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# Effect of Inflammatory Diseases of the Oral Cavity and Pharynx on Vocal Ability of Choir Students

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**Microbiological studies of mixed saliva and oropharyngeal swabs from patients with stomatitis (34 patients), and pharyngitis (13 patients) among choir students, as well as change in the frequency range of the voice. An increase in the number of oral Fusobacterium necrophorum, Treponema denticola, Peptococcus actives in all cases, as well as in patients with Streptococcus haemoliticus pharyngitis. All patients had a reduction in the frequency range of voice. The obtained results can be used to select the most effective treatment that promotes more rapid recovery and restoration of vocal abilities.**

**Key words:** Vocal, culturing, Mixed saliva, Stomatitis, Pharyngitis, Frequency range of voice.

Inflammatory diseases of the oral cavity and pharynx are serious medical and social problem. According to the WHO, acute inflammation of the upper respiratory tract in the adult population is observed with the incidence from 5 to 8% per one year, mostly with unserious course. An incidence is higher in large cities than that in rural areas because of the frequency of contacts and exposure to harmful exogenous factors. Inflammatory diseases of the upper respiratory tract may be caused by more than 300 various microorganisms. Antibodies, specific protection from them, are acquired throughout all the life. The level of antibodies to many pathogens decreases with time, making the person susceptible to them again[1-2]. It is known that respiratory infections contribute to the development of chronic diseases of oro- and nasopharynx, bronchi and lungs (bronchial asthma, adenoiditis, tonsillitis, sinusitis, obstructive bronchitis, recurrent laryngotracheitis) leading to increased sensitization and formation of functional disorders of cardiovascular and bronchopulmonary systems[3-4].

The prevalence of this disease among adult population remains high; in addition there is a steady upward trend in the rate of complications of these diseases associated with impaired voice[5].

This is especially actual problem for professional singers because vocal tract disorders may lead to complete loss of vocal characteristics.

Singing as a variety of sound generation is a process of higher nervous activity. This process requires coordinated activities of many organs and systems of the human body: respiratory, abdominal, and laryngeal muscles of mouth, pharynx, etc. It is the central nervous system that coordinates complex activity of the vocal apparatus. One should remember that the functional state of cardiovascular and endocrine systems affects the process of phonation[5].

Speech function of a throat consists of resonation of sound produced by the larynx.

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Timbre formation occurs in the cavities of the larynx, pharynx, nose, paranasal sinuses and mouth. Formation of consonant and vowel sounds to a greater extent occurs in the oral cavity and to a lesser extent in the pharyngeal cavity. When pronouncing vowels, soft palate isolates nasopharynx from the oral cavity, while the consonants are pronounced when the soft palate is lowered.

Frequently we can see cases when the director appointed a budding artist to the parties, which require sufficient theatre and vital experience as well as well-tested vocal technique. Nevertheless the director took into account only external and artistic data of the artist. As a result, a budding singer faced an unbearable task, feeling the pressure from the director and conductor, and underwent a certain psychological discomfort. However an artist tried to fulfill all his objectives by all available means. Singers used perverse techniques and increased the classroom time with the concertmaster and sometimes took additional classes with other teachers. As a result, this led not only to the emergence of functional and organic diseases of larynx (hypotonic, hypohypertonic dysphonia, phonastenia, vascular reactions, nodules of the vocal cords), but also sometimes to psychological disruption. This could lead even to the development of an inferiority complex required the help of a psychologist.
Voice pitch and its tone color depend not only on the movable part of the resonators. In many ways these properties are determined by the shape and size of the hard palate[5].

Quality voice of a professional singer is caused by the simultaneous presence of two components - natural abilities and vocal skills obtained in the learning process[6]. Anatomical background, physiological and genetic features together determine an ability to perform any activity, including vocal or artistic one[5].

Direction of modern scientific research in medicine is the use of new methods for diagnosis, prognosis and effective treatment of stomatitis and pharyngitis[7-9]. The role of microflora in the development of infectious and inflammatory diseases of the systems being considered has been currently established. Microbial growth in the oral cavity and pharynx is promoted by the following factors: slightly alkaline reaction of the medium, the presence of food residues in the mouth, optimum humidity and favorable temperature and other factors[10-11].

The purpose of the research is the determination of mixed saliva composition and microbiological evaluation of oropharyngeal swab specimens for diagnosis, influence on vocal characteristics and assignment of effective treatment of stomatitis and pharyngitis for choirs students.

## MATERIALS AND METHODS

We have examined 47 choir students, girls aged from19 to 22 years having the following vocal characteristics: contralto - 12 subjects, mezzo-soprano - 15 subjects, soprano - 11 subjects, coloratura soprano - 9 subjects. All subjects had complaints of the discomfort during singing, deterioration in general health (body temperature from 38º C to 38.3º C), decrease in the frequency range of voice and the length of the sound waves. Pharyngitis was diagnosed according to the Centor score which considers the following factors: an increase in the body temperature up to 38º C, absence of cough, increase and painfulness of cervical lymph nodes, swollen tonsils and the presence of the exudate (each parameter is estimated as 1 point).

On examination of 13 students (with the following vocal characteristics: contralto - 6 subjects, mezzo-soprano - 5 subjects, soprano - 2 subjects) it was revealed that Centor score was equal to 4 points.

Catarrhal stomatitis was diagnosed in the remaining 34 patients (with the following vocal characteristics: contralto - 6 subjects, mezzo-soprano - 10 subjects, soprano – 9 subjects, coloratura soprano – 9 subjects). The examination revealed swelling and soreness of the oral mucosa, its congestion and the presence of a white incrustation.

Composition of the mixed saliva was studied in all the patients. Its collection was carried out in patients with pharyngitis at rest. In patients with pharyngitis an additional oropharyngeal dry sterile cotton swab specimens were collected from the surface of the tonsils, palatine arches and posterior wall of the oropharynx. Swab specimen (working part of the probe with a cotton swab)

after collection was placed in a sterile disposable tube with transport medium.

Inoculation of collected specimen was performed on the agar by addition of 5% defibrinated horse blood. Blood agar base served as a basis for the preparation of blood agar, incubation temperature being 35-37 ºC. The results were evaluated after 24 hours.

Voice frequency range was determined using the software Cool Edit Pro, which provides a comfortable environment for the realization of the creative ideas, as well as everyday work with musical compositions. This software preserves the original quality of sound and also separates the music from the vocals.

Processing of the obtained data was carried out using software Statistica for Windows 6.0. The studied signs are used as variables in this program. The obtained variables of the frequency range in patients with pharyngitis and catarrhal stomatitis were analyzed using Kolmogorov-Smirnov criteria, according to the following formula:

$\lambda amp = 1.4$ i.e. $\leq 1.36$, therefore the indicator should be treated as a parametric variable as it obeys normal distribution.

The results of the study were analyzed by calculating arithmetic mean (M), arithmetic mean error (m), and significance of the differences (P).

Results and discussion. Study of inoculation of medium from the oropharynx revealed that 9 patients (70% of patients with pharyngitis) had $^2$-hemolytic zone with the width of $2.5 \pm 0.4$ mm. It was teardrop-shaped and had a brilliant color. The obtained result is most typical for the group A $^2$-hemolytic streptococcus producing hyaluronic acid. At the same time in all patients with pharyngitis the frequency range of voice was decreased down to $127.3 \pm 14.2$ Hz, while the conventional minimum is 170 Hz. Microbiological composition of the mixed saliva shown in Table 1.

As it is seen from Table 1, the study of the mixed saliva in all the patients revealed the following microorganisms: fusobacterium

**Table 1.** Microbiological composition of the mixed saliva in patients suffering from catarrhal stomatitis and pharyngitis

| Diagnosis | Species of identified microorganisms | Number of microorganisms, $10^9$/ml |
|---|---|---|
| Catarrhal stomatitis | Fusobacterium necrophorum | $8.4 \pm 0.6$ |
| Pharyngitis | | $8.9 \pm 0.5$ |
| Catarrhal stomatitis | Peptococcus activus | $6.4 \pm 0.5$ |
| Pharyngitis | | $6.6 \pm 0.4$ |
| Catarrhal stomatitis | Treponema denticola | $7.9 \pm 0.9$ |
| Pharyngitis | | $8.4 \pm 0.8$ |

**Table 2.** Changing in the frequency range of voice in patients suffering from catarrhal pharyngitis and stomatitis

| Vocal type | Diagnosis | Initial frequency range of voice (in clinically healthy subjects), Hz | Frequency range of voice in sick subjects, Hz |
|---|---|---|---|
| contralto | Catarrhal stomatitis | $172.3 \pm 1.5$ | $143.4 \pm 12.9$* |
| | Pharyngitis | $171.9 \pm 0.8$ | $124.4 \pm 11.7$* |
| mezzo-soprano | Catarrhal stomatitis | $174.7 \pm 2.6$ | $140.2 \pm 10.6$* |
| | Pharyngitis | $175.3 \pm 2.4$ | $122.9 \pm 11.5$* |
| soprano | Catarrhal stomatitis | $178.9 \pm 2.2$ | $148.8 \pm 13.7$* |
| | Pharyngitis | $179.4 \pm 2.0$ | $127.3 \pm 14.2$* |
| coloratura soprano | Catarrhal stomatitis | $180.2 \pm 1.9$ | $145.7 \pm 14.1$* |
| | Pharyngitis | $181.1 \pm 2.0$ | $126.6 \pm 11.9$* |

* $P < 0.005$ in comparison with clinically healthy subjects

(Fusobacterium necrophorum) $8.4 \pm 0.6 \times 10^9$/ml; treponemes (Treponema denticola) $7.9 \pm 0.9 \times 10^9$/ml; peptococcus (Peptococcus activus) $6.4 \pm 0.5 \times 10^9$/ ml. At the same time in all patients with stomatitis the voice frequency range was decreased down to $148.8 \pm 13.7$ Hz (Table 2).

It should be noted that microbial contamination of mixed saliva in patients with pharyngitis exceeded the corresponding values of patients with stomatitis (Table 1). In female singers with mezzo-soprano suffering from pharyngitis, the fullness of sound is reduced while voluminous of bass music virtually disappears. In female singers with contralto we could see the disappearance of the typical note density in the low octave.

Permanent bacterial flora in the oral cavity is located there due to adhesion to oral structures or to other microorganisms, as well as by mechanical delay. An adhesion may be caused by synthesis of extracellular polymers by the microbe, and the specific interaction between superficial layers of various kinds of microorganisms. The nature of such adhesion is not well understood. Microorganisms without any adhesive structures may be retained in the oral cavity. Amino acids and salivary proteins may be considered as nutritive substrates for microflora. The number of microorganisms in the oral cavity changes during the day, while the leading role belongs to the rate of saliva production, which decreases dramatically at night time. One of the important functions of the normal microflora is its participation in host colonization resistance to pathogens[12]. In case of a considerable decrease in colonization resistance there is an increase in the number and range of potential pathogens and their translocation through the intestinal wall or other organs and oral microorganism that may be accompanied by the development of endogenous infection. Pathological effect of the revealed bacterial species on the oral cavity is caused by the production of phospholipase A, contributing to tissue inflammation and hemostasis disorders, thereby facilitating invasion of bacteria into the deeper tissues and leukocidin which possess cytotoxic effect on the cells (especially white blood cells and macrophages)[12, 13].

Phagocytosis disturbance develops, which leads to the weakening of the immune response and increase in pathological processes in the oral cavity and pharynx[14].

According to some researchers[11; 12; 15] the protective function of inflammation is that the microbe is fixed at the point of penetration in the tissues and doesn't spread further throughout the body, and then it is destroyed in the focus of inflammation by phagocytes. Beginning of vascular inflammation is characterized by a rapid response and local violation of fluid circulation. In the focus of inflammation phagocytes form a bank, absorbing and digesting microbes. Recovery period begins after destruction of the microorganisms in the focus of inflammation. The process of reparative regeneration associated with inflammation is activated by epithelial and connective tissue structures, in particular by fibroblasts, which subsequently begin to actively build collagen fibers and other components of the extracellular matrix[16-17]. In those lesions of the skin and mucous membranes that affect minor areas (up to 1 cm) and low depth (0.1-0.2 mm) there's complete elimination of the defect and restoration of the normal epithelial layer. In those lesions that are larger in size and depth, the healing occurs under a scab (a dry crust) or by primary intention with forming a delicate connective scar or by secondary intention with forming a dense connective scar[12].

In case of considerable structural changes of the tissues, a scar is formatted in the site of inflammation, which may adversely affect the vocal characteristics.

It should be also noted that beta-hemolytic streptococcus produces hyaluronic acid, which enhances proliferation and migration of cells. Hyaluronic acid degradation products (oligosaccharides and very low molecular weight hyaluronates) exhibit proangiogenic (stimulating blood vessel growth) properties. In addition, recent studies have shown that fragments of hyaluronic acid are able to induce an inflammatory response in macrophages and dendritic cells during injury of the tissues[12].

One should remember that pharyngitis can be complicated by rheumatism and glomerulonephritis, which can lead to disability of a sick person.

It should be noted that dry, spicy foods and those irritating throat mucous should be eliminated from the diet of patients suffering from pharyngitis. Patients are recommended to eat small

portions of warm and non-spicy liquid or semi-liquid food in order to prevent irritation of the throat. Patients shouldn't use rinsing solutions that contain baking soda during chronic pharyngitis, as it dries pharyngeal mucous membrane and complicates the course of the disease.

Patients must stick to specific diet during treatment of catarrhal stomatitis: not to eat hot, sour, salty and spicy food.

A set of measures for the prevention of mucosal inflammation of pharynx and oral cavity includes general conditioning to the cold, strengthening of the immune system, healthy lifestyle (smoking cessation, avoiding polluted atmosphere), proper restoration of free nasal breathing in case of its malfunction.

Specified lesions develop in singers in case of muscle affection, which reduces the vocal cords followed by a hoarse overtone in voice that occurs even after a short singing. Intonation becomes impure, voice fails to achieve tessitura followed by the development of fatigue in the neck muscles and ligaments[5].

## CONCLUSIONS

Inflammation of the oral cavity is accompanied by an increase in the number of opportunistic infections (Fusobacterium necrophorum, Treponema denticola, Peptococcus activus) and by a decrease in vocal characteristics (decrease in the frequency range of voice).

Group A beta-hemolytic streptococcus is the causative agent of pharyngitis in most patients accompanied by a reduction in the frequency range of voice down to 127.3 ± 14.2 Hz. Based on the results of microbiological studies, we can select the most effective treatment that promotes more rapid recovery and restoration of vocal abilities.

## REFERENCES


1. Kryukov, A.I., A.S. Sedinkin and A.A. Uzdenikov, Problem of Pain Syndrome in Diseases of the Throat. *Attending Physician*, 2001; **1**: 9-11.
2. Levitsky, A.P., Physiological Microbial System of the Oral Cavity. *Bulletin of Stomatology*, 2007; **1**: 6-11.
3. Polyakova T.S. and A.V. Gurov, Comprehensive Look at the Problem of Bacterial Pharyngitis. *Russian Medical Journal*, 2007; **15**(7): 612 - 615.
4. Bisno, A.L., Acute pharyngitis. N. *Engl.J.Med*, 2001; **344**: 205-211.
5. Romanenko, S.G., O.G. Pavlikhin and O.V. Eliseev, The Role of the Otolaryngologist and Phoniatrics in Professional Selection of Students Entering in the Creative Universities. *Russian otorhinolaryngology*, 2008; **3**: 447-449.
6. Utkina, O.N., Methods of Measuring the Volume of a Teacher's Voice. *Bulletin of the Surgut State Pedagogical Institute*, 2012; **3**(18): 215-221.
7. Kuznetsov, E.V. and V.N. Tsarev, Microbial Flora of the Oral Cavity and its Role in the Development of Pathological Processes. Moscow: Medical, 2003; 178-212.
8. Centor, R.M., J.M. Witherspoon, H.P. Dalton *et al*, The diagnosis of strep throat in adults in the emergency room. *Med. Decis. Making*, 1981; **1**: 239-246.
9. Silk, H., *Diseases of the mouth. Prim Care*, 2014; **41**(1): 75-90.
10. Grigoriev, I.V. and A. Chirkin, Saliva as a Subject of Laboratory Diagnostics. *Medical News*, 1998; **4**: 9-12.
11. Hall, M.C., B. Kieke and R. Gonzales, Spectrum bias of a rapid antigen detection test for group A beta – hemolytic streptococcal pharingitis in a pediatric population. *Pediatrics*, 2004; **114**: 182-186.
12. Zemskov, A.M., V.M. Zemskov and V.A. Vornovsky, Typical Reaction of the Immune System in Pathological Processes. *Human Physiology*, 2001; **27**(1): 113-121.
13. Needman, C.A., K.A. McPhearson and K.H. Webb, Streptococcal pharyngitis: Impact of high – sensitivity antigen test on physician outcome. *J. Clin. Microb*., 1998; **36**: 3468-3473.
14. Shulman, S.T., A.L. Bisno, H.W. Clegg *et al*, Clinical practice guideline for the diagnosis and management of group A streptococcal pharyngitis: 2012 update by the Infectious Diseases Society of America. *Clin.Infect. Dis.*, 2012; **55**(10): 86-102.
15. Neuner, J.M., M.B. Hamel, R.S. Phillips *et al*, Diagnosis and management of adults with pharyngitis. A costeffectiveness analysis. *Ann. Intern. Med*., 2003; **139**: 113-122.
16. Rabinowitch, I.M., G.V. Banchenko, O.F. Rabinovich *et al*, The Role of Microflora in the Pathology of the Oral Mucosa. *Stomatology*, 2002; **5**: 48-50.
17. Savichuk, N.O. and A.V. Savichuk, Microecology of an Oral Cavity, Disbacteriosis and the Ways of its Correction. *Modern Stomatology*, 2002; **4**: 9-12.