Acoustic voice analysis following laser cordectomy

Anna Sinkiewicz¹, Hanna Mackiewicz-Nartowicz¹, Marcin Just², Piotr Winiarski³

1. Department of Phoniatry and Voice Rehabilitation, Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum in Bydgoszcz
2. DiagNova Technologies s.c. Wrocław
3. Department of Otolaryngology and Maxillofacial Surgery, Jan Biziel Memorial University Hospital in Bydgoszcz

The aim of this study was to objectively assess the voices of patients who were subjected to laser cordectomy due to early, stage T1 or T2, laryngeal cancer during 13-years follow-up.

Material and Methods

- The acoustic voice analysis included 58 male patients who were previously (1 to 13 years before the study) subjected to laryngeal microsurgeries.

Study participants were divided into three groups:

- I – patients up to one year post surgery (n=18)
- II – subjects who were operated on one to five years before the study (n=23)
- III – patients in whom surgery was performed more than 5 years before the study (n=17)
Acoustic analysis of voice:

Voice samples for the purpose of acoustic analysis were recorded in a soundproof room, using a volumetric microphone kept in a constant distance of 10 cm from examinee's mouth, plugged into a computer through a sound card.

From the set of tests for short- and long-term analyses, we used that with the double “a” vowel pronounced in isolation with prolonged phonation, and the declarative test sentence “Ten dzielny żołnierz był z nim razem”.

This sentence, due to included voiced and voiceless vowels and consonants, fricative and affricate consonants, and nasal phones, is considered representative for the Polish speech and as such sufficient for complex acoustic analysis.

Analyses were carried out with the aid of IRIS for Phoniatry software:

1) parameters of frequency changes (Jitter, RAP, PPQ)
2) parameters of amplitude changes (Shimmer, APQ)
3) parameters determining abnormalities in the harmonic structure of the voice: HPQ, HPQh, RHPQ, RHPQh and U2H, U2HL, U2Hh, S2H
4) parameter of formant intensity (R2H)
5) parameter of relative buzzing measure (NHR)
6) parameter describing the frequency and intensity distributions of voice sample (POLE)

The following dependences were analyzed:

1) cordectomy-related changes in selected acoustic parameter values
2) voice quality depending on time after surgery
3) relationship between the extent of neoplastic lesion and acoustic parameters
Reference values of normal acoustic parameters were obtained during acoustic voice analysis of 20 healthy adult males. During further analyses, acoustic parameters measured in the study group were related to these values (with values determined in the control group considered as 1).

While analyzing the relationship between acoustic parameters and time from surgery, the lowest and the highest values for every acoustic parameter were found in the study group and considered as 0 and 1, respectively. All remaining intermediate values were normalized, being assigned respective proportional values within this range.

A significant increase of nearly all parameters was noted following the surgery. The most pronounced changes were observed in cases of parameters that described the fractions of non-harmonic components (U2H, U2HL, S2H). Along with a decrease in buzzing (NHR) and a relatively weak increase in jitter, these findings suggest the generation of vibrations with regular harmonic structure, possibly originating from two separate stable sources of oscillation.

Additionally, a partial loss of long-term phonation control was observed in study participants, as confirmed by a nearly four-fold increase in the POLE parameter. The mean value of the Yanagihara scale was 2.5, i.e. nearly 1.5-fold higher compared to controls, suggesting the presence of audible hoarseness in the study group.

End of document.
Their location within the formants map corresponds to the area provided to the suitable vowel “a”.

In most parameters, there was an evident tendency towards improvement with time after the surgery, but this tendency was not statistically significant.

The most pronounced changes referred to the parameters of frequency and parameters that described the fraction of non-harmonic components (U2HI, S3H, U2H).

Marked improvement of phonation control is worth mentioning, as confirmed by the evident rapid decrease in the POLE parameter.

Moreover, insignificant improvement was observed in basal frequency (F0) and the degree of hoarseness measured using the YG scale.

Overall, mean value of all parameters determined in Group II corresponded to 66% and 62% of mean values for Groups I and III, respectively.

Changes in overall mean values of all acoustic parameters in relation to time after surgery along with a respective trend line. Statistical analysis revealed a tendency of improvement in all acoustic parameters with time after surgery as confirmed by Spearman’s coefficients of correlation.
Extent of neoplastic laryngeal lesions was scored in points, with one point corresponding to involvement of one anatomical part of the larynx (anterior comissure, anterior portion of the vocal cord, middle portion of the vocal cord, posterior comissure, area behind the vocal cords).

Changes in overall mean values of all acoustic parameters in relation to the extent of surgery. A significant relationship was observed between the extent of the neoplastic lesion and voice quality with the worst values of studied parameters associated with anterior comissure involvement.

Conclusions:

1. Acoustic analysis revealed the existence of a double vibrating system, clinically corresponding to a vibrating surgical scar and vibrations of normal vocal folds.

2. Voice acoustic analysis confirmed the loss of long-term-phonation control directly post laser cordectomy, with a tendency for significant improvement with the passage of time after surgery.

3. Relationships exist between voice quality after laser cordectomy and the extent of neoplastic lesions, as well as time since surgery.