

POST LARYNX RESECTION VOICE ACOUSTIC ANALYSIS

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ABSTRACT

The consonants of 26 patients, who had undergone partial resection of the larynx, were tested by the method of spectral analysis. The results of the test showed that the acoustic characteristics deviate from the norm: lack of high singing formant, the main vocal tone is lowered, the spectrum includes some additional noise components. The course of recuperative phonotherapy, including the exercises for modulation improvement and vocal range expansion allow for the rounding spectrum to coincide with the norm. However, the change of timbre does not significantly influence its endurance. The patients can continue their work with full vocal load.

At the present time the efficiency evaluation of recuperative treatment has to be substantiated by objective values. The most adequate of modern methods of analysis of the physical features of the voice is the method of spectral analysis. The consonant spectrum of a normal voice has been investigated by many authors /1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11/. Spectrographical analysis with vocal pathology was performed with cases of phonastenia /12, 13/, of rhiniphonia /14, 15, 16, 17/, of pseudovoice /18, 19/, of functional larynx disease /20/. Any reference to investigations on acoustic vocal structure after larynx resection in the available literature has not been found.

The purpose of the present investigation was to determine objective criteria for evaluate of a restored voice after larynx resection of different modifications in case of tumors by the method of spectral analysis.

The investigation has been carried out according to standard procedure together with V.I. Konarev, the engineer. Spectral analyzer F-4325 and tape-recorder "Mayak-205" were used. The subject of analysis were frequency characteristics of

the fundamental vocal tone (FO), the first (FI) and the second (FII) formants, the most semantically important and constituting the base of a speech phoneme. There were 26 patients in the age group of 21 to 67 (21 men and 5 women). Most of the people were in their working age. 17 of them underwent front-side larynx resection and 9 - chordaectomy. All patients at the time could communicate in a whisper.

The course of phonopaedy consisted of the formation of vocal sound (due to activation of the remainders of vocal organs), introduction of this voice into spontaneous speech and a course of vocal exercises aimed at development of modulations and range expansion. The results of recuperative therapy before investigations were defined as "satisfactory" and "good" by the audio method. "Satisfactory" was understood as sonorous, but low modulated voice, easily growing weak and unable to provide satisfactory communication. "Good" was understood as a sonorous steady voice, that allowed the patients to continue their work without any restrictions of their voice.

Spectral analysis revealed the following.

The main vocal tone varied within the range of 100 to 140 Hz. In the majority of cases (73%) the main tone of male voices varied from 160-250 Hz, of female voices - from 250-400 Hz. The frequency of the main vocal tone coincided with the first formant of either the patients with low modulated, rated "satisfactory" voice, or the patients whose voice had been restored almost to the normal. In the first case the patients had to have an extensive larynx surgery, and the formants of almost all of their consonants coincided infrequently and were below normal. In second case, the formant characteristics of consonants coincided with the established standards which showed the compensating abilities of anatomic and physiological larynx structures.

The first formant of almost all pa-

tients was easily analysed. The great majority of its values (64.2%) corresponded to the norm. 19.5% of patients with low harsh voices were characterised by frequency decrease. In 16.3% of cases frequency of the first formant was increased, which was peculiar to all men and women, who before the operation had a high-timbre voice.

The second formant was determined in patients with "good" modulated sonorous voices. Its parameters were determined within the normal range for some exceptions (6.3).

The results of investigations also showed that consonant spectra of patients with harsh voices varied within a wide range of 100 to 1000 Hz. In the regions of high and low frequency there appeared additional noise spectra: single ones below 100 Hz and more often on the frequency close to 10 000 Hz.

After recuperative therapy, when the patients returned to normal life, their spectrum remained wide, and though it preserved its former noise components, there appeared the components within the vocal range, the main tone and formants were distinguishable. The rounding spectrum within the vocal range was approaching normal.

The vocal spectrum of patients with poor speech before vocal exercises could not even roughly match up with the normal vocal spectrum. Only some noise components at different spectrum sections were revealed. After the treatment course with the significant voice improvement the spectrum was narrowed, additional noise frequencies disappeared.

Thus, the acoustic characteristics of consonants in the colloquial speech of patients who experienced larynx resection of different modifications and underwent a course of recuperative treatment, can coincide with acoustic characteristics of the norm, and the rounding spectrum can totally coincide with it.

Change of timbre of a voice restored after surgery can be accounted for the absence of a high singing formant in the spectrum, which makes the voice light and clear, as well as for the change of vibration frequency of the vocal source. Patients who had undergone larynx resection the range of 100-140 Hz which almost matched the frequency range of a normal voice of 200-500 Hz /6/. Lowering it in some cases to 100, 200 or 160 Hz was also peculiar to patients who had extensive larynx resections, with harsh, low voices.

Absence of correlations of resection modifications and quality of a restored voice confirm that the results of the recuperative treatment depend on the compensating abilities of a patient.

The coincidence of the rounding spectrum of the first and second formants which are semantically important and pho-

netically determining, with a variation of the norm allow to recommend the patients who underwent larynx resection and recuperative treatment to continue their work.

Thus, the spectral analysis of consonants in patients with larynx resection made it possible to provide an objective evaluation of the efficiency of recuperative therapy. Acoustic characteristics of the voice after larynx resection deviate from the norm: lack of high singing formant, the main vocal tone is lowered, the spectrum includes some additional noise components. The course of recuperative phonotherapy, including the exercises for modulation improvement and vocal range expansion allow for the rounding spectrum to coincide with the norm. However, the change of timbre does not significantly influences its endurance. The patients can continue their work with full vocal load.

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