

Phonatory characteristics following different surgical techniques in the treatment of Reinke's edema

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Key words: Reinke's edema, endolaryngeal microsurgery, quantitative voice assessment.

Summary. The aim of the study was to compare different surgical techniques in treatment of Reinke's edema according to subjective and quantitative changes of voice characteristics.

We evaluated 62 surgically treated patients from 34 to 68 years (mean 47.7 years) with Reinke's edema. Two endolaryngeal microsurgical methods were used: classical as mechanical stripping of the mucosa – Ist, mechanical stripping group (n=30), and removal of fluid through aspiration with preservation of vocal cord medial edges mucosa – IInd, preserving mucosa group (n=32). Clinical voice assessment was composed of laryngoscopy, subjective voice evaluation (GRBAS hoarseness scale, visual analogue scale of voice quality, and pitch) and quantitative voice evaluation (seven quantitative voice parameters obtained from voice range profile (VRP) and registering of maximum phonation time). Patients were evaluated twice – before operation and at mean 23.8 days after. Postoperative follow-up data was registered from 57 patients: 28 from Ist and 29 from IInd groups.

According to our data the positive dynamics for all voice parameters was observed in both patients' groups. Surgical approach with preservation of vocal cord medial edges mucosa on overall benefit after operation according to the voice quality is statistically significantly better compared to classical operation technique ($\chi^2=8.9$, $p=0.029$). While comparing these two approaches statistically significant differences were found for subjective voice parameters – grades of hoarseness and roughness, and for quantitative VRP parameters: pitch range, maximum–minimum intensity range, total voice area, and overall vocal dysfunction degree. The mean values of most voice parameters in early postsurgery period significantly differed from normal. Clinical voice assessment may be useful for evaluation of surgical treatment efficacy as well as for comparison of surgical techniques.

Introduction

Reinke's disease is a chronic, benign laryngeal disease of the superficial layer of the vocal cord (VC) lamina propria in which there is a buildup of fluid in the submucosal lining of Reinke's space. The first to describe this layer of VC and the edema were M. Hajek and F. Reinke in the end of the 19th century (1). Further investigation of the microstructure of the vocal cord has shown that the subepithelial space is one of main elements in the phonation mechanism (2). The disease is associated with smoking, vocal abuse, and with reflux (1). It accounts for 4–17.5 percent of the surgical diseases of the larynx and the incidence is constantly growing, as the disease is precipitated by the nowadays increasingly popular causing factors, as much as because of the improving diagnostic measures

(3,4). The main method of treatment is surgical. Three surgical approaches can be distinguished: 1) classical, when the hyperplastic mucosa of the medial edge of the VC is excised; 2) preserving the mucosa of the medial edges of VC, when the contents of the Reinke's space is aspirated; 3) and the laser coagulation of the subepithelial layer (1,5-7). Although, every technique has its own advantages and shortcomings, the two latter measures are more up-to-date. There are few studies that would compare the different methods. Most of those analyze small numbers of patients and are mostly set towards the laser therapy. Only subjective parameters and speaking fundamental frequency, also changes of jitter (pitch perturbation) are mostly analyzed, and there is a lack of thorough quantitative assessment of the postoperative results.

The aim of this study was to evaluate and compare the results of the different surgical methods of the Reinke's disease, according to the changes of the subjective and quantitative voice characteristics.

Material and methods

Sixty-two patients aged from 34 to 68 years (mean 47.7 ± 7.3) with Reinke's edema (30 males and 32 females) surgically treated in Kaunas University of Medicine Hospital ENT department during 1992–2001 were evaluated. According to endolaryngeal microsurgical methods we used, patients were divided into two groups. The patients of the first group underwent mechanical stripping of the VC mucosa (mechanical stripping group) ($n=30$), the patients of the second one – a removal of fluid through aspiration with preservation of VC medial edges mucosa (preserving mucosa group) ($n=32$) (Fig. 1). Postoperatively, patients were asked to remain on strict voice rest for at least 1 week and were continued on a rigorous antismoking and antireflux protocol. Patients were evaluated twice – before the operation and after an average of 23.8 days. At the follow-up 57 patients were evaluated - 28 (12 male and 16 female) from the Ist group and 29 (15 male and 14 female) from the IInd group. Control group consisted of 122 healthy voice persons (confirmed perceptually and on laryngoscopy) randomized selected from volunteers aged 18-67 years (mean 34.1 ± 11.3), 34 being male and 88 female. Patients and control

group were matched according to the professional voice training (untrained voice persons were selected).

Voice assessment. Complex evaluation of the patients included laryngoscopy, subjective and quantitative voice assessment. Laryngoscopy was performed using laryngeal mirror or transoral rigid (Kay Elemetrics 70°) endoscope (videolaryngoscopy). The extension of vocal cord edema was stated according H. Yonekawa et al. (8) clinical three-type classification (1992). Type I: edematous swelling is observed on the upper surface of the vocal folds, while potency of glottis is adequately preserved. Type II: edematous swelling extends from the upper to the lower surface beyond the margins of both vocal folds, which are partly in contact with each other. Type III: edematous swelling is further advanced so that opening can be seen only at the posterior portion of the glottis.

Subjective voice assessment. Vocal assessment was carried out by two experts. Subjective judgments of voice quality were made on 1) pitch (adequate, too high, and too low); 2) presence of hoarseness, evaluated according to GRBAS hoarseness scale (three items of the scale were assessed: G– grade of hoarseness, R– roughness, S- strain quality, according to the 4 point severity scale (0 – none, 1 – mild, 2 – moderate, 3 – severe)); and 3) voice quality according visual analogue scale (VAS) of 100mm, where a score of '0' means normal voice, and 100 mm (points) means extreme voice deviance (9). The quantitative evalua-

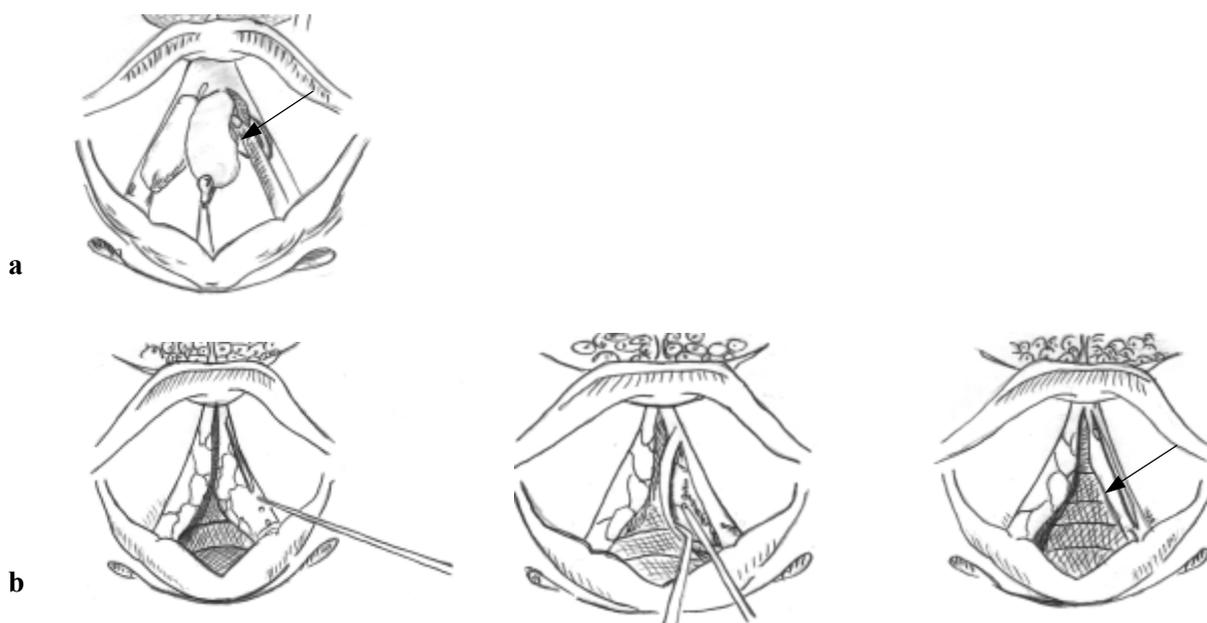


Fig 1. Different surgical approaches in Reinke's edema:
a) mechanical stripping of the vocal cord mucosa, b) removal of fluid through aspiration with preservation of vocal cord medial edges mucosa.

tion in points was obtained measuring the marked segment with rule.

Quantitative voice assessment. Quantitative voice parameters were obtained from two voice tests – combined voice range profile (VRP) and registration of maximum phonation time (MPT). VRP is recording of minimum and maximum phonatory sound level as functions of fundamental frequency. With habitual speaking fundamental frequency recording in addition it composed combined VRP. VRP was registered in an ordinary 5x3 m room (the noise level did not exceed 40 dB (A)) in a classical way (by hand), according to the recommendations of the Union of European Phoniatrists. The pitch range was measured with the help of electronic keyboard (Fujiyama 3 A) in a range of 4 octaves in a manner of half tone step. Sound pressure level (SPL) was determined from a sound pressure level meter (VEB Robotron), using the slow meter damping and A weighted frequency scale – dB (A). A constant microphone distance of 30 cm from the mouth was held. Only precisely corresponding sounds, sung 2 sec. at least were registered. We used a modified by squares registration form (10). Speaking fundamental frequency was registered in the same manner by counting from 1 to 30. Five quantitative VRP parameters were analyzed: 1) pitch range (PR), measured in semitones (st); 2) maximum-minimum intensity range (max. -min. IR) in dB (A); 3) total VRP area in squares (A_{Total}), measured in cm^2 ; 4) area in range of high frequency (A_{High}), originally calculated parameter as part of total area, measured in cm^2 ; 5) speaking fundamental frequency (SF_0), measured in Hertz (Hz). Overall vocal dysfunction degree (VDD) was calculated from the most informative four VRP parameters (PR, max.-min. IR, A_{Total} , A_{High}) according to the original rules from 0⁰ (norm) to III⁰ (severe dys-

function) (10). Maximum phonation time (MPT) was registered by clock from the longest-sustained /a/ vowel in sec.

Overall benefit after operation according to the voice quality was determined as 1) healthy voice (healthy voice on subjective and quantitative evaluation ($G=0$ and $VDD=0$), or one of tests is not more than first degree of damage); 2) much better (VDD is shifted to the normality by two degrees); 3) better (VDD is shifted by one degree); 4) no change.

Statistical analysis was performed with SPSS 10 for Windows. The unpaired t-test was used for comparing differences between groups in parametric data, Mann-Whitney U and χ^2 test – in nonparametric data. Paired-sample t-test was used to evaluate the differences in the same group before and after treatment in quantitative voice assessment. Wilcoxon and χ^2 tests – differences in nonparametric data. A significance level of $p \leq 0.05$ was used.

Results

At the baseline the patient groups were close by age – the mean age of the Ist group was 46.9 ± 6.8 years, the IInd - 48.6 ± 7.6 years ($p > 0.05$), and gender proportions ($p > 0.05$). Most of the patients - 79% (49/62) in both groups, equally males and females, were active smokers. Laryngoscopic evaluation revealed that patients from both groups mostly had bilateral edema of IInd or IIIrd type – 76.6% (23/30) and 81.2% (26/32) respectively ($p > 0.05$). There was no significant difference in duration of illness, time of the follow-up, grade of hoarseness and VDD before operation between the patient groups (Table 1). Five subjects failed to show-up at the control follow-up: two males from the Ist group, and one male and two females from the IInd group. Excluding the data of these

Table 1. Baseline characteristics according to surgical treatment group

Data		I group (n=30)	II group (n=32)	χ^2/F	df	p
Duration of illness (year, mean \pm SD)		3.0 \pm 2.8	1.97 \pm 1.5	/3.47	1	ns
Time of follow-up (days, mean \pm SD)		19.0 \pm 23.0	28.5 \pm 20.0	/2.81	1	ns
Bilateral edema (proc./n)		83.3/25	93.7/30	1.677	1	ns
Grade of hoarseness G (%/n)	II	26.7/8	40.6/13	0.764	1	ns
	III	73.3/22	59.3/19			
Vocal disfunction degree (%/n)	II	40.0/12	50.0/15	2.172	3	ns
	III	46.9/15	34.4/11			

SD – standard deviation, ns – not significant difference. I group – mechanical stripping group, II group – preserving mucosa group.

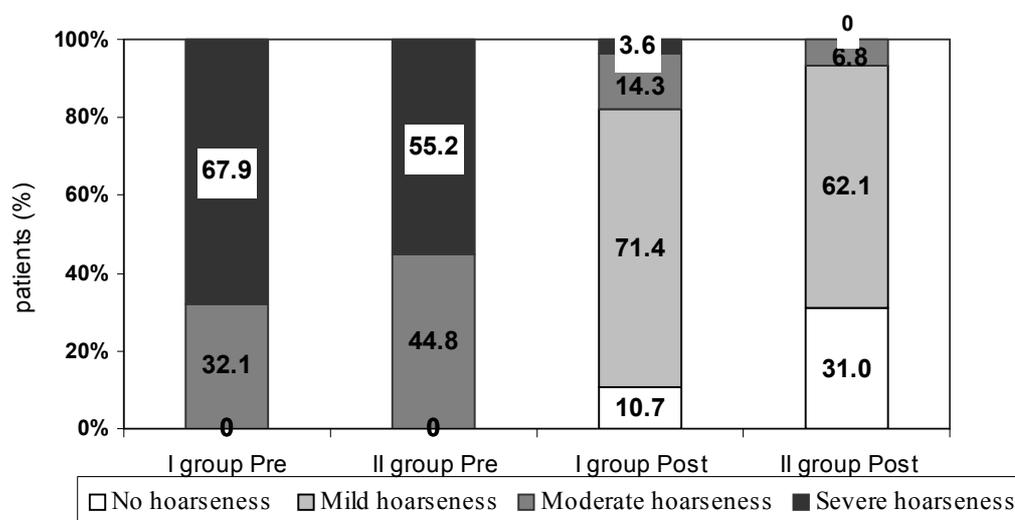


Fig 2. Distributions of grade of hoarseness according to GRBAS scale following different surgical approaches for Reinke's edema

Pre – presurgery data, post – postsurgery data; I group – patients who underwent mechanical stripping of the vocal cord mucosa, II group – patients who underwent removal of fluid through aspiration with preservation of vocal cord medial edges

Table 2. Results of subjective voice assessment according to GRBAS scale following different surgical approaches for Reinke's edema

Parameters	Data (mean, Md/Mo)								$p_{I-IIgr.} <$
	I group				II group				
	pre (n=30)		post (n=28)		pre (n=32)		post (n=29)		
G points	2.7	3/3	1.1	1/1	2.6	3/3	0.8	1/1	0.038
	p<0.000				p<0.000				
R points	2,5	3/3	1.0	1/1	2.3	2/2	0.6	1/1	0.005
	p<0.000				p<0.000				
S points	0.7	0.5/0	0.5	0/0	0.6	0.6/0	0.3	0/0	ns
	p<0.064				p<0.004				

Md – median, Mo – mode, ns – not significant. I group – mechanical stripping group, II group – preserving mucosa group. Pre – presurgery data, post – postsurgery data.

individuals, the differences in the group and between groups did not change significantly.

Subjective voice assessment. The voice was judged as improved in mostly cases in both patient groups. Results of subjective judgments of voice quality according GRBAS scale are summarized in Fig 2, and Table 2. The most statistically significant improvements were accounted for by reductions in grade of hoarseness and roughness ($p<0.0005$), however, reduction of grade in strain quality of voice was significant only for the patients operated by preserving mucosa technique (IInd group) ($p<0.004$). Healthy voice according GRBAS hoarseness scale was stated for 3

of 28 (10.7%) in Ist, and for 9 of 29 (31.0%) in IInd group patients.

Mean postoperative voice quality values assessed by experts according 100mm VAS scale were on average 26.6 ± 17.6 points for Ist group patients, and 20.5 ± 12.8 points for IInd group patients, equally in males and females (100 points shows extreme voice deviance). The changes were significant in both groups ($p<0.0001$).

Lower than normal vocal pitch was stated for 15 patients (53.6%) of Ist and 17 patients (58.6%) of IInd group. Six of 15 patients (5 female and 1 male) in the Ist group and 8 of 17 patients (7 female, and 1 male) in

Table 3. Results of quantitative voice assessment following different surgical approaches for Reinke's edema in male subjects

Parameters	I group		p<	II group		p<	Controls	p<
	pre (n=14) $\bar{X} \pm SD$	post (n=12) $\bar{X} \pm SD$		pre (n=16) $\bar{X} \pm SD$	post (n=15) $\bar{X} \pm SD$		(n=34) $\bar{X} \pm SD$	
PR st.	20.8±2.9	25.5±5.9	0.020	22.3±4.4	28.9±3.6	0.000	33.7±3.1	0.000
Max.-min. IR dB (A)	29.8±4.7	34.1±5.4	0.025	27.8±5.8	37.1±3.0	0.000	45.1±4.2	0.000
A _{Total} cm ²	11.4±3.6	16.7±6.2	0.006	12.4±5.0	18.9±3.4	0.000	26.5±3.1	0.000
S _{High} cm ²	0.2±0.7	1.4±2.4	nr	0.3±0.9	1.8±1.6	0.002	5.8±2.7	0.000
SF ₀ Hz	101.3±43.8	111.4±25.7	nr	111.0±32.1	123.6±23.5	0.044	113.2±16.4	ns
MPT sec.	11.3±5.7	16.6±9.3	nr	14.7±4.7	19.7±3.9	0.000	29.9±9.2	0.000

Pre – presurgery data, post – postsurgery data, \bar{X} – mean, SD – standard deviation, ns – not significant. I group – mechanical stripping group, II group – preserving mucosa group.

Table 4. Results of quantitative voice assessment following different surgical approaches for Reinke's edema in female subjects

Parametrai	I group		p<	II group		p<	Controls	p<
	pre (n=16) $\bar{X} \pm SD$	post (n=16) $\bar{X} \pm SD$		pre (n=16) $\bar{X} \pm SD$	post (n=16) $\bar{X} \pm SD$		(n=88) $\bar{X} \pm SD$	
PR st.	17,7±5,7	21,1±4,1	0,002	20,3±4,2	24,8±2,3	0,000	29,1±3,4	0,000
Max.-min. IR dB (A)	24,2±5,6	30,3±5,4	0,000	26,7±4,2	33,3±3,0	0,000	42,6±3,8	0,000
A _{Total} cm ²	8,0±4,6	11,6±4,5	0,000	9,9±2,9	14,7±2,3	0,000	21,8±3,2	0,000
S _{High} cm ²	0,1±0,4	0,2±0,6	ns	0,1±0,3	0,4±0,6	0,046	4,6±1,7	0,000
SF ₀ Hz	178,9±33,3	196,3±24,4	ns	165,2±32,5	181,3±24,0	0,047	212,0±24,1	0,000
MPT sec.	12,3±7,0	16,2±6,8	0,006	13,1±6,6	15,7±6,4	ns	22,5±5,5	0,000

Pre – presurgery data, post – postsurgery data, \bar{X} – mean, SD – standard deviation, ns – not significant. I group – mechanical stripping group, II group – preserving mucosa group.

the IInd group were considered still to have abnormal low vocal pitch postsurgically. The differences between the different treatment groups were significant for grade of hoarseness (U p<0.038, χ^2 p<0.06) and roughness (U p<0.005, Fisher's exact test p<0.02). Voice was significantly better in the patients operated with preservation of VC medial edges mucosa. With respect to sex, the results were better in males. Voice quality in early postsurgical period significantly differed from normal for both group patients (p<0.001).

Quantitative voice assessment. Positive changes of all quantitative parameters after surgery, as well as in subjective assessment, were registered in both groups of patients (Tables 3, 4). Statistically significant (p<0.0005) changes of the average values of combined voice range profile parameters for both group patients were stated in three of five parameters – the pitch range, max.-min. intensity range and total VRP area – 3.7 st, 5.12 dB (A), and 4.2cm² in the Ist group, and 5.6 st, 8.0 dB (A), and 5.7cm² in the IInd group respectively (Table 5). The changes were greater for patients, who underwent the mucosa preserving sur-

gery (IInd group) as the postoperative data of these parameters varied between the groups significantly: for the pitch range p<0.002, for max.-min. intensity range p<0.01, for total VRP area p<0.02. Postoperative increasing in mean values of VRP area in high frequencies as well as in speaking fundamental frequency were significantly only for the IInd group patients for both genders (p<0.05). Average values of MPT increased significantly in both groups (p<0.05).

Reduction in overall vocal dysfunction degree was significant for both patients groups, but significantly better results were found for the IInd group patients (p_{I-IIgr.} <0.008). Quantitatively defined healthy voice (VDD=0) at follow-up was stated for 3 of 28 (10.7%) patients in Ist group and 9 of 29 (31.0%) in IInd group. The third vocal dysfunction degree (VDD=3) persisted only in 7 (25%) patients, who underwent mechanical stripping of VC mucosa. No significant difference was found in the changes of the means of quantitative parameters in comparison of male and female results (Tables 3, 4). Comparing the postoperative results with respect to different surgical techniques (among the

Table 5. Quantitative parameters that showed statistically significant difference in changes while comparing different surgical approaches

Parameters	Total			Males			Females		
	I gr.	II gr.	p<	I gr.	II gr.	p<	I gr.	II gr.	p<
	$\Delta \bar{X}$	$\Delta \bar{X}$		$\Delta \bar{X}$	$\Delta \bar{X}$		$\Delta \bar{X}$	$\Delta \bar{X}$	
Pitch range st.	3.7	5.6	0.002	4.6	6.5	ns	3.3	4.5	0.005
Max.–min.IR dB (A)	5.0	7.9	0.008	4.2	9.2	0.05	6.2	6.6	ns
Total VPR area cm ²	4.3	5.7	0.021	5.3	6.5	ns	3.6	4.9	0.024

$\Delta \bar{X}$ changes of means, ns – not significant difference. I group – mechanical stripping group, II group – preserving mucosa group.

groups) a greater difference was found in women (Table 5). The mean values evaluated in early postoperative period of almost all VPR parameters as well as MPT had not returned to within the normal range for both group patients and differed significantly as compared to control group ($p < 0.05$). Only mean SF_0 values for counting were in normal range for male subjects in both patients groups.

According to stated criteria for overall benefit, 12 patients (3/28 – Ist group, and 9/29 IInd group) were classified as healthy; no change was stated for 5 Ist group patients (Fig 3). Comparison between the patient groups showed significantly better results in the IInd group patients using preserving mucosa operation technique ($\chi^2 = 8.9$, $p = 0.029$).

Discussion

The impairment of the layered structure of the VC causes hoarseness, specifically the rough character of it. The goal of the endolaryngeal microsurgery is to reconstruct the impaired structure of layers in the VC, by exposing the VC to a minimal trauma (2, 11). In the

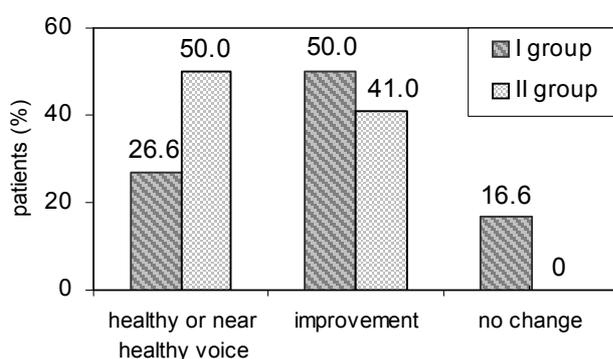


Fig 3. Outcomes of voice quality in early postsurgery period following different surgical approaches for Reinke's edema.

I group – mechanical stripping group, II group – preserving mucosa group. Difference between data of patients groups is statistically significant ($p < 0.05$).

early stages of the disease (edema type I), the surgery is usually performed by aspirating the contents of the Reinke's space and preserving mucosa of the medial edges of VC. However, in edema type III, sometimes II, the classic technique of surgery usually has to be considered. To evaluate objectively and to compare the effectiveness of the treatments, which is highly important in validating the indications for the surgical treatment and in avoiding misunderstandings between the physician and patients, a quantitative evaluation of results is needed.

Our studies have shown that subjective and quantitative results of the complex voice evaluation confirm a statistical difference between the data before surgery and after both types of endolaryngeal microsurgical operations. The parameters of the combined voice range profile – the pitch and the maximum-minimum intensity range, total VPR area in squares and the overall vocal dysfunction degree were the most useful in following the effectiveness of the surgical treatment and in comparing the different surgery techniques. The value of these parameters is affirmed by earlier studies done in Lithuania (12,13). The dynamics of the VPR area in range of high frequency and in speaking fundamental frequency of the patients, on which the preserving of vocal cord medial edges surgery were performed, was lower than those of other quantitative measurements, but still significant. Normalization of these values is slower, as the pathophysiology of the disease is determined by the diminished ability of straining of the vocal cord. Accumulated fluid makes the vocal cord cover less stiff and more massive as a vibrating structure (6). There is little data on the comparison of the surgical treatments of Reinke's edema. The subjective parameters of the voice and the change in the speaking fundamental frequency are mostly analyzed. S. M. Zeitels et al. (1) in their study that analyzed 18 women 2-4 months after endolaryngeal microsurgery according to Hirano (pre-

serving mucosa method), among other, have also established a significant decrease in incidence and severity of the subjective voice characteristics according to GRBAS scale, however, speaking fundamental frequency remained too low in almost all patients (in our study the voice pitch remained too low in 40% of women). According to quantitative analysis, similarly to our study, significant elevation of the speaking fundamental frequency was found, however unlike the data of the IInd group in our study, there was no significant change of MPT data. The average values of the investigated parameters, as in our study, had not returned to the normal range. While comparing the values with the control group, one should turn their attention towards extensive smoking, as some authors stress that 165 Hz could be a normal value for a healthy smoking woman (14). The elevation of the speaking fundamental frequency and improvement of the subjective parameters of voice after both types of surgical treatment have also been shown by other authors (1,5,14-15). However, Y. Ikeda et al., after evaluating another quantitative parameter of the voice - VRP voice volume (the equivalent of the VRP area) (n=38), came up with the results that were opposite to our study: according to them, this parameter was of no value in tracking the effectiveness of treatment (16). Such results could have been conditioned by too early follow-up time, the significance of which has also been noted by other authors (6,17). Additionally, one should remember that the results of the treatment depend not

only on the surgical technique, but also on the quality of the surgical equipment, the experience of the surgeon, the type of edema, and behavior of patients post-operatively. In summary, we agree that both surgical methods are effective, however, the preserving mucosa of the medial edges of VC surgery normalizes the quality of the voice earlier.

Conclusions

1. Assessment of voice quality in early period after endolaryngeal microsurgical operations in patients with Reinke's edema showed improvement in subjective and quantitative voice testing. Surgical approach with preservation of vocal cord medial edges mucosa on overall benefit after operation according to the voice quality is significantly better in comparison to classical operation technique ($\chi^2=8.9$, $p=0.029$). The mean values of almost all voice parameters except for speaking fundamental frequency in male subjects in early postsurgery period significantly differed from normal independent on the operating technique.

2. Subjective parameters – grade of hoarseness and roughness according to GRBAS scale, and quantitative VRP parameters – pitch range, max.-min. intensity range, total area, and overall vocal dysfunction degree showed a statistically significant difference while comparing the data of different surgical approach groups.

3. Clinical voice assessment may be useful for evaluation of surgical treatment efficacy as well as comparison of different surgical techniques.

Balso charakteristikų palyginimas po skirtingų endolaringinių mikrochirurginių Reinkės ligos operacijų

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Raktažodžiai: Reinkės liga, endolaringinė mikrochirurgija, kiekybinis balso vertinimas.

Santrauka. Darbo tikslas. Įvertinti ir palyginti skirtingų Reinkės ligos chirurginio gydymo būdų rezultatus remiantis kompleksine subjektyvia ir kiekybine balso charakteristikų analize.

Tirti 62 34–68 metų (amžiaus vidurkis 47,7±7,3 metų) Reinkės liga sergantys ligoniai, kuriems atliktos endolaringinės mikrochirurginės operacijos. Pagal chirurginio gydymo būdą ligoniai suskirstyti į dvi grupes: pirmą grupę (n=30) sudarė ligoniai, kuriems atliktos standartinės ekstirpacinės endolaringinės mikrochirurginės operacijos; antrą grupę (n=32) – ligoniai, operuoti tausojančiu medialinių balso klosčių kraštų gleivinę būdu. Kompleksinį foniatrinio ligonio tyrimą sudarė gerklų apžiūra, subjektyvus (balso aukštis, užkimimo skalė, balso pakankamumas bendrauti pagal vizualinio analogo skalę) ir kiekybinis (5 balso lauko parametrai, maksimalus fonacijos laikas, bendrasis balso pažeidimo laipsnis) balso vertinimas. Pacientai tirti du kartus: prieš operaciją ir po jos praėjus vidutiniškai 23,8 paros. Kontrolinio tyrimo atvyko 28 pirmos ir 29 antros grupės pacientai.

Tyrimo duomenimis, ankstyvuoju laikotarpiu po endolaringinės mikrochirurginės operacijos, abiejų grupių pacientams nustatytas teigiamas subjektyvių ir kiekybinių balso parametrų kitimas. Pacientų, kuriems atliktos

tausojančios balso klosčių gleivinę operacijos (antra grupė), apibendrinti pooperaciniai balso tyrimo duomenys buvo statistiškai reikšmingai geresni palyginti su pacientų, operuotų standartiniu būdu (pirma grupė) ($p < 0,05$). Reikšmingas skirtumas tarp grupių duomenų nustatytas bendrojo užkimimo laipsnio, grubaus užkimimo faktoriaus, balso lauko tonų diapazono, maksimalaus–minimalaus balso intensyvumo diapazono, balso lauko ploto bei bendrojo balso pažeidimo laipsnio. Daugumos balso parametrų vidurkiai tiriamuoju laikotarpiu nesinormalizavo abiejų grupių pacientams. Klinikinis balso tyrimas yra informatyvus vertinant chirurginio gydymo efektyvumą ir gali būti naudingas gretinant skirtingus chirurginio gydymo metodus.

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@article{iupinskien2002PhonatoryCF, title={Phonatory characteristics following different endolaryngeal microsurgical techniques in Reinke's disease.}, author={Nora {iup{vs}inskien}— and Migle Skumaniene}, journal={Medicina}, year={2002}, volume={38 10}, pages={. 982-9 } }. Nora {iup{vs}inskien}—, Migle Skumaniene. The aim of the study was to compare different surgical techniques in treatment of Reinke's edema according to subjective and quantitative changes of voice char...