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ELECTROGLOTTOGRAPHIC ASSESSMENT OF THE RESULTS OF MEDICAL TREATMENT OF PATIENTS WITH VOCAL CORDS POLYPS

The subject matter of this paper is a multileyered objective analysis of extipartion phonomicrosurgery in treatment of benign vocal cords lesions, assessed in electroglottographic examinations. A group of 26 patients with benign larynx lesions were included in a prospective clinical trial. All phonomicrosurgery procedures were conducted at the Department of Otolaryngology at the CM UJ in Kraków. For electroglottographic analysis the following were used: mean irregularity factor for the word "ola", and the voice profile for the vowel "a" using the mean parameter of glottis closure Qx - mean, mean frequency of glottis tone – Fx mean, Jitter factor first mean and Schimmer factor plus mean. In electroglottographic assessment after the phonomicrosurgical procedures stable improvement of the phonation function of larynx. This trial proved the usefulness of the electroglottographic examinations for the multi-layered analysis of the phonation function of glottis in diagnosis and treatment of patients suffering from vocal cords polyps.

1. INTRODUCTION

Out of many means of communication among people, no doubt speech is the most important. The importance of voice lies in the fact that its characteristic features i.e. colour, melody, intonation, purity and intensity express our personality. The quality of voice plays a vital role in our lives – it is a source of information about ourselves, has a cognitive function, sometimes determines our careers in some professions (actors, singers, speakers etc.) [7].

The most important role in the process of voice production is attributed to the vibrations of vocal folds. Vocal cords vibration allows to transform the aerodynamic energy (coming from the exhalation phase of the lower airways) into acoustic energy, that is why from the point of view of physics larynx is the equivalence of sound generator [8].

In the laryngological practice there are more and more patients with functional or organic dysphonia. It is assessed that out of all of patients complaining of voice dysfunction fifty per cent suffer from benign hypertrophic lesions of vocal cords [9]. It is closely related to the civilisational progress because of which an increasing number of people use their vocal organ in their work. The most frequent of benign hypertrophic lesions of vocal cords are polyps. Surgical treatment of vocal cords polyps consists in phonomicrosurgical procedures whose aim is a precise resection of lesions from vocal folds leaving the layers of

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vocal cords microstructure possibly unchanged. In this trial electroglottography (EGG) was used in diagnosis and treatment.

2. AIM

The aim of this trial is an objective assessment of results of phonomicrosurgery in patients with vocal cords polyps in the light of electroglottography in connection with this two questions were asked:
1. Is the improvement of phonation function of larynx reflected in the normalisation of electroglottographic parameters?
2. Does the placement of the polyp on a vocal cord influence the result of phonomicrosurgical treatment in the light of electtroglottography?

3. THE SCHEME OF PATIENT TREATMENT

1. Examination 1 (before the phonomicrosurgical treatment) assessment: laryngoscopic and electroglottographic.
2. Surgical procedure – phonomicrosurgical extirpation.
3. Histological examination.
4. Examination 2 (early control examination between 30th and 60th day after the operation assessment: laryngoscopic and electroglottographic.
5. Examination 3 (late control examination 180 days after the operation, but not later than seven months after the procedure) assessment: laryngoscopic and electroglottographic.
6. Multi-layered analysis of data from electroglottographic examination.

4. METHOD

Electroglottography (EGG) is an examination which is useful in the assessment of larynx phonation function. Its core is the registration and analysis of impedance during the vocal cords vibration. This method consists in assessing the change in electrical impedance of electric current between two electrodes situated on the surface of the throat symmetrically at the level of the alae of the thyroid cartilage.

A high frequency 0.5–10 MHz electrical current of small voltage and amperage is attached to one of the electrodes, whereas the other receives the voltage/amperage of passing electrical current. The electrical current parameters on the other electrode depend on the changes of impedance which is lower when glottis is closed and higher when it is open [1,2,5,6].

The outcoming signal of the laryngoraph Lx represents the function of vocal folds and is the basis for mapping out the basic frequency of laryngeal tone Fx in the way depicted in Fig.1.

The cycle of LX signal consists of three consecutive phases. The first one has a fast increase of the signal which corresponds to closing of vocal cords. The second phase is a slow decrease of the signal value which corresponds to the dehiscence of glottis. In the last

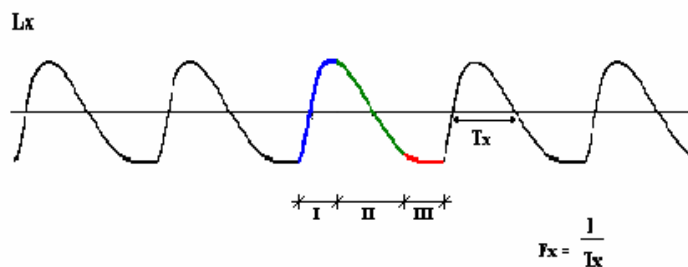third phase the value of signal is flat which is connected with the vocal cords resting i.e. open glottis.

Fig.1. A mode EGG curve (Lx) correlated with the movement of vocal folds during articulation. Formula for basic frequency (Legend: I – glottis closed; II – dehiscence of the glottis; III – glottis open)

5. REGISTRATION AND ANALYSIS OF ELECTROGLOTTOGRAPHY

Electroglottography was conducted using Laryngograph Processor PCLX with Speech Studio (Fig.2, Fig.3).

The examination consisted in placing two laryngograph electrodes on volunteers' throats – each electrode was placed symmetrically over each alae of the thyroid cartilage. In order to assess their voices each examinee read a text which consisted of vowels a, e, o, u, single words Ala, Ela, Ola, Ula, and a short sentence: *Dziś jest ładna pogoda*. (The weather today is fine.). These signals were selected on the basis of bibliography [3,4,10].

Each of the sounds was repeated three times, additionally once the vowels and single words were pronounced with lengthened phonation. The registrations were conducted three times according to the above-described trial scheme. Speech sounds emitted by examinees were directly registered using Speech Studio program, and then analysed. Finally for the electroglottographic assessment mean irregularity quotient for the word "ola" was used and the vowel "a" profile was assessed basing on the mean Qx quotient, mean Fx, Jitter first mean and Schimmer plus mean.

It is worth noticing that the choice of the word "ola" and the vowel "a" was not accidental. Earlier all vowels, words and the sentence used in the trial were analysed and calculations for them were made. When the results were averaged out, it occurred that the parameters of the word "ola" as well as the vowel "a" meet the mean values derived from calculation for the remaining sounds.
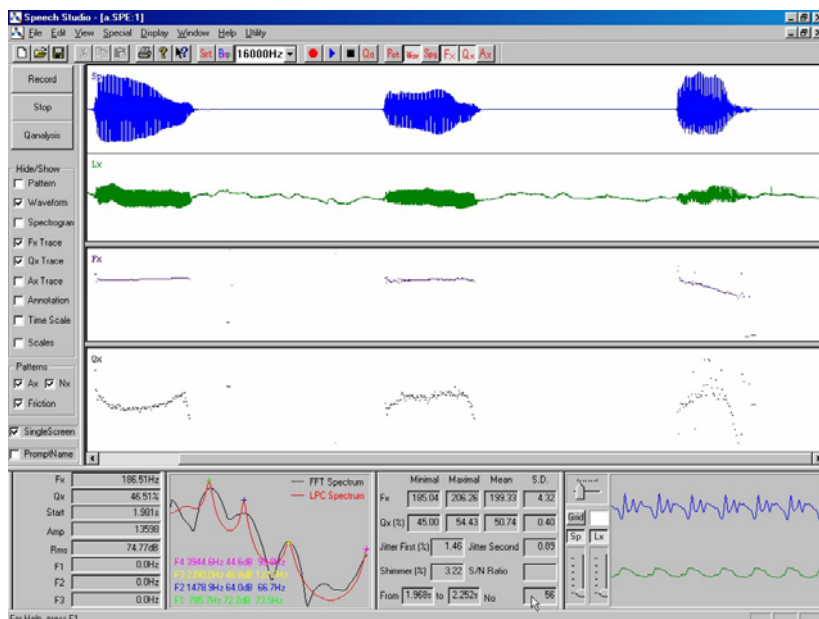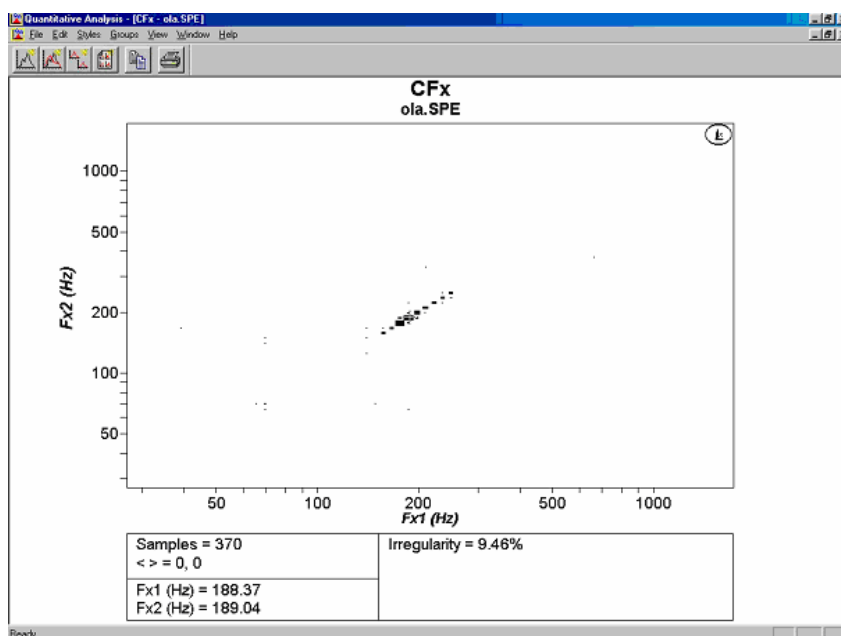
Fig.2. Speech Studio window – analysis of vowel „a"

Fig.3. Speech Studio window – histogram Cx for the word „*ola*".

6. MATERIAL

A group of 26 patients with vocal cords polyps were assesses including 10 (38.5%) women and 16 (61.5%) men aged from 19–70 years. The control group consisted of 25 persons, including 12 (48%) women and 13 (52%) men. In laryngological examination of the volunteers no pathologies of speech were found. It should be stressed that the voices of these people in a subjective assessment were average.

Patients with laryngeal polyps were divided in three groups: Group A – patients with a polyp on the 1/3 front vocal cord (13 persons), Group B – patients with a polyp on the 1/3

middle vocal cord (7 persons), and Group C – patients with a polyp on the 1/3 back vocal cord (6 persons).

Table 1. Selected EGG parameters for Group A (received in three consecutive registrations – 1, 2, 3)and for the control group k.

parameter	1	2	3	k	All groups
Irregularity[ola] mean	54,78846	27,79231	24,65231	9,90960	25,65266
Irregularity [ola] N	13	13	13	25	64
Irregularity [ola] sd	34,67580	26,69618	16,52564	7,35430	26,68471
mean Fx mean	136,6123	203,1846	18,6662	187,8632	168,5406
Fx mean N	13	13	13	25	64
Fx mean sd	51,4007	87,9361	103,2915	72,0667	77,3005
mean Qx mean	67,07000	36,17692	60,89231	49,70400	50,72516
Qx mean N	13	13	13	25	64
Qx mean sd	9,31777	13,90521	22,84208	4,41273	15,29356
Jitter first mean	7,29846	4,99077	2,70154	1,42080	7,66250
Jitter first N	13	13	13	25	64
Jitter first sd	7,63524	31,45089	1,14036	2,35816	16,86438
Shimmer plus mean	15,16385	5,09077	7,27615	5,75040	9,05719
Shimmer plus N	13	13	13	25	64
Shimme plus sd	7,457756	2,588772	9,554127	3,434405	7,259776

Table 2. Selected EGG parameters for Group B (received in three consecutive registrations – 1, 2, 3) and for the control group k.

parameter	1	2	3	k	All groups
Irregularity[ola] mean	33,91000	29,80157	12,18000	9,90960	16,93437
Irregularity [ola] N	7	7	7	25	46
Irregularity [ola] sd	29,44079	12,66225	20,52974	7,35430	17,56517
Mean Fx mean	143,6529	201,7686	217,6429	187,8632	203,0007
Fx mean N	7	7	7	25	46
Fx mean sd	53,5255	26,0682	124,6774	52,0667	81,9201
Mean Qx men	57,82143	39,70857	53,83714	49,70400	51,56891
Qx mean N	7	7	7	25	46
Qx mean sd	9,39558	12,37228	15,27172	4,41273	11,26808
Jitter first mean	20,39143	4,40429	3,04857	1,42080	5,00935
Jitter first N	7	7	7	25	46
Jitter first sd	12,12683	3,91246	0,77111	2,35816	8,32521
Shimmer plus mean	15,84143	5,92857	11,77571	5,75040	8,68652
Shimmer plus N	7	7	7	25	46
Shimmer plus sd	6,423427	1,010090	7,806617	3,434405	6,305356

Table 3. Selected EGG parameters for Group C (received in three consecutive registrations – 1, 2, 3) and for the control group k.

parametr	1	2	3	k	All groups
Irregularity[ola] mean	41,36867	25,49333	28,66880	9,90960	24,01003
Irregularity [ola] N	6	6	6	25	43
Irregularity [Ola] sd	39,85696	22,23786	29,72124	7,35430	27,63041
Mean Fx mean	126,2653	186,8833	173,9220	187,8632	192,8949
Fx N	6	6	6	25	43
Fx średnia sd	34,64195	53,01531	48,79057	52,06670	78,39834
Mean Qx mean	67,99200	65,54067	40,65067	49,70400	52,93357
Qx mean N	6	6	6	25	43
Qx średnia sd	10,86550	25,59317	11,89843	4,41273	16,40255
Jitter first mean	15,08800	5,45533	9,77400	1,42080	7,00400
Jitter first N	6	6	6	25	43
Jitter first sd	21,89276	3,99547	9,34276	2,35816	12,15820
Shimmer plus mean	12,37867	4,89667	9,05000	5,75040	8,76629
Shimmer plus N	6	6	6	25	43
Shimmer plus sd	8,295145	2,484083	9,608915	3,434405	7,314810

7. ANALYSIS OF THE ELECTROGLOTTOGRAPHIC EXAMINATION

In the statistical analysis of the examination 1 conducted before the phonomicrosurgery procedure it was found that the value of all above-mentioned parameters differ significantly from the control group k. Thus EGG examination confirms objectively the subjective assessment of the degree of deformation of the patients' speech signal. In the statistical analysis of the examination 2 conducted between 30th and 60th day after the phonomicrosurgery procedure it was found that the values of all above-mentioned parameters normalise and meet the control group k. It is reflected in the fact that in the majority of patients their voice after the procedure was subjectively assessed as better i.e. clear and less hoarse.

In the statistical analysis of the examination 3 conducted 180 days after the phonomicrosurgery procedure it was found that the value of all above-mentioned parameters differ from values from examination 2, but are still comparable to and approximate values of the parameters of control group k.

8. CONCLUSIONS

1. In the light of electroglottographic examination the effect of improvement of the phonation function of larynx after phonomicrosurgical procedures in patients with laryngeal polyps is stable.
2. Independently of the primary placement of the laryngeal polyp, the phonomicrosurgical-procedures bring about a stable improvement of the phonation function of larynx.

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