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CHANGES IN THE ACOUSTIC CHARACTERISTICS OF THE VOICE AFTER CONSERVATIVE AND SURGICAL TREATMENT OF CHRONIC TONSILLITIS

Svistushkin V.M., Starostina S.V., Avetisyan E.Ye.*

Department of ENT Diseases, I.M. Sechenov First Moscow State Medical University, Moscow, Russia

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Abstract

In a number of metatonsillar complications an important role is played by changes in the voice acoustic characteristics. The study of possible changes in the voice with different forms of chronic tonsillitis was the aim of our study. We examined 2 groups of patients with chronic tonsillitis: one with toxic-allergic form 1 and the second with form 2. The first group of patients underwent treatment by washing lacunas of palatine tonsils with solution of chlorhexidine, and the second group of patients – cold knife tonsillectomy. The complex of patient studies included voice acoustic analysis, voice evaluation using a Voice Handicap Index questionnaire, videolaryngostroscopy, nasopharynx endoscopy. First group patients were conducted directly before and after the course of treatment, second group patients – the day before tonsillectomy, 1 and 6 months after surgery.

The study showed that after a course of washing the palatine tonsils lacunae with a 0.05% aqueous solution of chlorhexidine, the tonal range of the voice widened by an average of 1 ton, the dynamic range increased by an average of 6 dB. Maximum phonation time increased on average by 2-7 seconds, Jitter decreased by an average of 0.43-0.6%. In this group, Voice Handicap Index scale drops from 9.3 to 2.6.

The study results of the patients with tonsillectomy showed that in 6 months after tonsillectomy the tonal range of the voice expanded on average by 1 ton, the dynamic range increased by an average of 11 dB. Maximum phonation time increased by an average of 2.2-2.5 seconds; Jitter decreased by an average of 0.4-0.44%. In this group, the Voice Handicap Index scale drops from 12.4 to 7.8.

This article presents the modern level of studies about the impact of chronic tonsillitis and tonsillectomy on the acoustic characteristics of the voice and the data obtained from our observations.

Keywords: *acoustic analysis of voice, phonetography, spectrography, voice, chronic tonsillitis, tonsillectomy.*

Introduction

In the literature, there are a few studies about the influence of chronic tonsillitis on voice and speech [*Ivanova O, 2009; Angotoeva I, Rudin L, 2012*]. The causes of voice functional disorders in chronic tonsillitis are disorders of neuroreflex mechanisms, changes in the volume of the oropharyngeal resonator, changes in local and general immunological reactivity of the organism [*Shamsheva T, 1984*]. Most of the researches are devoted to the influence of tonsillectomy on the voice. Indications for tonsillectomy are decompensated form of chronic tonsillitis, as well as obstruction of the airways associated with hypertrophy of palatine tonsils or asymmetric hypertrophy and neoplasm of palatine tonsils [*Seshamani M et al., 2014*]. Postoperative complications may include bleeding, pain, wound inflammation and voice changes [*Maryn Y et al., 2004; Ramos S et al., 2013*].

Up to 80 metatonsillar diseases are known in modern clinical practice [*Karpova Ye et al., 2014*]. However, the problem of the effect of chronic inflammatory processes of ENT organs, chronic tonsillitis and tonsillectomy on the voice function has not found its final solution at present [*Chuma A et al., 1999*; *Mora R et al., 2009; Celebi S et al., 2011; Atan D et al., 2017*].

The negative impact of tonsillectomy on the voice quality can be due to the possible development of palatopharyngeal insufficiency, a significant pain syndrome in the immediate postoperative period, in particular when swallowing and talking. Postopera-

Address for Correspondence:

Emil Ye. Avetisyan
8-2 Trubetskaya Street, Moscow 119991, Russia
Tel.: +79153056306
E-mail: avetisyanemil@gmail.com

tive pain can lead to a disturbance of the soft palatine closure. Usually, such changes are temporary and are resolved within a few weeks. However, in a number of patients, the disorder become stable, sometimes for their relief it is necessary to resort to voice therapy [*Chuma A et al., 1999*]. Finally, some researchers believe that in the long run tonsillectomy does not have a statistically significant effect on voice and speech, unless performed on people with voice and speech related professions, because it does not directly influence the phonatory function of larynx and thus is not expected to affect the frequency at which vocal folds oscillate during phonation [*Celebi S et al., 2011; Atan D et al., 2017*].

Assessment of the voice includes acoustic assessment and aerodynamic analysis. Acoustic examination is based on subjective and objective data [*Liu X et al., 2015; Shilenkova V, 2015*]. Acoustic characteristics objectively reflect the qualitative and quantitative characteristics of the voice [*Williamson G, 2009; Shadyev Kh et al., 2002; Liu X et al., 2015; Shilenkova V, 2015*].

Among the methods of objective assessment of acoustic characteristics of the voice is the assessment of frequency characteristics of formants – spectrography which allows to break down the voice into components (overtones), which graphically illustrate the produced sound [*Chitkara P et al., 2003*]. Vowels with a high tongue positioning, namely [i] and [u] have a lower first formant (F1), whereas vowels [æ] and [a] have a higher F1. Given that the intensity (force) of the voice is recorded on the spectrogram using colour variations of the signal from dark to light, this method is considered to be perfect for studying the intensity of each voice overtone [*Shilenkova V, 2015*].

Subjective acoustic analysis includes the use of Voice Handicap Index and Voice-Related Quality Of Life questionnaires and their various modifications, as well as the assessment of subjective voice characteristics using the GRBAS scale [*Khami M et al., 2015; Shilenkova V, 2015*].

According to the studies of I.B. Angotoeva and L.B. Rudin (2012) acoustic voice analysis indicates a statistically significant improvement in objective acoustic characteristics of the voice following a course of washes of tonsil crypts [*Angotoeva I., Rudin L, 2012*]. Patients with chronic tonsillitis toxic-allergic form 1 who are enrolled into vocal educational institutions, should undergo check-ups in dispensaries with an otolaryngologist and a phoniatritian: they have to be treated with preventive measures and conservative treatment [*Jafek B, Stark A, 2001*].

The study aimed to discover the changes in acoustic characteristics of the voice, which take place when the patient has a chronic tonsillitis or has had a tonsillectomy.

Own research

We have investigated the influence of the cold dissection tonsillectomy and conservative treatment method (washes of the palatine tonsil crypts with a 0.05% chlorhexidine digluconate aqueous solution No 7) on characteristics of the voice.

The research conducted on the basis of the clinic of ear, nose and throat diseases at I.M. Sechenov First Moscow State Medical University, involved 25 people (9 men and 16 women) aged between 18 and 46 years with a decompensated form of chronic tonsillitis toxico-allergic form 2, who complained about frequent sore throats (more than twice a year), pain in heart area and in joints, discomfort in oropharynx and dislodgement of tonsil stones from palatine tonsil crypts, hoarseness and fatigue of the voice, accumulation of mucus in laryngopharynx. From them 12 patients had voice-related professions and 6 patients had smoked for more than 5 years. The research did not involve patients with anomalies and injuries of the face scull, medical history of gastroesophageal reflux disease, any form of impaired hearing, psychoneurologic diseases; patients who had previously had a tonsillotomy, adenotomy performed on them; patients who at some point had a voice correction.

A bilateral cold knife tonsillectomy was performed on all patients. The following procedures were performed on the patients 1 day before the operation and also 1 and 6 months after the surgical treatment: a general otolaryngologic inspection, endoscopy of the nasopharynx, videolaryngostroboscopy, assessment of the subjective complaints of the patients using a specialized questionnaire "Voice Handicap Index", acoustic analysis of the voice using a computer programme "lingWAVES Voice Program 3.1".

The size of palatine tonsils was assessed using a 4-point scale: 1 point – palatine tonsils behind palatine arches; 2 points – palatine tonsils level with palatine arches, 3 points – palatine tonsils take up 1/3 of

the space between the front palatine arch and the mid-line of the pharynx; 3 points – palatine tonsils take up 2/3 of the space between the front palatine arch and the mid-line of the pharynx; 4 points – palatine tonsils take up the whole space between the front palatine arch and the mid-line of the pharynx.

Using the computer programme "lingWAVES Voice Program 3.1" the following acoustic parameters of the voice were determined: maximum phonation time in seconds, frequency and dynamics ranges in *Hz* and *dB* respectively, frequency (Jitter) and range (Shimmer) instability of the voice in %, the S/Z index, the dysphonia index, fundamental frequency (F0) in *Hz*, intensity of quiet, normal, loud speech and screams in *dB*, spectrogram of vowels [a], [æ], [o], [u], [i] of the Russian alphabet.

The results of acoustic voice analysis have indicated that 6 months after tonsillectomy a positive dynamic has been noted in the majority of objective indicators of the voice, namely: a reduction of the coefficient of instability of fundamental frequency (Jitter) prior to the bilateral tonsillectomy from 1.08% in average to 0.68% and from 0.99% to 0.55% in men and women respectively; expansion of the dynamic range from 29*dB* to 36*dB* and from 29*dB* to 37*dB* in men and women respectively; an increase in fundamental frequency from 108*Hz* in average to 158*Hz* and from 221*Hz* to 274*Hz* in men and women respectively. The dysphonia index prior to tonsillectomy averaged at 1.9, which corresponds to a moderate episodic dysphonia; 6 months after the operation it averaged at 4.2, which corresponds to a minor episodic dysphonia, the S/Z index decreased from 1.42 to 0.9. However, the change in certain acoustic parameters was not statistically significant: the average maximum phonation time increased from 21 to 23.2 and from 16.8 to 19.3 seconds in men and women, respectively; range instability of the voice (Shimmer) decreased from 6.46% to 4.4% and from 7.3% to 5.83% in men and women, respectively (Table 1 and 2).

Table 1

Acoustic parameters of the voice 1 day prior to the operation, 1 month and 6 months after bilateral tonsillectomy

Parameters	Norm	Time of tonsillectomy Average (min-max)		
		Before	In 1 month	In 6 months
Maximum phonation time (*seconds*)				
Men	≈30.5	21 (16.3-25)	20.8 (18.9-23.7)	23.2 (22.8-28.6)
Women	≈19.1	16.8 (14.4-21.1)	17.0 (15.9-21.4)	19.3 (16.8-24.8)
Jitter (%)				
Men	<1	1.08 (0.61-1.2)	0.91 (0.66-1.0)	0.68 (0.57-0.95)
Women	<1	0.99 (0.68-1.3)	0.85 (0.66-1.1)	0.55 (0.45-0.74)
Shimmer (%)				
Men	<5	6.46 (5.8-7.88)	5.43 (4.0-7.55)	4.4 (0.9-7.2)
Women	<5	7.3 (6.2-7.95)	6.88 (5.9-7.8)	5.83 (5.4-6.3)
S/Z Ratio	<1.4	1.42 (1.1-1.7)	0.9 (0.8-1.1)	0.9 (0.8-1.1)
Dysphonia Index	>4.4	1.9 (1.6-2.2)	3.1 (2.7-3.4)	4.2 (3.4-4.8)

Table 2

Acoustic parameters of the voice 1 day prior to the operation, 1 month and 6 months after bilateral tonsillectomy

Parameters	Norm	Time of tonsillectomy Average (min-max)		
		Before	In 1 month	In 6 months
Fundamental Frequency (*Hz*)				
Men	≈130	108 (89-152)	122 (105-161)	158 (122-181)
Women	≈220	221 (203-241)	255 (201-271)	274 (215-294)
Intensity of quiet speech (*dB*)				
Men	≈60	57 (52-61)	47 (44-52)	54 (48-56)
Women	≈52	52 (48-54)	42 (40-45)	53 (48-54)
Intensity of normal speech (*dB*)				
Men	≈76.6	64 (56-68)	62 (60-64)	65 (63-69)
Women	≈74	68 (62-69)	69 (65-71)	70 (66-72)
Intensity of loud speech (*dB*)				
Men	≈90	86 (84-88)	79 (76-82)	90 (85-92)
Women	≈84	81 (79-84)	79 (77-84)	90 (87-92)
Intensity of screems (*dB*)				
Men and Women	>90	91 (86-98)	87 (84-93)	94 (88-110)

Acoustic parameters of the voice can also be illustrated as spectrograms. Spectrograms are used for identification of speech and visualisation of formants. They demonstrate the dependence of signal frequency on time. Each sound is attributed with a particular frequency band, in which, as a result of resonance, a number of tone harmonics produced by vocal folds are strengthened – that is, in a particular spectrum of sound, a formant is an area of intensified frequencies that is distinctly identifiable. We were analysing the acoustic spectrograms of vowels in the Russian alphabet. Based on the results of this analysis we classified spectrograms using the Yanagihara classification with the modifications by Wilson, Shilenkova and Korotchenko [*Shilenkova V, 2015*]. Prior to tonsillectomy all 25 patients had a vowel spectrogram of II type according to the above mentioned classification – they had distinguished noise components in all or several vowel spectra. Six months after the received treatment the spectrograms of 21 patients were classified as I-type – with indistinct noise components in all or several vowel spectra. The spectrograms of 4 patients remained II-type (Fig. 1, 4, 7, 10, 13).

In our research with the use of videolaryngostroboscopy we researched the mobility of both halves of the larynx, the degree of vocal cord closure during phonation, the tonus and the symmetry of the "mucosal wave" of the vocal folds, the presence of mucous secretion in the larynx. Before the tonsillectomy signs of hypotonus (oval or triangular fissures during phonation, gaping Morgagni's ventricles, incurvation of the free edge of the vocal folds during inhalation, an increased range of oscillations) of the vocal folds were observed in 18 patients after the operation: after one month – in 14, after six month – in 6 out of 25 patients. This implies that tonsillectomy has contributed to tonus normalization of the vocal folds in the late postoperative period.

By using endoscopy of the nasal cavity we assessed the palatopharyngeal function of the patients. As articulated earlier tonsillectomy may cause an impaired closure of the soft palatine after the operation and eventually a voice disorder, however in this case it did not happen: before the operation incomplete closure of the soft palatine was observed in 8 patients, whereas after the operation – just in 2 patients. It can therefore be concluded that tonsillectomy has had a positive influence on the palatopharyngeal function.

Subjective acoustic analysis implies the use of various questionnaires – Voice Handicap Index, Voice-Related Quality Of Life and their modifications, as well as assessment of the subjective characteristics of the voice using the GRBAS scale. In our research we used Voice Handicap Index questionnaires (Table 3). Voice Handicap Index is a questionnaire that includes 30 questions (10 in each of the 3 parts) about the influence of the voice on physical, emotional, as well as functional aspects of voice formation and life overall, and is used for subjective analysis of the voice (Table 4). Answers to each question are evaluated using a 5-point scale (0-4). The total result can fall between 0 and 120. A higher result means a subjectively more serious voice disorder. In our research in the group of patients underwent bilateral tonsillectomy the average score using the Voice Handicap Index scale dropped from 12.4 to 7.8, which could be interpreted as an improvement in voice quality as defined by the patients themselves. In the group of patients underwent washes of tonsil crypts the average score using the Voice Handicap Index scale dropped from 9.3 to 2.6.

We also investigated the effect of washes of tonsil crypts on the vocal apparatus. Through pharyngoscopy and medical history recollection, all the patients showed signs of a chronic inflammation of the palatine tonsils, which corresponded to the chronic tonsillitis toxico-allergic form 1. All the patients received a 7-session treatment of washes of palatine tonsil crypts with a 0.05% chlorhexidine bigluconate aqueous solution. Dysphonia was not treated. The study of voice quality with the use of acoustic analysis was carried out before and after the conservative treatment.

The research involved 25 patients (7 men and 18 women) aged between 18 and 58 years who had a toxico-allergic 1-type chronic tonsillitis and had complained about frequent sore throats, discomfort in oropharynx, recurrent dislodgement of tonsil stones from palatine tonsil crypts, hoarseness and fatigue of the voice, accumulation of mucus in laryngopharynx. From them 16 patients had voice-related professions and 3 patients had smoked for more than 5 years. The research did not involve

Table 3

Voice Handicap Index Questionnaire according to B. Jacobson and co-authors (1997)

Name _____ Date_____ Follow-up#_____

Voice Handicap Index (VHI)
(Jacobson, Johnson, Grywalski et al., 1997)

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

(Never = 0 points; Almost never = 1 point; Sometimes = 2 points; Almost always = 3 points; Always = 4 points)

	Перечень вопросов для оценки слуха	**0** Never	**1** Almost never	**2** Sometimes	**3** Almost always	**4** Always
F1	My voice makes it difficult for people to hear me					
P2	I run out of air when I talk					
F3	People have difficulty understanding me in a noisy room					
P4	The sound of my voice varies throughout the day					
F5	My family has difficulty hearing me when I call them throughout the house					
F6	I use the phone less often than I would like					
E7	I'm tense when talking with others because of my voice					
F8	I tend to avoid groups of people because of my voice					
E9	People seem irritated with my voice					
P10	People ask, "What's wrong with your voice?"					
F11	I speak with friends, neighbors, or relatives less often because of my voice					
F12	People ask me to repeat myself when speaking face-to-face					
P13	My voice sounds creaky and dry					
P14	I feel as though I have to strain to produce voice					
E15	I find other people don't understand my voice problem					
F16	My voice difficulties restrict my personal and social life					
P17	The clarity of my voice is unpredictable					
P18	I try to change my voice to sound different					
F19	I feel left out of conversations because of my voice					
P20	I use a great deal of effort to speak					
P21	My voice is worse in the evening					
F22	My voice problem causes me to lose income					
E23	My voice problem upsets me					
E24	I am less outgoing because of my voice problem					
E25	My voice makes me feel handicapped					
P26	My voice "gives out" on me in the middle of speaking					
E27	I feel annoyed when people ask me to repeat					
E28	I feel embarrassed when people ask me to repeat					
E29	My voice makes me feel incompetent					
E30	I'm ashamed of my voice problem					

Place "X" mark anywhere along this line to indicate the severity of your voice
Normal Mild Moderate Severe
P_____ F _____ E _____ Total _____

Note: *The letter preceding each item number corresponds to the subscale (E = emotional subscale, F = functional subscale, P = physical subscale).*

patients with anomalies and injuries of the face scull, a medical history of gastroesophageal reflux disease, any form of impaired hearing, psychoneurologic diseases; patients who had previously had a tonsillotomy, adenotomy performed on them; patients who at some point had a voice correction.

The results of acoustic voice analysis have indicated that after a course of washes of palatine ton-

Table 4

Voice Handicap Index Questionnaire suggested by Shilenkova V (2015)

Voice Handicap Index (VHI)

Name _____ Date_____

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

(Never = 0 points; Almost never = 1 point; Sometimes = 2 points; Almost always = 3 points; Always = 4 points)

Place "X" mark anywhere along this line to indicate the severity of your voice

Part I-F (Functional subscale)

		0 Never	**1** Almost never	**2** Sometimes	**3** Almost always	**4** Always
F1	My voice makes it difficult for people to hear me					
F3	People have difficulty understanding me in a noisy room					
F5	My family has difficulty hearing me when I call them throughout the house					
F6	I use the phone less often than I would like					
F8	I tend to avoid groups of people because of my voice					
F11	I speak with friends, neighbors, or relatives less often because of my voice					
F12	People ask me to repeat myself when speaking face-to-face					
F16	My voice difficulties restrict my personal and social life					
F19	I feel left out of conversations because of my voice					
F22	My voice problem causes me to lose income					

Result _____

Part II-P (physical subscale)

		0	1	2	3	4
P2	I run out of air when I talk					
P4	The sound of my voice varies throughout the day					
P10	People ask, "What's wrong with your voice?"					
P13	My voice sounds creaky and dry					
P14	I feel as though I have to strain to produce voice					
P17	The clarity of my voice is unpredictable					
P18	I try to change my voice to sound different					
P20	I use a great deal of effort to speak					
P21	My voice is worse in the evening					
P26	My voice "gives out" on me in the middle of speaking					

Result _____

Part III-E (emotional subscale)

		0	1	2	3	4
E7	I'm tense when talking with others because of my voice					
E9	People seem irritated with my voice					
E15	I find other people don't understand my voice problem					
E23	My voice problem upsets me					
E24	I am less outgoing because of my voice problem					
E25	My voice makes me feel handicapped					
E27	I feel annoyed when people ask me to repeat					
E28	I feel embarrassed when people ask me to repeat					
E29	My voice makes me feel incompetent					
E30	I'm ashamed of my voice problem					

Result _____

Total Result _____

sil crypts a positive dynamic has been noted in the majority of objective indicators of the voice, namely: a reduction of the coefficient of instability of fundamental frequency (Jitter) from 1.2% in average to 0.77% and from 1.1% to 0.5% in men and women respectively; an expansion of the dynamic range from 31*dB* to 36*dB* and from 32*dB* to 39*dB* in men and women, respectively; an increase in fundamental frequency from 115*Hz* in average to 147*Hz* and from 198*Hz* to 251*Hz* in men and women, respectively. The dysphonia index prior to the course of treatment averaged at 2.8, which corresponds to a light form of dysphonia; after the course of treatment it averaged at 4.8, which corresponds to dysphonia, the S/Z index decreased from 1.42 to 0.9. However the change in certain acoustic parameters was not statistically significant: the average maximum phonation time increased from 19 to 26 and from 19 to 21 seconds in men and women respectively; range instability of the voice (Shimmer) changed from 4.8% to 4.5% and from 3.2% to 5.3% in men and women, respectively (Table 5 and 6).

According to the results gained through videolaryngostroboscopy, prior to the course of washes of palatine tonsil crypts, signs of hypotonus (oval or triangular fissures during phonation, gaping Morgagni's ventricles, incurvation of the free edge of the vocal folds, an increased range of oscillations) of the vocal folds were observed in 12 patients, after the course of treatment – in 6 out of 25 patients. This implies that the course of washes of palatine tonsil crypts has contributed to tonus normalisation of the vocal folds. The average score from the Voice Handicap Index questionnaire (Table 3, 4) dropped from 10 to 5, which could be interpreted as an improvement in voice quality as defined by the patients themselves.

Clinical Case 1: The Patient A., aged 26 years, is a fifth year university student at the department of academic vocal (a coloratura soprano). She was admitted to the clinic with complaints about frequent sore throats, discomfort in her oropharynx and dislodgement of tonsil stones from palatine tonsil crypts, narrowing of the vocal range of her singing voice due to the inability to "catch" the higher tones of the tessiture. She has been ill for about half a year and has been regularly gargling her throat with antiseptic solutions with short-lasting positive results.

Table 5

Acoustic voice parameters before and after the course of washes of palatine tonsil crypts

Parameters	Norm	Course of washes of palatine tonsil crypts Average (min-max)	
		Before	After
Maximum phonation time (*seconds*)			
Men	≈30.5	19 (14.5-22)	26 (22-28)
Women	≈19.1	19 (14-21)	21 (14-22)
Jitter (%)			
Men	<1	1.2 (0.74-1.4)	0.77 (0.51-0.98)
Women	<1	1.1 (0.54-1.3)	0.5 (0.25-0.69)
Shimmer (%)			
Men	<5	4.8 (3.6-8.3)	4.5 (0.8-6.1)
Women	<5	3.2 (2.6-5.4)	5.3 (2.4-6.7)
S/Z Ratio	<1.4	1.42 (0.4-1.6)	0.9 (0.4-1.0)
Dysphonia Index	>4.4	2.8 (2.2-5)	4.8 (4.5-5)

Table 6

Acoustic voice parameters prior to the course of washes of palatine tonsil crypts and after the course of washes of palatine tonsil crypts No 7

Parameters	Norm	Course of washes of palatine tonsil crypts Average (min-max)	
		Before	After
Fundamental Frequency (*Hz*)			
Men	≈130	115 (94-141)	147 (120-161)
Women	≈220	198 (189-232)	251 (211-271)
Intensity of quiet speech (*dB*)			
Men	≈60	56 (53-60	52 (47-55)
Women	≈52	54 (52-55)	50 (47-53)
Intensity of normal speech (*dB*)			
Men	≈76.6	67 (65-69)	66 (63-68)
Women	≈74	67 (64-69)	68 (65-70)
Intensity of loud speech (*dB*)			
Men	≈90	87 (85-88)	88 (85-89)
Women	≈84	86 (78-88)	89 (86-92)
Intensity of screems (*dB*)			
Men and women	>90	91 (88-98)	98 (92-115)

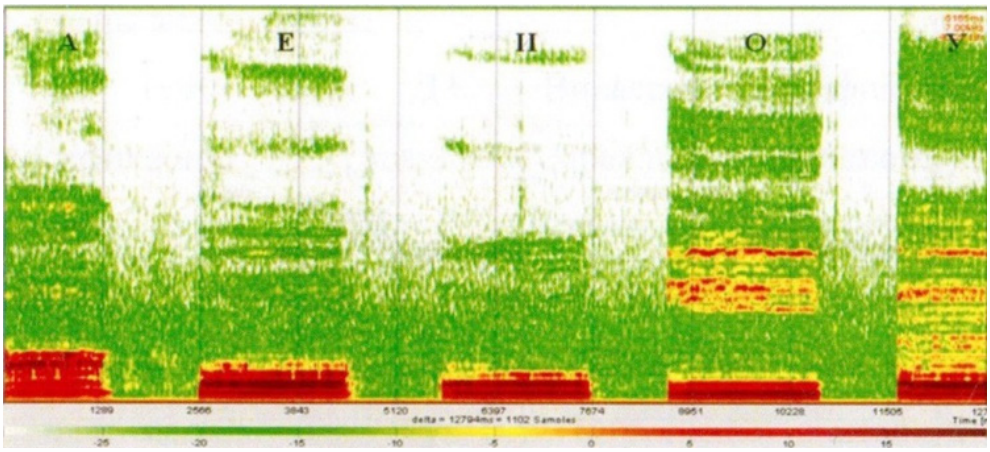

Figure 1. *A general view of a normal spectrogram for Russian vowels [a], [ye], [i], [o], [u] [Shilenkova V, 2015]*

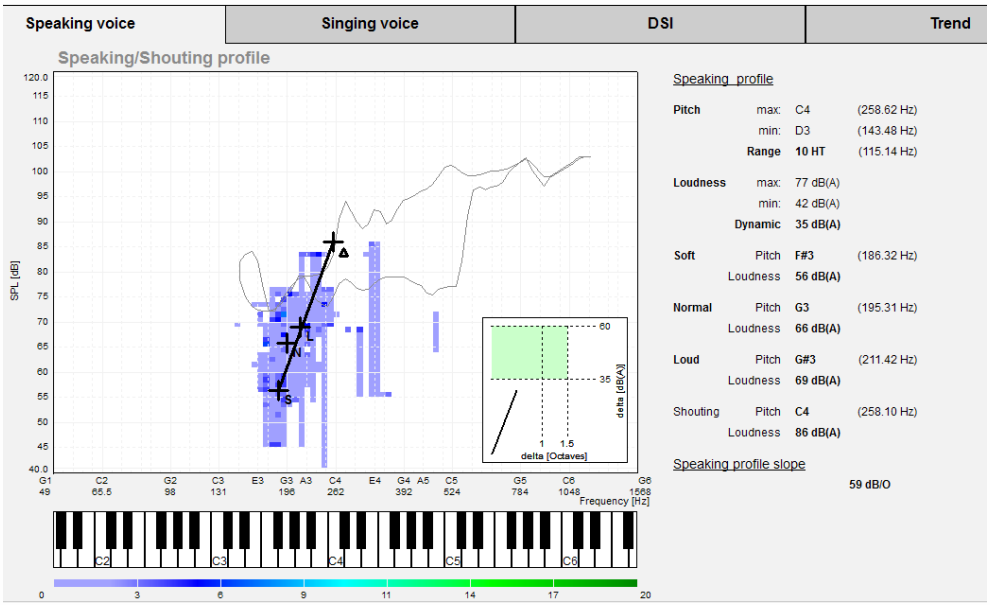

Figure 2. *Speech phonetogram of the patient No 1 prior to the course of washes of palatine tonsil crypts*

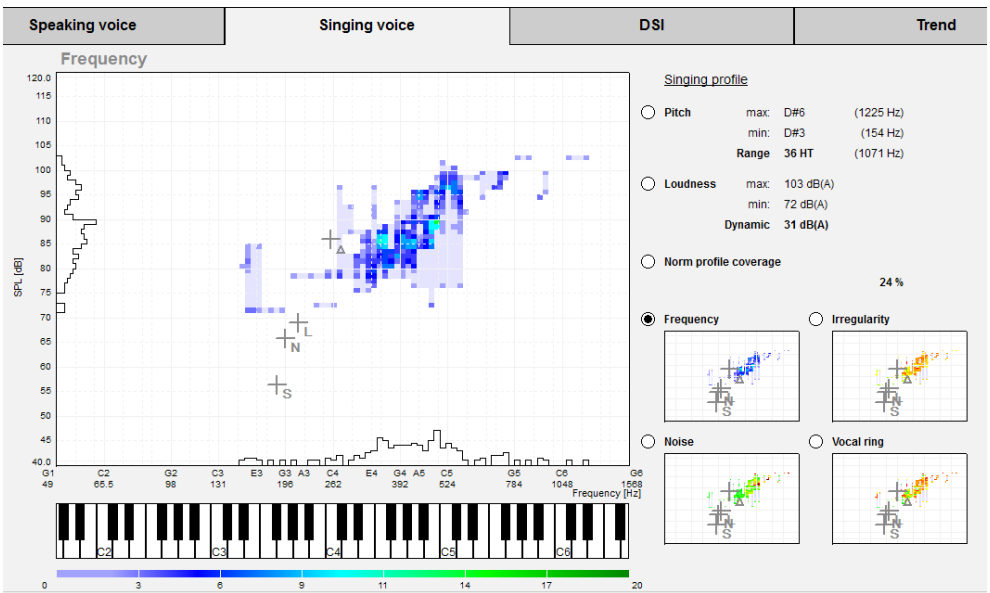

Figure 3. *Vocal phonetogram of the patient No 1 prior to the course of washes of palatine tonsil crypts*

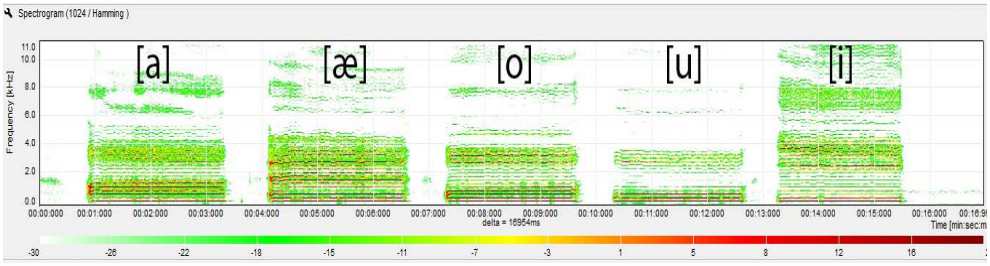

Figure 4. *Spectogram of the patient No 1 prior to the course of washes of palatine tonsil crypts: in the spectrum of vowels [a], [æ], [o] noise components can be observed in the area of 3-4 kHz*

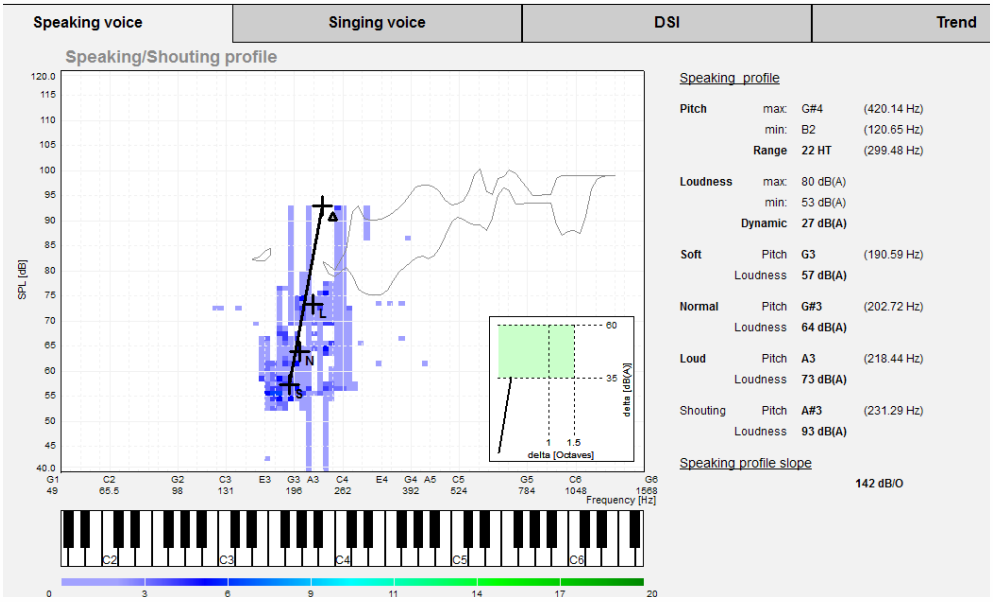

Figure 5. *Speech phonetogram of the patient No 1 after the course of washes of palatine tonsil crypts*

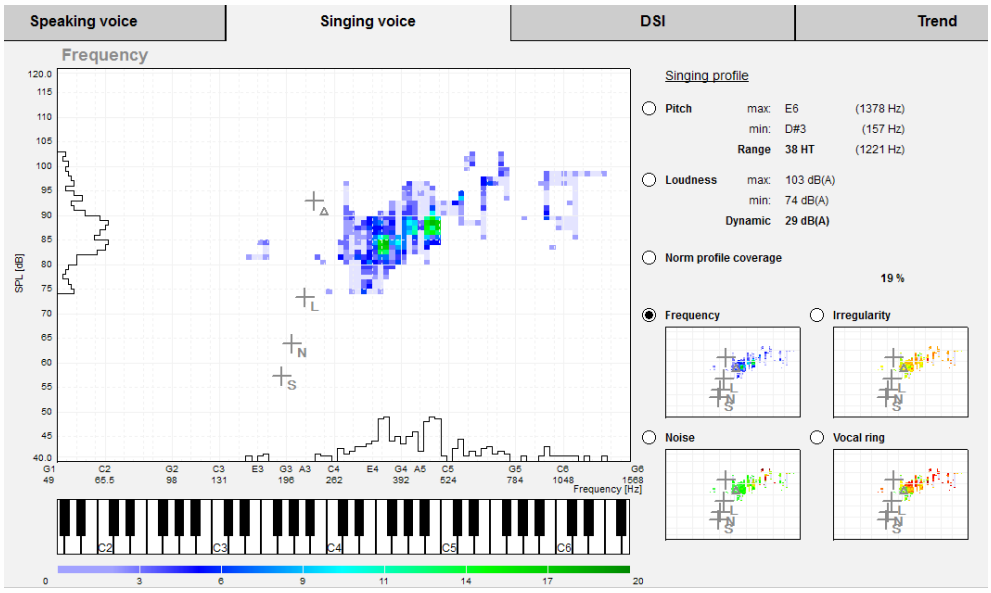

Figure 6. *Vocal phonetogram of the patient No 1 after the course of washes of palatine tonsil crypts*

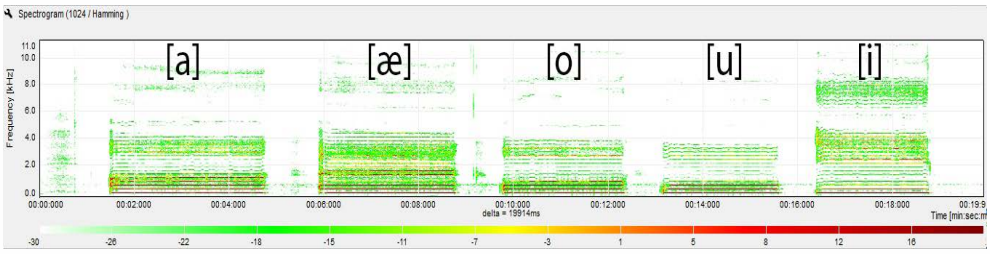

Figure 7. *Spectogram of the patient No 1 after the course of washes of palatine tonsil crypts: there are almost no noise components in any of the voice spectra*

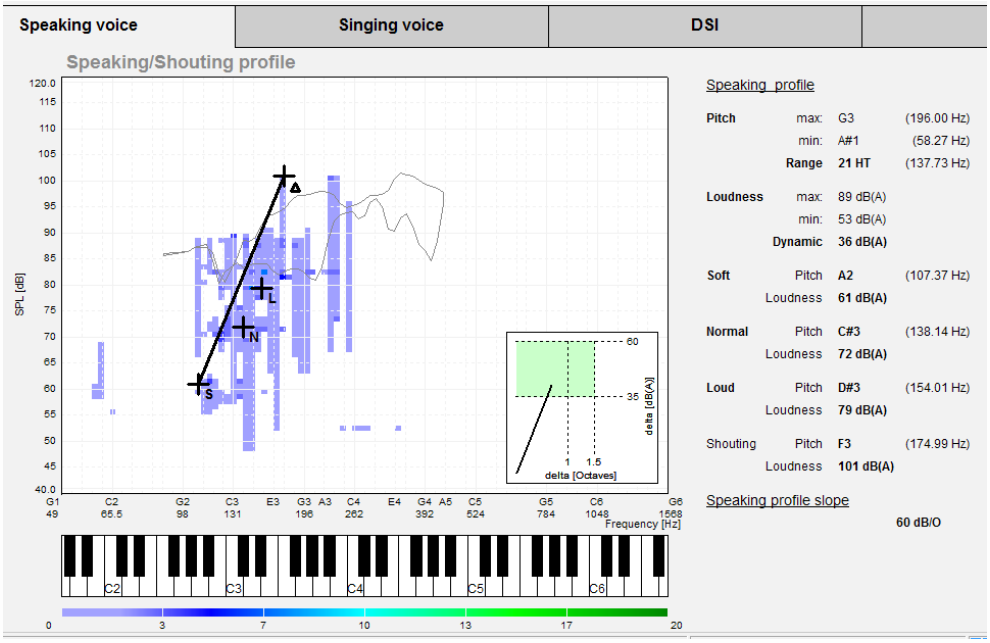

Figure 8. *Speech phonetogram of the patient No 2 prior to bilateral tonsillectomy*

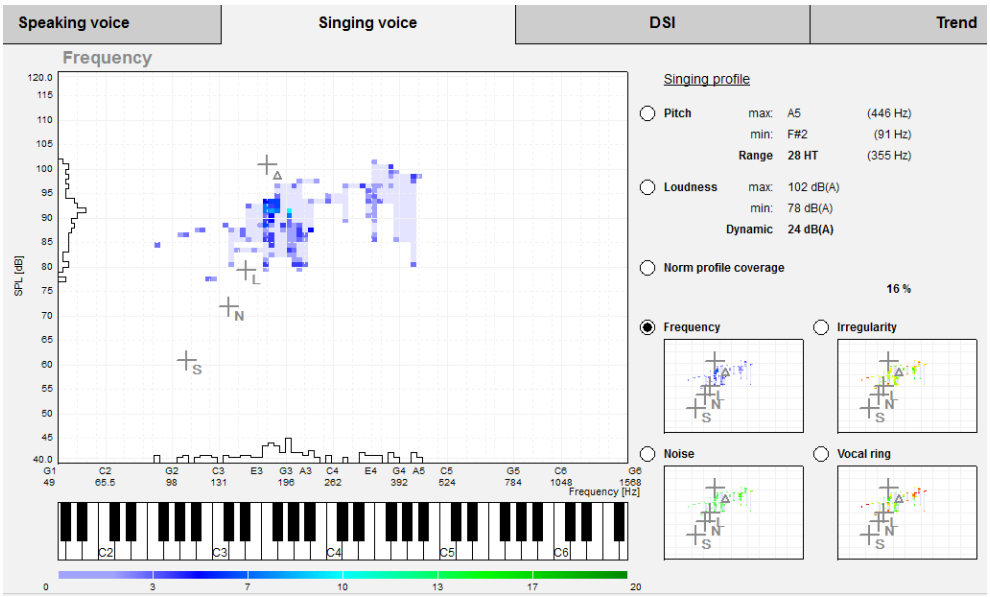

Figure 9. *Vocal phonetogram of the patient No 2 prior to bilateral tonsillectomy*

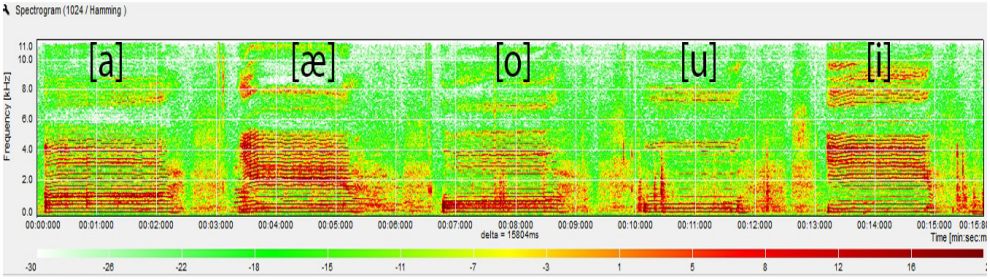

Figure 10. *Spectrogram of the patient No 2 prior to bilateral tonsillectomy: distinct noise components, unclear differentiation of harmonic and noise components can be observed in the spectrum of all the vowels*

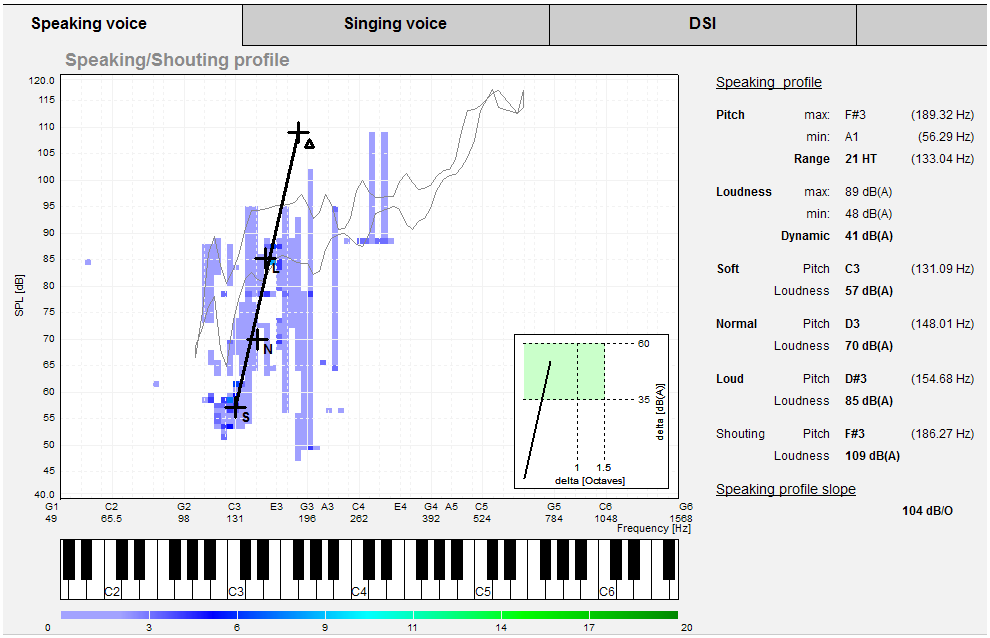

Figure 11. *Speech phonetogram of the patient No 2 6 months after bilateral tonsillectomy*

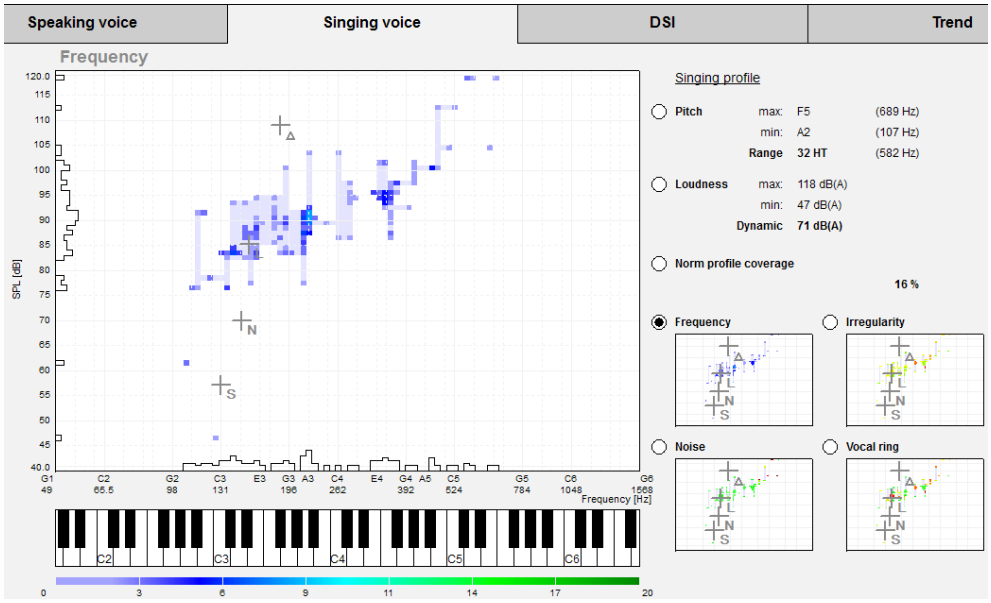

Figure 12. *Vocal phonetogram of the patient No 2 after 6 months from bilateral tonsillectomy*

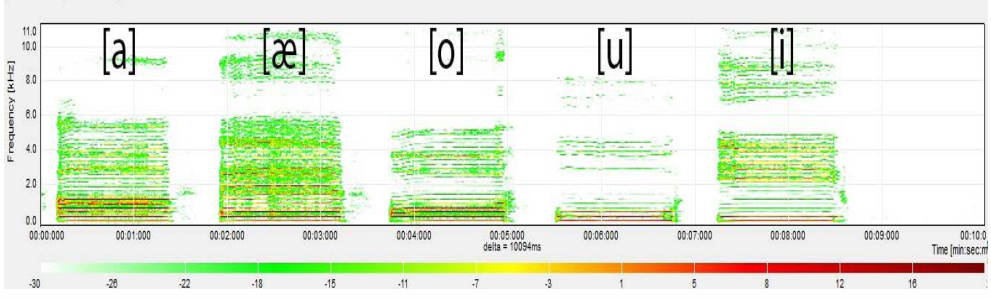

Figure 13. *Spectrogram of the patient No 2 6 months after the bilateral tonsillectomy: in the spectrum of vowels [a], [æ], [o], [u], [i] poorly distinguished noise components can be observed in the area of 3-5 kHz*

Status localis: oropharynx – palatine arches are somewhat reddened, palatine tonsils are level with the arches, the tonsil crypts are filled with a little caseous mass. The mucous membrane of the back wall of the larynx is pink and wet. From videolaryngostroboscopy: the epiglottic vallecula and piriform sinuses are empty, the epiglottis is leaf-shaped, the vocal folds are pearl-white and somewhat dilated, the underfold space is empty. During phonation vocal folds do not close completely throughout the full length, leaving a gap of 1-1.5 *mm*. There is flotation of mucous on vocal folds, which continues even after clearing the throat. All the other ENT organs are free from pathologies.

Laboratory test results: antistreptolysin-O – 68 *IU/ml*, the basic blood and urine analyses are normal.

Clinical diagnosis: Chronic tonsillitis, toxico-allergic form 1. Functional hypotonic-type dysphonia.

According to the data gained through acoustic voice analysis prior to the treatment:

Speech profile: The tonal range of the speaking voice constitutes 10 semitones: max C4 (258.6*Hz*) – the C of the fourth octave, min D3 (143.5*Hz*) – the D of the third octave. Fundamental frequency (F0) is 232 *Hz*. The dynamic band is in the range of 35*dB*: max 77*dB*, min 42*dB* (Fig. 2).

Vocal profile: The tonal range of the singing voice has constituted 36 semitones: max D#6 (1225*Hz*) – the D sharp of the sixth octave, min D#3 (154*Hz*) – the D sharp of the third octave. The dynamic band is in the range of 31*dB*: max 103*dB*, min 72*dB* (Fig. 3).

General information: Jitter = 0.13%, Shimmer = 3.93%, S/Z index – 0.83 (the norm being less than 1.4). Maximum phonation time is 19 seconds (the lower bound of the norm being 16 seconds). Irregularity of voice cord closure is 0.84, according to the index (the norm being <1*dB*). The level of normalised noise energy in the sound signal is 0.26 (the norm being <1*dB*). Intonation is accessible in full. The indicator of roughening is 0.88 according to the index (the norm being <1). The dysphonia index is 5 – no dysphonia observed.

The patient has had a course of washes of palatine tonsil crypts with a 0.05% solution of chlorhexidine No 7. The following dynamic in the data from acoustic voice analysis has been observed after the treatment:

Speech profile: The tonal range of the speaking voice has constituted 22 semitones: max G#4 (420*Hz*) – the G sharp of the second octave, min B2 (120*Hz*) – the B of the small octave. Fundamental frequency (F0) is 226*Hz*. The dynamic band is in the range of 27*dB*: max 80*dB*, min 53*dB* (Fig. 5).

Vocal profile: The tonal range of the singing voice has constituted 38 semitones: max E6 (1378*Hz*) – the E sharp of the sixth octave, min D#3 (157*Hz*) – the D sharp of the third octave. The dynamic band is in the range of 29*dB*: max 103*dB*, min 74*dB* (Fig. 6).

General information: Jitter = 0.17% (the norm being <1%), Shimmer = 4.92% (the norm being <5%), S/Z index – 1.29 (the norm being 1.4). Maximum phonation time is 23.7 seconds (the lower bound of the norm is 16 seconds). Irregularity of voice cord closure is 0.75, according to the index (the norm being <1*dB*). The normal level of normalised noise energy in the sound signal is 0.59 (the norm being <1*dB*). Intonation is accessible in full. The indicator of roughening is 0.96 according to the index (the norm being <1). The dysphonia index is 5 – no dysphonia observed.

Subjectively the patient has noted an absence of discomfort in the larynx, almost complete recovery of the tonal range of the tessiture.

Status localis: oropharynx – palatine arches are pink, palatine tonsils are level with the arches, the tonsils crypts have no pathological content. The mucous membrane of the back wall of the larynx is pink and wet. From videolaryngostroboscopy: the epiglottis is leaf-shaped and somewhat dilated during phonation – a complete closure throughout the full length. There is less dislodging of tonsil stones, and the underfold space is free.

Clinical Case 2: The Patient G., aged 37 years, was admitted to the clinic with complaints about frequent sore throats (2-3 times a year) over the past 6 years, discomfort in his oropharynx, recurrent discomfort in his heart area, recurrent pain in his knee joints. It is known from his medical history that he has been practicing Pop and Jazz vocal for 17 years. He has experienced sore throats over the past 4-5 years and the latest occasion was 10 months ago. He treated his condition by gargling his throat with antiseptic solutions and getting washes of tonsils with short-lasting improvements.

Status localis: oropharynx – palatine arches are somewhat reddened, palatine tonsils are hypertro-

phied (I degree), there is some caseous mass in tonsil crypts. The mucous membrane of the back wall of the larynx is pink and wet. From videolaryngostroboscopy: the epiglottic vallecula and piriform sinuses are empty, the epiglottis is leaf-shaped, the vocal folds are pearl-white and somewhat dilated. During phonation vocal folds do not close completely through the lateral 2/3 of the length, leaving a gap of 1-1.5 *mm*. There is flotation of mucous on vocal folds, which continues even after clearing the throat. The fissure of glottis in the lateral third is about 13 *mm*, the underfold space is empty. All the other ENT organs are free from pathologies.

Laboratory test results: antistreptolysin-O – 238 *IU/ml*, the basic blood and urine analyses are normal.

Clinical diagnosis: Chronic tonsillitis, toxico-allergic form 2. Functional hypotonic-type dysphonia.

Speech profile: The tonal range of the speaking voice has constituted 21 semitones: max G3 (196*Hz*) – the G of the third octave, min A#1 (58*Hz*) – the A sharp of the first octave. Fundamental frequency (F0) is 154*Hz*. The dynamic range has expanded to 36*dB*: max 89*dB*, min 53*dB* (Fig. 8).

Vocal profile: The tonal range of the singing voice has constituted to 28 semitones: max A5 (446*Hz*) – the A of the fifth octave, min F#2 (91*Hz*) – the F sharp of the second octave. The dynamic band is in the range of 24*dB*: max 102*dB*, min 78*dB* (Fig. 9).

General information: Jitter = 0.11%, Shimmer = 3.9%, S/Z index – 1.07 (the norm being 1.4). Maximum phonation time is 17 seconds (the lower bound of the norm being 16 seconds). Irregularity of voice cord closure is 1.48, according to the index (the norm being <1*dB*). The level of normalised noise energy in the sound signal is 0.21 (the norm being <1*dB*). Intonation is accessible in full. The indicator of roughening is 1.49 according to the index (the norm being <1). The dysphonia index is 2 – a dysphonia of a moderate form.

The patient has had a bilateral tonsillectomy performed using the traditional method with a combined endotracheal anesthesia. Below is the data gained through acoustic analysis of the voice 6 months after the conducted treatment.

Speech profile: The tonal range of the speaking voice has constituted 21 semitones: max F#3 (189*Hz*) – the F sharp of the first octave, min A1 (56*Hz*) – the A of the great octave. Fundamental frequency (F0) is 111*Hz*. The dynamic range has expanded to 41*dB*: max 89*dB*, min 48*dB* (Fig. 11).

Vocal profile: The tonal range of the singing voice has expanded to 32 semitones: maxF5 (689*Hz*) – the F of the third octave, minA2 (107*Hz*) – the A of the small octave. The dynamic range has expanded to 71*dB*: max 118*dB*, min 47*dB* (Fig. 12).

General information: Jitter = 0.06% (the norm being 1%), Shimmer = 5.17% (the norm being 5%), S/Z index – 1.08 (the norm being 1.4). Maximum phonation time is 16.1 seconds (the lower bound of the norm being 16 seconds). Irregularity of voice cord closure is 0.82, according to the index (the norm being <1*dB*). Intonation is accessible in full. The indicator of roughening is 0.85 according to the index (the norm being <1). The dysphonia index is 3 – a dysphonia of a light form.

Subjectively the patient has noted an absence of discomfort in the throat, almost complete recovery of the tonal range of the tessiture.

Status localis: oropharynx – palatine arches are pink, tonsil crypts are empty. The mucous membrane of the back wall of the larynx is pink and wet. From videolaryngostroboscopy: the epiglottis is leaf-shaped, vocal folds are pearl-white; they close completely throughout the full length during phonation, the mucous wave is symmetric, the quantity of mucous discharge is low. The underfold space is empty.

Conclusion

Thus, on the basis of systematic analysis of both Russian and international literature, as well as the data gained from our observations, the following conclusions can be made:

Chronic inflammation of palatine tonsils has an impact on voice characteristics.

Tonsillectomy, when free from obvious scarring in the oropharynx area, leads to an improvement in the main acoustic parameters of the voice (the coefficient of instability of fundamental frequency (Jitter), dysphonia index, expansion of the tonal and dynamics range), an increase in harmonic components and a decrease in noise components in the vowel spectre.

Conservative treatment of patients with a basic form of chronic tonsillitis and chronic tonsillitis toxico-allergic 1-type contributes to an improvement in the main acoustic parameters of the voice (the coefficient of instability of fundamental fre-

quency (Jitter), dysphonia index, expansion of the tonal and dynamics range) and an elimination of noise components in the vowels spectre.

Tonsillectomy has a positive effect on the functional capacities of the vocal apparatus itself, which is confirmed by normalisation of the videolaryngostroboscopy image.

Conservative treatment of patients with a basic form of chronic tonsillitis or chronic tonsillitis toxico-allergic 1-type contributed to a recovery of the tonus of vocal folds, according to the data gained through videolaryngostroboscopy.

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