та дихання після операцій на органах ший. В якості контролю було сформовано та клінічно досліджено 12 умовно здорових осіб, без патологічних змін органів ший. Для об'єктивізації клінічної симптоматики, протягом 7-денного післяопераційного періоду, всім хворим виконували ультразвукове дослідження ділянки гортані в статичному та динамічному режимах. Отримані дані дозволили вважати методику ультразвукового дослідження тканин щитоподібної залози найбільш чутливим засобом для діагностики ймовірних уражень її паренхіми та функцій органів гортані. Доведено, що метод ультразвукового моніторингу є доцільним та об'єктивним засобом післяопераційного моніторингу стану та порушень функцій органів гортані. Післяопераційне ультразвукове дослідження гортані є засобом диференційної діагностики між механічним ушкодженням поворотного нерву та функціональних транзиторних порушень, пов'язаних із набряковими явищами слизової оболонки гортані. Автори впевнені, що поєднане застосування ультразвукового дослідження гортані із загальноновживаними засобами прямої та непрямой ларингоскопії підвищує достовірність диференційної діагностики ймовірних порушень функцій гортані та дозволяє більш раціонально визначати прогностичні критерії та подальшу тактику лікування.

Ключові слова: щитоподібна залоза, шия, хірургічні операції, гортань, голосовий апарат, порушення фонації, ультразвукове дослідження, діагностика.

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Larynx and phonation disorders after thyroid and neck surgery is an uncommon (0.1–3.0 %) but very serious postoperative complication [8, 11]. Approximately 1 in 10 patients experience temporary voice impairment after thyroid surgery, and 1 in 25 experience permanent voice impairment [14]. Clinical manifestations can range from a slight voice timbre change, isolated or combined swallowing and phonation difficulties and coughing to external respiratory function worsening. These phenomena can be combined with subjective "lump" feeling or discomfort in the throat of different degrees.

The recurrent laryngeal nerve (RLN) damage is the main cause of phonation disorders after thyroid surgery due to its close location to the thyroid gland. This nerve is responsible for all laryngeal muscles innervation except of cricothyroid one [9]. Patients show slight voice timbre changes after RLN unilateral damage while with its bilateral damage patients develop aphonia, dyspnea, and stridor which might be a life-threatening condition that requires immediate surgical intervention [9, 14]. Diagnosis of this severe complication in case of vocal nerves injury is carried out using objective methods of laryngoscopy via laryngeal organs external examination and dynamic tests.

However, one could register not so often vocal apparatus and laryngeal muscles innervation disturbance in clinical practice but rather its mucous layer reaction to damage either the severity or degree (volume) after surgical trauma. These events are more often characteristic for thyroid gland voluminar operations (in case of huge multinodular goiter, volumetric thyroiditis, thyrotoxicosis etc.) or other neck tumor neoplasms with the obligatory surgical aggression, lymphadenectomy in the larynx and trachea.

It should be noted that the postoperative period manifestation after thyroid gland and neck organs surgery is significantly determined by the inflammatory process which expression is always unpredictable, depends on patients' many individual factors and can maintain the exact pathological process for a long time as the result of low-grade chronic inflammation [1, 15]. One could see a high risk of abovementioned complications in the presence of hidden or comorbid pathology despite the entirely surgical success. The possibility OF laryngeal soft tissues and neck organs functional state objective control in such case becomes extremely important.

There is no possibility of objective estimation of laryngopharyngeal mucosa interstitial state, vocal cords, subligamentous space and motor muscles while performing direct or indirect laryngoscopy. The ultrasound diagnostic method is well known to allow evaluating the degree of infiltration, edema, density of the internal tissue structures of investigated organs. The ultrasound method technical possibilities are quite wide using the modern hardware with the help of special layouts and modes of clinical researches.

The purpose of the study was to assess the clinical reasonability of laryngeal organs ultrasound examination to recognize complications or transient functional disorders occurring after the neck organs surgical operations.

Materials and methods. 12 patients (8 women and 4 men) aged 32 to 68 years with various disorders of phonation, swallowing and breathing after neck organs surgery were under observation during the 2020–2024 years in surgical department of Odesa National Medical University Multidisciplinary Medical Center. The patients' average age was 44 ± 8 years. As a control group we examined clinically 12 practically healthy individuals without pathological changes in neck organs.

All patients and healthy volunteers were informed about their objective examination results use with scientific purposes. Written agreement was signed by each of them.

We used the "Kontron" ultrasound system ("Kontron AG", Switzerland) with an 8–12 MHz linear sensor for all patients' larynx and neighboring soft tissues ultrasound examination in static and dynamic modes to objectify the clinical symptoms during the 7-day period after the operation.

Results of the study and their discussion. The laryngeal area ultrasound picture in conditions of intact neck soft tissues was the following (fig. 1).

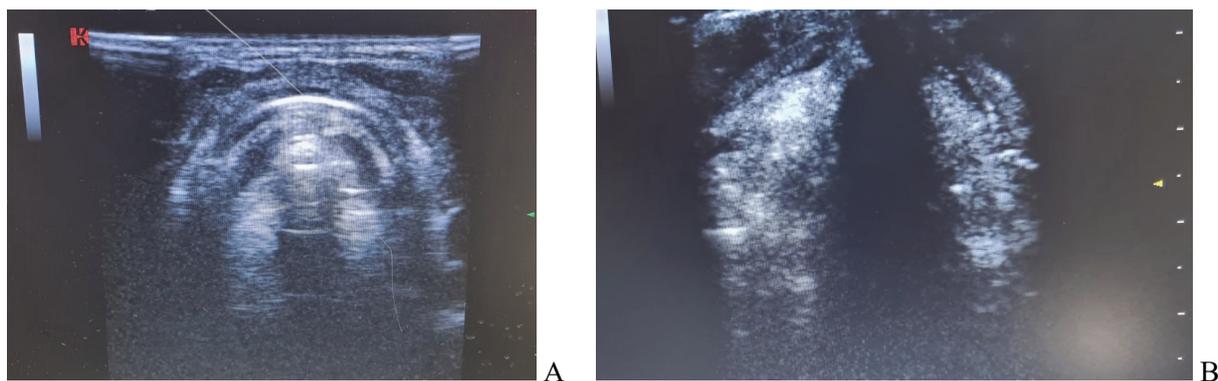


Fig. 1. Normal ultrasound picture of the laryngeal soft tissues and vocal cords. A – glottis closing stage; B – glottis opening stage.

Non-swollen and symmetrical vocal cords are clearly visualized, which are characterized by moderate and uniform echogenicity. There signs of muscle tissue compaction are absent. Dynamic examination with voice tests determines symmetrical mobility, glottis closing and opening.

Such a clinical and sonographic picture was taken as relatively normal. In the future, we considered it appropriate to use the above signs to study and evaluate sonographic data in the main group of patients for certain postoperative complications or transient disorders better interpretation.

The moderately expressed changes in voice timbre were registered in 5 patients of the main group (41.7 %) after operations on the neck organs which were not followed by permanent disorders of swallowing and external respiratory function. They had transient nature, did not worsen the patients' clinical condition and completely disappeared within 2 to 6 months.

These patients' larynx ultrasound examination showed the following picture (fig. 2).

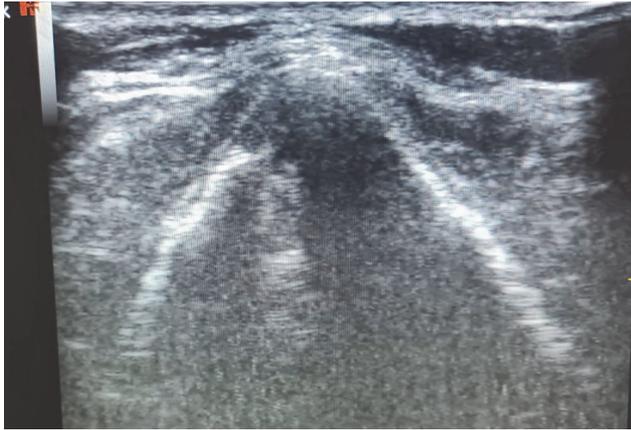


Fig. 2. Unilateral soft tissue edema on the right, without vocal cord paresis.

We can clearly see the laryngeal right ligament and surrounding structures hyperechoicity, their increased perfusion in the Doppler mode, in contrast to those on the left side. There were no restrictions or asymmetry of the laryngeal vocal organs movements during dynamic tests. Although, when performing laryngoscopy in these patients, there was a restriction of the right vocal ligament motor activity against the background of laryngeal mucosa expressed edema.

Therefore, we conclude that clinical disorders of laryngeal function are precisely associated with laryngeal mucosa edema without the LN branches mechanical damage.

These signs we suppose can be used as a differential diagnostic test for clinical symptoms transient or functional nature.

The following ultrasound picture was characteristic in 4 main group patients (33.3 %) who also complained on phonation disturbances, problems of swallowing and foreign body feelings inside the throat which expression was significantly greater (fig. 3 A).

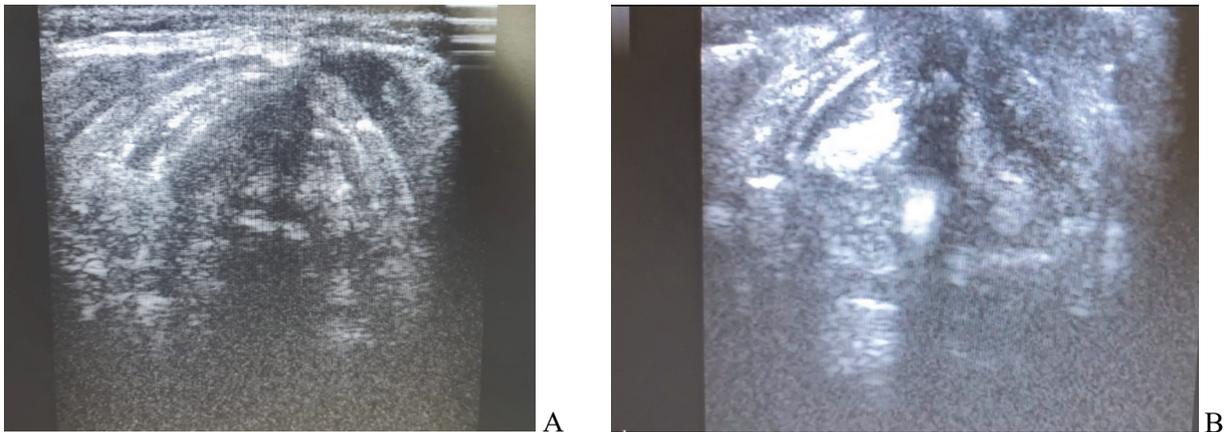


Fig. 3. Edema of soft tissues of the larynx in the postoperative period. A – bilateral soft tissue edema of the larynx and vocal cords; B – bilateral laryngeal soft tissue edema and right vocal cord paresis.

We found hyperechogenicity, increased perfusion and signs of laryngeal soft tissues interstitial edema using both static and dynamic ultrasound investigation mode. At the same time there were no signs of impaired external respiration. The expressed bilateral edema of mucous layer, vocal cords and subligamentous apparatus was observed during laryngoscopy. Both vocal cords reduced motor activity expressed to a greater or lesser extent was registered.

However, we did not observe disorders of laryngeal ligament apparatus movements in these patients of the main group during dynamic ultrasound monitoring with voice tests. During further clinical observation these patients revealed negative clinical symptoms complete regression – subjectively 6 months after thyroid surgery they estimated their well-being as completely satisfactory.

Nevertheless, we registered severe clinical symptoms in 3 patients of main group (25.0 %). Along with expressed disorders of phonation and swallowing, there was a lung ventilation insufficiency which required a certain period of treatment in the intensive care unit with the oxygen therapy, and in one patients (bilateral partial damage of RLN branches) – temporary tracheostomy imposition for 3 months.

These patients' ultrasound examination showed an expressed vocal cords area hyperechogenicity with the surrounding soft tissues edema (fig. 3 B). One could see the median vocal cord location in the area of the intact RLN (in this case, on the left side) and complete atony with the vocal cord paradoxical passive mobility on the side of RLN damage. These sonographic features were also confirmed laryngoscopically but without the possibility of differentiation.

Thus, the data obtained allowed us to consider the technique of thyroid tissue ultrasound examination as the most sensitive tool for diagnosing possible lesions of its parenchyma and laryngeal organs functions. We believe the ultrasound monitoring of the larynx during the postoperative period is a

unique tool for differential diagnosis between RLN mechanical damage and functional transient disorders associated with laryngeal mucosa edema which allows to choose the adequate treatment tactics in each specific case.

To discuss the data obtained, let us focus on the following.

Firstly, we note the importance of preserving the human voice which is the main tool for unhindered communication in society, the leading device for human second signaling system functioning, for interpersonal relationships formation and thoughts and emotions expression. The voice is the main working tool for most people, especially for teachers and lecturers, actors and singers, etc. And that's why its loss or weakening as a result of any thyroid surgery, in addition to the general medical one, also has a social and economic facet.

The second point of our results discussion concerns the understanding of the mechanisms of laryngeal voice disorders and soft tissue damage after thyroid surgery. Additionally to RLN damage, the external branch of the upper laryngeal nerve injure, which is a vagus branch and contains motor fibers that innervate the cricothyroid muscle and are responsible for vocal folds tension regulation, can lead to the above-mentioned phonation disorders [2, 13].

60 % of patients in these conditions after thyroid surgery revealed the significant decreases of the volume of the voice, the glottis becomes flaccid, the person is unable to produce high tones - that is especially important for people who work with their voice [2, 10, 12]. The timbre of the voice may change also. With upper laryngeal nerve external branch bilateral damage the person's voice becomes monotonously hoarse and tends to weaken in close dependence on the time of vocalization, one could notice also the upper half of the larynx sensitivity impairment which leads to dysphagia and asphyxia during swallowing [2–4].

It's clear that only the above-mentioned probable lesions of the nerve trunks which are extremely compactly and sometimes individually unexpectedly located inside the thyroid gland thickness are a "sufficient" condition for vocal fold paralysis development after thyroid surgery. The additional and extremely important relevance of our diagnostic study and the results obtained becomes clear after the anatomical, functional and clinical data presented in the discussion.

It is impossible to avoid the risk of inflammatory syndrome development in the postoperative period after thyroid surgery. Its etiological factors at least might be the following: nerve fibers probable mechanical injury (which is an undesirable and optional consequence of thyroid surgery) and/or intraoperative mechanical impact on the gland parenchyma, which according to fundamental aspects essentially triggers the primary alterative changes [7, 10]. The further local inflammation manifestation can significantly determine the clinical features of the entire postoperative period and the vocal apparatus functional activity.

Hence, phonation disorders, which most often are the result of RLN damage or the external branch of the upper laryngeal nerve during thyroid surgery, significantly reduce the patients' quality of life and can cause permanent disability. Because of this we believe the phonation disorders after thyroid surgery diagnostic assessment as an important and urgent task. The following measures are extremely important from a prospective point of view: 1) preoperative assessment of the human voice and the vocal cords condition, as well as a special laryngological examination; 2) obligatory neuromonitoring of RLN and the external branch of the upper laryngeal nerve which should generally ensure a voice disorders and loss cases reduction after thyroid surgery. Our colleagues agree with such ideas [2, 13].

We used ultrasound technique for thyroid gland and other internal organs and tissues pre- and postoperative assessment for a long time and we would like to share our experience. Ultrasound investigation diagnostic/resolution capability is less vs that of CT (the sensitivity of ultrasound monitoring is 81.0–85.2 % and specificity is 79.2–81.5 % vs 91.4 % and 94.4 %, respectively, for CT), but CT usually is not performed on every patient with thyroid pathology. It is associated also with radiation exposure and the iodine-containing contrast solution use [6].

Resuming, we emphasize the importance of ultrasound monitoring of laryngeal anatomical structures for diagnostic purposes during thyroid surgery. Our experience as well as the similar opinion of our colleagues [5] allows us to recommend the combined use of larynx ultrasound examination and special ENT methods for larynx functional state assessing after thyroid surgery and phonation complications development preventing.

Conclusions

1. The method of ultrasound investigation is an appropriate and objective tool of laryngeal organs condition and functional disorders postoperative monitoring.

2. Postoperative ultrasound examination of the larynx is a means of differential diagnosis between recurrent laryngeal nerve mechanical damage and functional transient disorders associated with laryngeal mucosa edema.

3. The combined use of larynx ultrasound with commonly used means of direct and indirect laryngoscopy increases the reliability of laryngeal functions probable disorders differential diagnosis and allows for more rational determination of prognostic criteria and further treatment tactics.

Prospects for further researches include further accumulation of experience in phonation disorders early and effective ultrasound diagnostics during the postoperative period after the thyroid gland and neck organs operations as well as surgical experience improvement to perform interventions without expressed phonation disorders.

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