
ORIGINAL PAPER

**ACOUSTIC ANALYSIS FINDINGS IN PATIENTS
WITH VOCAL FOLD POLYP**

Mirjana PETROVIĆ-LAZIĆ **ABSTRACT**
Rade KOSANOVIĆ
Snezana BABAC

*Department of Otorhinolaryngology
Zvezdara Hospital and Clinical
Centre*

Belgrade, Serbia

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Correspondence to:

Rade Kosanović

*Department of Otorhinolaryngology,
Zvezdara Hospital and Clinical Centre,
Belgrade, Serbia*

e-mail: orl_kbcz@ptt.yu

Objective: The aim of this study was to identify effect of endolaryngeal phonomicrosurgery (EPM) in patients with vocal fold polyps on the acoustic parameters of voice by comparing their voice samples before and after EPM, with that of control group.

Methods: The acoustic tests of voice were carried out on 37 female patients with vocal fold polyp before the endolaryngeal phonomicrosurgical intervention (EPM) and after its completion. Acoustic parameters of voice were compared with the control group without voice pathology. The results of the investigation were analyzed acoustically.

Results: It has been proved that jitter (%), shimmer (%), vFo, VTI, PPQ, APQ and HNR values significantly differentiate the patients with polyps of vocal fold from control group without pathological changes in the larynx. All of the analyzed parameters improved significantly after the phonomicrosurgical intervention and tend to approach normal values.

Conclusion: The acoustic analysis of voice may be used for evaluation of the presurgical and postsurgical voice status.

Keywords: *acoustic vocal analysis, vocal polyps, voice, phonomicrosurgery*

INTRODUCTION

Vocal polyps can vary in size, shape and color. Some polyps are roundish, limited, pedunculated, while some can be attached on a wider stem covering larger part of vocal cords.¹ In size, they vary from a pinhead, to those of a corn grain. They are usually located on the loose end of vocal fold. They are usually unilateral. Vocal polyps are usually caused by inflammatory or noninflammatory irritation and by vocal over use. The clinical features are dominated by more or less prominent hoarseness, depending on the size or position of the polyps. Vocal polyps are usually removed surgically, after which the patient is referred to a vocal therapist who is then to decide on the necessity, type and duration of vocal therapy.

In view of the phonation complexity and of vocal folds structure, it is necessary to plan the implementation of phonosurgical procedure very carefully and for

each patient individually, since such procedure sometimes is not justified. It is also vital to determine right timing for the procedure.

The attempts of objective acoustic evaluation of pathologic voice have been performed for about 20 years. The computerized multidimensional acoustic voice analysis enables visual and numeric information on the analyzed voice. The aim of such analysis is to provide impartial data and to support subjective voice evaluation. It facilitates comparison of data and serves as an additional resource in diagnostics and voice rehabilitation.³⁻⁵

The aim of the investigation was the acoustic analysis of voice in patients with vocal polyps, before and after the endolaryngeal phonomicrosurgery (EPM). It is necessary to determine to what extent the polypus on vocal fold impairs voice and what impact the phonosurgical intervention has on the acoustic structure of voice.

Table 1. Predisposing factors for vocal folds polyp development

Predisposing factors	Yes		No	
	N	%	N	%
Vocal over use	28	75.67	9	24.33
Allergy	21	56.76	16	43.24
Smoking	19	51.35	18	48.65
Smoking and vocal over use	9	24.32	28	75.68
Allergy and smoking	7	18.92	30	81.08
Smoking, allergy, and vocal over use	3	8.12	34	91.88

MATERIALS AND METHODS

The study included patients from Department of Phoniatry and Audiology, ENT Clinic, Zvezdara University Clinical and Hospital Centre. The studied group included 37 female patients aged 18-61 (mean 48.43 ± 9.21) with polyps on vocal folds. Control group included 21 patients aged 21-61 (mean 47.57 ± 9.23), who did not have any vocal complaints nor laryngeal pathology. Control group was stratified by gender and age. To verify that control and patients group were comparable, with regard to age, Chi square test- χ^2 was conducted between the two groups. No significant differences was found ($p > 0.05$).

All participants were checked up by an otorhinolaryngologist, and subsequently by a vocal therapist. After both check-ups, a voice recording was made. We were using the computerized voice analysis laboratory "Kay Elemetrics" (Multi-dimensional Voice Program). The research was carried out individually while the subject was seated in a quiet room. Microphone was placed at 5.0 cm distance from the patient's mouth. For credibility of the results, each group repeated the sustained vowel /a/ at their habitual pitch and loudness level for at least 3 s durations, three times, of which, the one with mean value was considered relevant for

the analysis.

Seven acoustic parameters were measured: fundamental frequency variation (vFo), frequency perturbation measure (Jitter %), amplitude perturbation measure (Shimmer %) two noise indices: NHR (Noise-to-Harmonic-Ratio) and VTI (Voice Turbulence Index), pitch perturbation quotient (PPQ %), amplitude perturbation quotient (APQ %)

Voices of vocal fold polyp group patients were recorded and evaluated twice: before the EPM and in the three weeks postsurgical period.

A statistical analysis was performed with the SPSS 10.0 for Windows (SPSS Corporation, Chicago, IL). Methods of descriptive and analytic statistics were used in describing and analyzing the data obtained during the investigation. When it comes to descriptive statistics methods, in our research we applied the measures of central tendency, variability, and tables. In analytic statistics, for assessment of the impact of difference, the Student's paired-sample t-test was used for parametric data, while Wilcoxon signed-ranks test-W and Chi square test - χ^2 were used for nonparametric data. Significance levels were 95%.

Table 2. Average values of acoustic voice parameters in patients' and control group

Acoustic Voice Parameters	Patients n=46		Control Group n=21		Difference		Probability p
	Mean	SD	Mean	SD	Absolute	%	
Jitter (%)	1.986	1.387	0.509	0.168	1.477	74.37	$p < 0.01$
Shimmer (%)	5.647	2.457	1.845	0.439	3.802	67.33	$p < 0.01$
vFo (Hz)	2.096	1.241	1.117	0.439	0.979	46.71	$p < 0.01$
HNR (dB)	0.158	0.042	0.111	0.008	0.116	73.42	$p < 0.01$
VTI	0.065	0.027	0.044	0.014	0.021	32.31	$p < 0.01$
PPQ (%)	1.191	0.850	0.319	0.148	0.872	73.22	$p < 0.01$
APQ (%)	4.156	2.156	1.102	0.365	3.054	73.48	$p < 0.01$

Table 3. Average values of acoustic voice parameters before and three weeks after phonomicrosurgery

Acoustic Parameter	Mean (SD)		Difference		Probability p
	Preoperative	Postoperative	Absolute	%	
Jitter (%)	1.986±1.387	0.562±0.251	1.424	71.70	p<0.01
Shimmer(%)	5.647±2.457	1.983±0.643	3.664	64.88	p<0.01
vFo (Hz)	2.096± 1.241	1.195±1.172	0.901	42.97	p<0.01
HNR (dB)	0.158±0.042	0.112±0.009	0.046	29.11	p<0.01
VTI	0.065±0.027	0.049±0.014	0.016	24.62	p<0.01
PPQ (%)	1.191±0.850	0.322±0.156	0.869	72.96	p<0.01
APQ (%)	4.156±2.156	1.397±0.392	2.759	66.39	p<0.01

RESULTS

The most frequent predisposing factors which may influence the emergence of vocal fold polyp were vocal over use in people who are using their voices professionally (75.67%), and upper airway allergies (56.76%), followed by smoking (51.35%). Also we were found out more than one predisposing factors in some cases (Table 1).

The performed acoustic analysis proved that in the patients group before phonomicrosurgical treatment, the mean values of employed parameters in study were: Jitter (%) 1.986, Shimmer (%) 5.647, vFo (Hz) 2.096, NHR (dB) 0.158, VTI 0.065, PPQ (%) 1.191, APQ (%) 4.156. In the control group, the analyzed parameters were the following: Jitter(%) 0.509, Shimmer (%) 1.845, vFo (Hz) 1.117, NHR (dB) 0.111, VTI 0.044, PPQ (%) 0.319, APQ (%) 1.102. The mean values and standard deviations of the acoustic voice parameters in the group of patients and in the control group are presented in Table 2. The obtained values in the patient's group were higher than in the control group. These group differences were statistically significant for the all parameters (p<0.01). A minimal value of

Jitter (%) was 0.552, a maximal value was 5.232. For Shimmer (%) these values were 1.820 and 10.180. In the control group minimal value for jitter was 0.180, maximal 0.821, and for shimmer 1.253, 3.511.

Table 3. shows preoperative and postoperative mean values and standard deviations as well as differences in absolute values and in percents of each acoustic parameter employed in study. After phonomicrosurgical treatment, in the patient's group, mean values of employed parameters in study were: Jitter (%) 0.562, Shimmer (%) 1.983, vFo (Hz) 1.195, NHR (dB) 0.112, VTI 0.049, PPQ (%) 0.322, APQ (%) 1.397. We observed statistically significant differences (p<0.01) between the indices as measured from preoperative to postoperative performance.

We did not find statistically significant differences (p>0.05) between the patients' postoperative values and control group concerning means of jitter, shimmer, vFo, HNR, VTI, PPQ, APQ (Table 4).

DISCUSSION

Similar to our results, Doyle et al. also, found connection between smoking, vocal over use, allergy as a predisposing factors, and vocal fold polyp.⁶

Table 4. Average values of acoustic voice parameters in patients' group three weeks after phonomicrosurgery in comparison to values in control group

Acoustic Parameter	Mean (SD)		Difference		Probability p
	Postoperative	Control Group	Absolute	%	
Jitter (%)	0.562±0.251	0.509±0.168	0.053	9.43	p>0.05
Shimmer (%)	1.983±0.643	1.845±0.439	0.138	6.96	p>0.05
vFo (Hz)	1.195±1.172	1.117±1.243	0.078	6.53	p>0.05
HNR (dB)	0.112±0.009	0.111±0.008	0.001	0.89	p>0.05
VTI	0.049±0.014	0.044±0.014	0.005	10.20	p>0.05
PPQ (%)	0.322±0.146	0.319±0.148	0.003	0.93	p>0.05
APQ (%)	1.397±0.392	1.102±0.365	0.295	21.12	p>0.05

The primary focus of this study was on the effect of polyp vocal fold to voice quality and to evaluate effect of phonosurgery on the voices. Measurements of acoustic voice parameters have been used in several studies for the objective assessment before and after phonosurgical voice status.⁷⁻⁹

The Parameters monitored in the procedure of vowel analysis were chosen because of their frequent usage in the studies.^{3,5,6,10,11} The most important vocal acoustic parameters for clinical use are measurements of noise-to-harmonic values, fundamental frequency and perturbation index - jitter and shimmer.^{12,13}

Our results suggested that voice quality significantly improved after EMP in all patients. This finding was consistent for all acoustic parameters, employed in study. In that respect, our findings support earlier studies.^{11,14,15} Increased values of jitter, shimmer, have been associated with changes in dysphonia and various laryngeal pathologies.^{16,17} We noticed higher mean values of all parameters in patients group than in control group.

Our results showed that successful phonomicrosurgical treatment of laryngeal disease leads to a decrease in values of most parameters. In all patients, it was postoperatively determined that there was not any need for vocal rehabilitation, since the phonation automatisms were not seriously impaired.

Analysis of these parameters gives clinicians a better understanding of the impact of voice disorders and the efficiency of phonomicrosurgery interventions. Thus, according to the data presented, acoustic voice parameters considered to reflect hoarseness, roughness, and breathiness of voice improved considerably after surgery.

CONCLUSIONS

The multidimensional voice analysis enables more precise, easier and faster examination, registering and processing of data related to the acoustic structure of voice. The disturbed acoustic structure of the analyzed vowel in examinees with vocal fold polyps has improved significantly following the phonosurgical procedure.

The results obtained in the study showed that the acoustic structure of vowel A differs in all of tested parameters before and after the surgical procedure.

The obtained results show that the acoustic structural changes are result of altered vocal mechanisms. The modern life style imposes great vocal demands on people, for which they are not sufficiently prepared both psychologically and physically, and at the same time, studying correct phonation automatisms has not been addressed with appropriate attention.

The research has shown that with the correct di-

agnostics of patients with the vocal fold polyps, it is possible to completely improve the disturbed acoustic structure of voice applying the phonosurgical procedure.

REFERENCES

1. Petrovic-Lazić M. Voice therapy. Science book, Belgrade, Serbia 2001.
2. Uloza V, Saferis V, Uloziene I. Perceptual and Acoustic Assessment of Voice Pathology and the Efficacy of Endolaryngeal Phonomicrosurgery. *J Voice* 2005;19 (1): 139-45.
3. Deliyski D. Acoustic model and evaluation of pathological voice production. Proceedings of the 3rd Conference on Speech Communication and Technology Eurospeech 93. Berlin, Germany 1993.
4. Petrovic-Lazic M. Spectral analysis of I vowel sound in speech disorder before and after voice therapy (In Serbian). Belgrade defectology school, N. 1, Belgrade, Serbia 1995; 67-73.
5. Petrović-Lazić M, Dobrota N, Jovanovic-Simić N. Multidimensional analysis of vowels in functional dysphonia. 27th World Congress of the International Association of Logopaedics and Phoniatrics, Technical University Denmark 2007; 173.
6. Doyle P, Perkell JS, Hammarberg B, Hillman RE. Aerodynamic and acoustic voice measurements of patients with vocal nodules: Variations in baseline and changes across voice therapy. *J Voice* 2003; 17: 269-82.
7. Giovani A, Revis J, Triglia JM. Objective aerodynamic and acoustic measurement if voice improvement after phonosurgery. *Laryngoscope* 1999; 109:656-60.
8. Van Lierde K, Moerman M, Vermeersch H, Van Cauwenberge P. An introduction to computerized speech lab. *Acta Oto-Rhino-Laryngologica Belg* 1996;50:309-15.
9. Laver J, Hiller S, Beck JM. Acoustic waveform perturbations and voice disorders. *J Voice*.1992;6:115-26.
10. Holmberg EB, Hillman RE, Hammarberg B, Sodersten M, Doyle P.: Efficacy of a behaviorally based voice therapy protocol for vocal nodules. *J Voice* 2001; 15: 395-412.
11. Horii Y. Jitter and shimmer in sustained observed in sustained phonation. *Folia Phoniatrica* 1985; 37:81-6.
12. Behlau M, Madazio G, Feijó D, Pontes P. Avaliação da Voz. In: Behlau M (org.) *Voz - O Livro do Especialista*. Vol. I. Rio de Janeiro: Revinter; 2001. Cap. 3, 86-180.
13. Kandogan T, Seifert E. Influence of aging and sex on voice parameters in patients with unilateral vocal cord paralysis. *Laryngoscope* 2005;115:655-60.
14. Halberstam B.: Acoustic and perceptual parameters relating to connected speech are more reliable measures of hoarseness than parameters relating to sustained vowels. *J Otto Rhino Laryngol* 2004; 66:70-3.
15. Sorenson D, Horii Y. Frequency and amplitude perturbation in the voice of female speakers. *J Commun Dis* 1983; 16:57-61.
16. Vieira MN, McInnes FR, Jack MA. On the Influence of laryngeal pathologies on acoustic and electrographic jitter measures. *J Acoust Soc Am*. 2002; 111: 1045-55.
17. Hartl DM, Hans S, Vaissiere J, Riquet M, Bransnu DF. Objective voice quality analysis before and after onset of unilateral vocal fold paralysis. *J Voice*. 2001;15:351-61.