Usefulness of assessment of voice capabilities in female patients with reflux-related dysphonia

Nora Šiupšinskienė, Kęstutis Adamonis¹, Robert J. Toohill²

Department of Otorhinolaryngology, ¹Department of Gastroenterology, Kaunas University of Medicine, Lithuania, ²Department of Otolaryngology and Communications Sciences, Medical College of Wisconsin, Milwaukee, Wisconsin, USA

Key words: laryngopharyngeal reflux; quantitative voice assessment; voice range profile; speech range profile.

Summary. Objectives. To analyze vocal capabilities in patients diagnosed with reflux related dysphonia versus controls with healthy voice with selection of the most informative discriminating quantitative parameters and to assess voice changes following treatment.

Material and methods. Six parameters of voice range profile (VRP) and five parameters of speech range profile were taken and analyzed from 60 dysphonic outpatient females with laryngopharyngeal reflux (LPR) diagnosed by reflux-related atypical and typical symptoms, videolaryngoscopic findings, upper gastrointestinal endoscopy, and positive response to empiric 3-month omeprazole treatment. Seventy-six females with healthy voice served as controls.

Results. All six parameters of voice range profile and three of 5 parameters of speech range profile showed significant differences comparing LPR patients with controls before omeprazole treatment (P<0.05). Logistic regression analysis revealed VRP maximum-minimum intensity range to be the most informative parameter for discrimination between reflux-related dysphonic and healthy voices (overall prediction accuracy, 86.8%). A threshold value of significant parameter was stated using the receiver operating characteristic curve. Treatment with omeprazole significantly improved voice quality showing the greatest changes in the mean scores of majority of voice range profile parameters.

Conclusions. Vocal capabilities, especially evaluated by voice range profile, are restricted in LPR female patients in comparison to subjects with healthy voice. Quantitative voice assessment with voice range profile may add more objective aspect for screening dysphonia and could be used as a criterion of evaluation of treatment efficacy in such patients.

Introduction

Laryngopharyngeal reflux (LPR) is a form of gastroesophageal reflux disease (GERD) and differs from classic GERD in many aspects. The most significant aspect is that the majority of patients with LPR do not have esophagitis or its primary symptom; heartburn and the diagnosis of LPR can be made based on the atypical symptoms and laryngeal findings (1). It is estimated that 15% of patients presenting to otorhinolaryngology clinics have laryngopharyngeal reflux-related disease (2). LPR may manifest as hoarseness, chronic cough, throat clearing, globus sensation, postnasal drip, dysphagia, or breathing difficulties (1, 2). Hoarseness is most common among these symptoms of LPR (3). Overall, hoarseness is a common cause of referral to otolaryngologists. Underlying causes of hoarseness, other than LPR, include vocal fold palsy, polyps, nodules, cysts, malignancy as well as infection, allergic or toxic laryngitis, and functional voice disorders (4). The recent study of reflux and voice disorders suggest that up to 55% of patients with hoarseness have LPR confirmed by 24-hour double-probe pH monitoring (3). Reflux laryngitis is one of the most common manifestations of LPR (1–4).

Quantitative voice assessment is important, especially in clinical practice, to test voice capabilities, to quantify the degree of dysphonia, and to assess the results of treatment (5, 6). In addition to the estimation of acoustic parameters such as jitter, shimmer, and harmonics-to-noise ratio, the examination of vocal capabilities using a voice range profile (VRP) that plots the dynamic range as a function of fundamental frequency documenting the extreme capabilities of the
voice and speech range profile (SRP) that graphically displays functional speech activity seems to be helpful for discrimination between healthy and disordered voices and evaluating voice education (7–9). Quantitative voice assessment using VRP and SRP leads to more reliable evaluation of treatment results (5–10). Accordingly, the aims of our study were to analyze vocal capabilities in patients with reflux-related dysphonia versus healthy voice controls with selection of the most informative discriminating quantitative parameters and to assess voice changes following treatment.

**Material and methods**

**Subjects.** Sixty-six females with dysphonia and at least one other reflux-related laryngeal symptom (e.g., cough, throat clearing, globus sensation, and sore throat) persisting for more than one month examined in the outpatient Department of Otorhinolaryngology of Kaunas University of Medicine were recruited. Laryngitis, in the absence of concurrent infections or allergic reaction, was diagnosed videoendoscopically. Videolaryngoscopic criteria for diagnosis of LPR were erythema, edema, and hypertrophy of the posterior glottis, vocal fold, or subglottis (1, 2, 11). Patients were excluded from the study if they had any of the following signs: upper tract infections during the previous month, allergy, nose and sinus pathology, nodules, polyp, cyst, dysplasia or neurological impairment that may cause voice changes, history of excessive voice use, chronic pulmonary diseases, prior antireflux surgery, treatment with proton pump inhibitors within the last month, pregnancy during study period, or diagnosed psychiatric illness.

Subjects included in the study completed a short history questionnaire including demographic data, history of smoking, allergies, level of voice training (patients were considered to have trained voices if they had voice training at least 2 hours per week for 2 years), accompanying diseases, reflux-related symptoms and had a videotaped laryngoscopic examination and upper gastrointestinal endoscopy. Voice was assessed quantitatively by voice and speech range profiles following self-rated voice quality using the visual analogue scale (VAS) and the voice handicap index (VHI). Following completion, all patients were treated with omeprazole 20 mg twice daily lasting a minimum of 10 to 12 weeks. Patients were considered responders if they had a reduction of at least 50% in their total symptom score and two points in videolaryngoscopic score and were satisfied with the results (rating: satisfied, very satisfied) (12). No additional speech therapy was given.

LPR diagnosis based on characteristic symptoms and their severity (at least 2 symptoms rated not less than 2 points on a 0–3 scale), videolaryngoscopic findings (at least posterior laryngitis after exclusion all other possible cases of laryngitis), and positive response to an empiric 3-month omeprazole treatment according to the chosen criteria with or without erosive esophagitis on endoscopy was confirmed for 60 female patients those data were analyzed. Patients were evaluated at baseline and after 10 to 12 weeks of treatment.

The control group consisted of 76 female subjects with no history of the otolaryngologic problems with healthy voice during the examination and no organic pathology of the vocal folds. Controls were randomly selected from adult female volunteers and evaluated once.

Written informed consent was obtained from all subjects. The protocol was approved by the Ethics Committee of Kaunas University of Medicine, Lithuania.

**Methods. Symptom assessment.** Severity of five laryngeal symptoms (hoarseness, cough, throat clearing, globus sensation, sore throat) and heartburn were rated using a 4-point Likert scale: 0, no symptom; 1, mild; 2, moderate; and 3, severe symptoms. The total symptom score (0–78 points) was calculated as the sum of laryngeal and esophageal scores obtained from the sum of the symptom severity score multiplied by the number of presenting symptoms (11).

Videolaryngoscopies with a Kay Elemetrics 70° endoscope (Lincoln Park, NJ) were performed by the first author. In order to ensure technical consistency, all examinations were performed with the same equipment by the same examiner according to a standard protocol. Laryngeal abnormalities of four laryngeal regions (posterior, vocal folds, vestibular folds, and subglottic area) were evaluated, with each region receiving a rating on color, edema, and hypertrophy using a 4-point Likert scale: 0, no sign; 3, severe signs. The sum of the separate region (maximum 9 points each) scores composed total videolaryngoscopic score with a range from 0 to 36 points (11, 12). More than 2-point score for posterior region was considered positive for posterior laryngitis. Patients with mostly posterior laryngeal region inflammation and/or mild vocal fold edema were considered to have minor LPR (13). Rating of video recordings was blinded to the study and control patients. Test-retest intraobserver reliability (six video recordings randomly selected from the list, time interval at least one month) was 0.90 using the Pearson correlation coefficient.
Upper endoscopy of the gastrointestinal tract was performed for all patients by the gastroenterologist (K.A.). The extent of visible esophageal mucosal damage was assessed using the Los Angeles classification of four-grade system (from A to D) (14).

Voice assessment. Voice range profile was registered in an ordinary room (5×3 m), and the noise level did not exceed 40 dBA in a classical way following the recommendations of the Union of European Phoniatricians (15). The pitch range was measured with the help of an electronic keyboard (Fujiyama 3A; Fujiyama Tech. Co., Shenzhen, China) in a range of four octaves in half-tone step. Sound pressure level was determined using a sound pressure level meter (VEB Robotron, TYP 00011-26), using the slow meter damping and an A-weighted frequency curve (dBA) with a condenser multi-direction microphone MK 102. Standard calibration procedure of the sound pressure level meter was performed with a calibrator PF 101 TYP 00003 with 117.8 dB control sound pressure level. Only precise target tone sounds (vowel /a/) sustained for at least 2 s with two or more values within 3 dBA of target tone were registered in modified by squares (four squares equaled 1 cm²) original registration form (8, 16). VRP analysis included frequency-related parameters – high frequency limit expressed as the numeral classification of semitones from W. Vennard (st. No.) (17) and pitch range (st.); intensity-related – minimum voice intensity and maximum-minimum intensity range (dBA); and combined – VRP area (cm²) and area in high frequencies – part of the total area, calculated from 349.2 Hz for male and 523.3 Hz for female subjects represented mean register change place (cm²) (Fig. 1) (8).

SRP parameters were registered while using above-mentioned recording devices and under the same conditions in a counting from 1 to 30. Speaking curve was drawn initially calculating habitual voice and afterward increasing to maximum pitch. Speaking voice analysis also included 5 parameters: fundamental frequency (Hz) and speak tone range (st.), which were frequency related; maximum intensity and speaking intensity range (dBA), which were intensity-related, and slope of speaking curve – fundamental frequency rising per 10 dBA (st./10 dBA), which was combined (Fig. 2).

Stability of VRP and SRP was tested on five persons with healthy voice in two additional sessions (on the next day and after one month) after the first examination. Intraindividual variations of intensity parameters for repeated assessments were within 2 dBA and for frequency parameters within 2 se-

![Fig. 1. Quantitative parameters of voice range profile of a healthy subject](image-url)

\( A_{\text{high}} \), area in high frequencies; max.-min., intensity range, maximum-minimum intensity range (original registration form).
mitones, with no statistically significant difference ($P>0.05$). Based on previous investigations and our findings, we considered changes of 3 dBA or more for intensity parameters and more than 2 semitones for frequency parameters as clinically significant (5, 8, 16, 18, 19).

Subjective voice quality (self-)evaluation by a person. The impression of the voice quality was self-rated by subjects on the visual analogue scale (VAS) of 100 mm. A score of 0 means normal voice (no deviation), while 100 means extreme voice deviance (6). One millimeter measured by a rule is equal to one point; 0–70 points were considered as slight to moderate damage.

The impression of self-perception of vocal handicap was self-rated by the subjects with the 30-item Voice Handicap Index (VHI) questionnaire. Using the following values – 0 (never) and 4 (always) – each statement was rated by frequency. The VHI generated a total score ranging from 1 to 120 and three subscale scores: functional, physical, and emotional (20).

Statistical analysis was performed with SPSS 10 for Windows (SPSS Corporation, Chicago, IL, USA). The $t$ test was used for normally distributed quantitative parameters. The Mann-Whitney $U$, chi-square tests were used for nonparametric data. Normally distributed data are expressed as mean and standard deviation; skewed or categorical data are shown as median. Binary logistic regression was applied for selection of the most informative discriminating parameters. With classification tables, the sensitivity (the proportion of dysphonic cases correctly identified by the test), specificity (the proportion of normal cases correctly identified by the test), and overall discrimination accuracy were calculated. A threshold value of selected parameter was stated using ROC (receiver operating characteristic) curve coordinate points. Pearson correlation coefficient ($r$) was used for correlation analysis ($r>0.7$ shows strong correlation). Paired-samples $t$ test was used to test the difference of voice parameters in repeated measures. A level of significance of 0.05 was chosen.

**Results**

Demographic and clinical characteristics. We selected 60 out of 66 dysphonic female patients with a mean age of 38.5±13.3 years. Six were excluded because they were lost to follow-up after the treatment. Seven (11.7%) patients had smoking history and 11 (18.3%) had trained voices. The mean age of 76 controls were 34.9±12.0 years. Seven (9.2%) were smokers and 20 (26.3%) had trained voices. LPR patients and controls were matched in respect to age, smoking history, and voice training ($P>0.05$).

![Fig. 2. Quantitative parameters of speech range profile in voice range profile (shadowed) of a healthy subject](image-url)

- $F_0$, fundamental frequency (original registration form).
Presenting symptoms (prevalence and median severity score on a scale of 0–3) besides of hoarseness (100%, 2.0) included chronic cough (71.7%, 2.0), throat clearing (88.3%, 2.0), globus sensation (78.3%, 2.0), and sore throat (75%, 1.0). Heartburn was reported in more than half of patients (70%, 1.0). The symptom score was significantly higher in the LPR group versus controls \((P<0.0001)\).

Videolaryngoscopic abnormalities were seen in the posterior laryngeal region (100%), vocal folds (90%), vestibular folds (35%), and subglottic area (21.7%). Predominant findings were composition of posterior glottis hypertrophy and vocal fold edema (88.3% of cases). More than half (70.0%) of patients showed minor LPR; 18.4% of LPR patients had severe edema in the posterior laryngeal region and hypertrophy bulging into airway or severe edema of the vocal fold. The median videolaryngoscopic score was 8.0 points for LPR patients and 0.0 for controls \((P<0.0001)\). Erosive esophagitis was confirmed in 14 (23.3%) of selected patients, and predominant grade A esophagitis was present in 12 cases.

**Voice assessment.** Comparison of parameters of voice range profile and speech range profile in LPR female patients versus healthy voice controls. Table 1 summarizes the results of VRP and SRP assessments. Mean values of all six tested VRP parameters – frequency-, intensity-related, and combined – were significantly reduced in LPR female patients compared to those of controls with healthy voice \((P<0.0001)\). High frequency limit was found to be lowered on the average of 4.7 st., pitch range reduced on the average of 6.4 st., maximum-minimum intensity range of 10.5 dBA, total VRP area and area in high frequencies were restricted on the average of 7.6 cm² and 3.4 cm², respectively. Although minimum voice intensity had significantly increased as compared to the controls: on the average of 2.4 dBA.

Analysis of SRP showed a significant difference between groups in 3 of 5, mostly intensity-related, evaluated SRP parameters means \((P<0.0001)\), while fundamental frequency and speak tone range for LPR individuals were within normal limits. Consequently, maximum speech intensity for LPR females was reduced on the average of 5.3 dBA, intensity range of 5.1 dBA and slope of speaking curve had increased of 0.8 st. per 10 dBA, respectively.

**Subjective (self)-evaluation of voice quality on VAS by a person.** LPR patients rated their voice mostly as slight or moderate hoarse on the 100-mm VAS: 70% of cases \((100=extreme voice deviance)\). The median score of rating was 50.0 points versus 0.0 points of controls \((P<0.001)\).

Voice handicap index was registered for 60 LPR patients and 55 control females. The total median VHI score for LPR female patients was found to be 31.0,

### Table 1. Parameters of quantitative voice range profile and speech range profile in LPR patients and controls

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LR Patients (N=60)</th>
<th>Controls (N=76)</th>
<th>Mean difference</th>
<th>95% CI of difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean (SD)</td>
<td>mean (SD)</td>
<td></td>
<td>lower</td>
<td>upper</td>
</tr>
<tr>
<td><strong>Voice range profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High frequency limit, st. No.</td>
<td>62.9 (4.3)</td>
<td>67.6 (2.9)</td>
<td>-4.7</td>
<td>-5.9</td>
<td>-3.5</td>
</tr>
<tr>
<td>Pitch range, st.</td>
<td>24.4 (5.2)</td>
<td>30.8 (4.3)</td>
<td>-6.4</td>
<td>-7.9</td>
<td>-4.7</td>
</tr>
<tr>
<td>Minimum voice intensity, dBA</td>
<td>53.3 (2.7)</td>
<td>50.7 (2.2)</td>
<td>2.6</td>
<td>1.7</td>
<td>3.4</td>
</tr>
<tr>
<td>Maximum-minimum intensity range, dBA</td>
<td>34.2 (7.4)</td>
<td>44.7 (4.9)</td>
<td>-10.5</td>
<td>-12.6</td>
<td>-8.4</td>
</tr>
<tr>
<td>Total area, cm²</td>
<td>16.0 (4.6)</td>
<td>23.6 (3.8)</td>
<td>-7.6</td>
<td>-9.0</td>
<td>-6.2</td>
</tr>
<tr>
<td>Area in high frequencies, cm²</td>
<td>2.0 (2.1)</td>
<td>5.4 (2.4)</td>
<td>-3.4</td>
<td>-4.2</td>
<td>-2.6</td>
</tr>
<tr>
<td><strong>Speech range profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental frequency, Hz</td>
<td>210.2 (24.1)</td>
<td>212.8 (22.3)</td>
<td>-2.5</td>
<td>-10.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Speak tone range, st.</td>
<td>10.7 (2.7)</td>
<td>10.7 (2.6)</td>
<td>0.0</td>
<td>-0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Maximum intensity, dBA</td>
<td>85.5 (5.6)</td>
<td>90.8 (3.9)</td>
<td>-5.3</td>
<td>-6.9</td>
<td>-3.7</td>
</tr>
<tr>
<td>Speaking intensity range, dBA</td>
<td>23.2 (5.3)</td>
<td>28.3 (5.6)</td>
<td>-5.1</td>
<td>-6.9</td>
<td>-3.2</td>
</tr>
<tr>
<td>Slope of speaking curve, st./10 dBA</td>
<td>4.6 (1.1)</td>
<td>3.8 (0.8)</td>
<td>0.8</td>
<td>0.5</td>
<td>1.2</td>
</tr>
</tbody>
</table>

LPR, laryngopharyngeal reflux; CI, confidence interval of the difference.
*Statistically significant difference between LPR patients and controls.
showing a mild but a significantly higher self-perception of vocal handicap than controls (median 2.0) \((P<0.0001)\). Similar results were found for the scores of functional, physical, and emotional domain subscales: 7.0, 14.0, and 7.0 versus 1.0, 1.0, and 0.0, respectively \((P<0.0001)\).

Selection of the most informative quantitative voice parameters discriminating between LPR female patients and controls with healthy voice. Firstly, using a binary logistic regression analysis, sensitivity and specificity of each individual quantitative voice parameter were calculated. The data presented in Fig. 3 (A, B) show that VRP parameters were more sensitive than SRP. A sensitivity of VRP parameters ranged

![Bar chart A](image1.png)

![Bar chart B](image2.png)

**Fig. 3.** Sensitivity and specificity of each parameter of voice range profile (A) and speech range profile (B) calculated from 60 dysphonic LRP patients and 76 healthy subjects using logistic regression analysis.
from 53.3% to 80%, showing VRP area and maximum-minimum intensity range to be the most sensitive. A sensitivity of SRP parameters ranged from 0% to 63.3%, showing maximum speaking intensity to be the most sensitive. Secondly, with the same procedure, the most informative model for separation of voice quality between LPR patients and controls with healthy voice was determined. It was revealed that such model included only one VRP parameter: maximum-minimum intensity range (overall prediction accuracy, 86.8%; cut value of probability, 0.5). The model is in good fitness (chi-square of omnibus tests of model coefficients, 0.0001). Thirdly, a threshold value of selected VRP maximum-minimum intensity range using coordinate points of the ROC curve with maximum of sensitivity and specificity percent was found as equal to 41 dBA (sensitivity of threshold value point, 81.7%; specificity, 82.9%). Accordingly, female subject voice with smaller than threshold value in more than 81% could be classified as disordered.

Assessment of voice changes following omeprazole treatment. All 60 patients with reflux-related dysphonia following the 3-month omeprazole treatment were classified as responders according to chosen criteria with reduction of at least 50% in their laryngeal symptoms and heartburn, two points in videolaryngoscopic score and self-satisfaction with the results. Table 2 summarizes the results of changes in voice parameters. A statistically and clinically significant improvement, but not full normalization, was achieved at follow-up in majority of mean scores of VRP parameters, except minimum voice intensity, with major change of maximum-minimum intensity range ($P<0.005$). A significant improvement of means was also registered for tested SRP parameters, but in a less capacity ($P<0.05$) with no clinical significance. SRP parameters at the follow-up were found to be normal or near normal. Accordingly, self-rated hoarseness on VAS and VHI scores also significantly decreased on the average by 30.2 and 13.9 points, respectively ($P<0.0001$) following the treatment, but still a significant difference remained between the groups (median 1.0 point versus 0.0 point for VAS, $P=0.03$; and 17.0 points versus 2.0 points for VHI, $P=0.001$).

Discussion

Laryngopharyngeal reflux could cause more devastating effect on voice production than GERD because of direct damage to the vocal folds. Acid injury to the larynx may affect not only the organic appearance of the laryngeal tissues, but also functions of the larynx, especially voice production, even in a very small amount of gastric contents (21). Because

<table>
<thead>
<tr>
<th>Table 2. Changes in mean scores of quantitative voice parameters in LPR female patients (N=60) following three-month omeprazole treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Voice range profile</strong></td>
</tr>
<tr>
<td>High frequency limit, st. No.</td>
</tr>
<tr>
<td>Pitch range, st.</td>
</tr>
<tr>
<td>Minimum voice intensity, dBA</td>
</tr>
<tr>
<td>Maximum-minimum intensity range, dBA</td>
</tr>
<tr>
<td>Total area, cm²</td>
</tr>
<tr>
<td>Area in high frequencies, cm²</td>
</tr>
<tr>
<td><strong>Speech range profile</strong></td>
</tr>
<tr>
<td>Fundamental frequency, Hz</td>
</tr>
<tr>
<td>Speak tone range, st.</td>
</tr>
<tr>
<td>Maximum intensity, dBA</td>
</tr>
<tr>
<td>Speaking intensity range, dBA</td>
</tr>
<tr>
<td>Slope of speaking curve, st./10 dBA</td>
</tr>
</tbody>
</table>

LPR, laryngopharyngeal reflux; CI, confidence interval of the difference of changes.

*Statistically significant changes. Note: the decrease in score for slope of speaking curve to be positive changes.

Medicina (Kaunas) 2009; 45(12)
dysphonia is one of the main and characteristic symptoms of the disease, quantitative voice assessment may be informative for screening dysphonic voice with an objective confirmation of hoarseness and objective evaluation of treatment efficacy. Treatment with proton pump inhibitors (PPI) remains one of the main recommended approaches to confirm LRP diagnosis in clinical practice, when diagnosis is in question, and to treat proven LPR (1, 21, 22). Mostly, treatment efficacy has been assessed by reduction of symptoms and laryngeal findings (13, 23, 24). Only few studies have evaluated voice function in patients with LPR to determine how vocal function could be affected by acid irritation of the larynx. In vast majority of them, vocal function has been assessed by perturbation measures in period (jitter), amplitude (shimmer), and harmonic to noise computations with conflicting and not very promising results (10, 19, 23–26). We hypothesized that investigation of vocal capabilities by registering voice and speech range profiles, sensitive for discriminating healthy from disordered voice, would be more relevant for LPR patients. We looked for discrepancies in vocal capabilities between patients with reflux-related dysphonia and healthy voice controls and possibility to use voice assessment in quantification of hoarseness and treatment efficacy.

The results of this study showed that all tested VRP parameters – frequency, intensity-related and combined and some SRP parameters, mostly intensity-related – are sensitive enough for the detection of voice changes due to reflux to the larynx even in minor LPR cases: 70.0% of patients of this study had mostly posterior laryngeal region inflammation with mild vocal fold edema and slight to moderate impairment of self-perception of voice quality. It is not surprising that LPR patients demonstrated a significant reduction in singing voice limits all over the frequency and intensity ranges. Inflammation in the larynx may alter the mass and tension of the vocal fold, thereby influencing the pattern and timing of vocal fold vibration, both of which are prerequisites for control of voice frequency and intensity (19). Because of increased vocal fold mass due to edema, vocal fold ability for tension decreased and was reflected in decreases in frequency-related parameters (5). In addition, an incomplete closure of the vocal folds and increased glottal resistance that requires greater driving pressure to initiate and maintain vocal fold vibration could reflect on other intensity-related parameters. The reduction in the means of VRP parameters detected in this study is in concordance with the results of other study on LPR patients (27).

According to current study results, speaking voice parameters in LPR patients were impaired less than VRP. The mean values of only 3 of 5 estimated SRP parameters – maximum intensity, intensity range and slope of speaking curve – showed a statistically significant reduction of vocal capacity for LPR female patients as compared to controls with healthy voice, leaving fundamental frequency and frequency range within normal range. These data could be explained that the speaking voice and its registration methodology are more rough compare to singing voice. Few studies on LPR patients have obtained results on speech frequency parameters consistent with those reported here (19, 26–28). There are no data in the literature revealing changes in other SRP parameters.

Selection of parameters, which could detect differences in mild organic pathology, is very important in clinical practice. We have found the most informative parameter in discrimination of LPR patients’ voices from voices of healthy subjects selected by the logistic regression analysis was VRP maximum-minimum intensity range – the distance between the softest and the loudest sound pressure levels registered by the meter with a threshold value of 41 dBA. Registration of this parameter is simple and quick; moreover, the establishing of a threshold value of this parameter bears clinically applicable significance as it is convenient to apply it in everyday practice.

The results of this study showed that quantitative voice parameters could be useful for evaluation of treatment efficacy. Short-term treatment with omeprazole showed a significant objective improvement in voice quality further supported by a significant decrease in subjective self-rating of hoarseness and voice handicap and with a reduction of at least 50% in their laryngeal symptoms and heartburn, two points in videolaryngoscopic score and self-satisfaction with the results. VRP parameters showed great responsiveness to changes. Changes in the mean scores of all VRP parameters, except minimum voice intensity, were significant. Improvement in the mean scores of SRP parameters was in a less capacity with no clinical significance. Whereas VRP registration is a standardized procedure, and previous investigations proved reliability and stability of VRP registration we believe registered changes confirmed treatment effect. Considering that symptoms reduction preceding laryngeal findings resolution, minimal changes of softest phonation, as well as deviation from norm for the rest VRP parameters at the follow-up could reflect still existing slight laryngeal edema that needs longer treatment to normalize larynx. Data on this question in the literature are few and controversial. Willems-

Medicina (Kaunas) 2009; 45(12)
Bloemer et al. (29) have investigated dysphonia changes on PPI for LPR patients. Their results showed no statistically significant changes in VRP pitch and intensity range possibly because of small number of the patients (15 patients of both genders) and absence of control group. Selby et al. (19) also did not find a significant improvement with antireflux treatment on tested SRP parameters in LPR patients for the same reasons.

Our study can be criticized because only female subjects were included; therefore, there is a need for further investigations with male LPR patients. Another limitation of our study is a lack of pH monitoring in the diagnosis of LPR, but to diagnose LPR, we followed current accepted recommendations (1, 21, 22). The presence of gastroesophageal reflux symptoms in vast majority of patients in the current study enhances the fact of reflux-related dysphonia.

**Conclusions**

Singing and speaking vocal capabilities are reduced in female patients with reflux-related dysphonia as compared to controls with healthy voice. Voice range profile parameters are more sensitive for screening voice dysfunction than speech range profile. The most informative voice parameter in discrimination between LPR female patients and controls with healthy voice was VRP maximum-minimum intensity range (overall prediction accuracy, 86.6%). Short-term treatment with proton pump inhibitors improved voice quality showing the greatest changes in the mean scores of majority of VRP parameters. Quantitative voice assessment, especially with VRP, may add more objective aspect for screening dysphonia and could be used as criterions of evaluation of treatment efficacy together with standard assessment in such patients.

---

**Balsų galimybių tyrimo informatyvumas tiriant pacientes, sergančias disfonija, sukelta refluksu**

Nora Šiupšinskienė, Kęstutis Adamonis¹, Robert J. Toohill²

¹Kauno medicinos universiteto Ausų, nosies ir gerklės ligų klinika, ²Gastroenterologijos klinika,
²Viskonsino medicinos kolegijos Otorinolaringologijos ir komunikacijos mokslų klinika, Milvokis, JAV

**Raktąžodžiai:** gastroezofaginio reflukso ligos laringofaringinė forma, kiekvienasis balsas vertinimas, balsos lauko tyrimas, kalbos parametrų.

**Santrauka.** **Tyrimo tikslas.** Palyginti pacientų, sergančių gastroezofaginio reflukso ligos laringofaringinė forma (GERL LF) ir sveiko balsos moterų balsų galimybės ir nustatyti informatyviausius balsos parametrus, kurie padėtų atskirti tokių pacientų balsą nuo sveikų bei įvertinti balsos parametrų kitimą po antirefluksiino gydymo. Tvirtųjų medžiaga ir tyrimo metodus. Tyrimui atitinka šešiasdešimt GERL LF sergančių pacientų, kurioms diagnozė nustatyta atiškéléliai vienų balsų paralelę ir būdingų reflukso simptomų, vaizdolaringoskopinius radinius, ezofoagoskopijos rodmenis ir teigiamą smeigtinio mėgėnį. Kontrolinę grupę sudarė 76 sveiko balso moterys. Visoms tiriamosios balsų ir kalbos laukus. Analizuoti šešis balso laukai, ypač kalbos lauko. Rezultatai. Prieš gydymą tarp GERL LF pacientų ir sveiko balsos moterų statistikiskai reikšmingas skirtumas nustatytas vieniems tirtiems balsos laukai ir trimis iš penkių kalbos lauko parametrų vidurkiais (p<0,05). Dvinares logistinės regresinės analizės metodu nustatyta, kad informatyviausius paramečius, pagal kurį galima atskirti sveiką moterų balsą nuo pažeisto refluksu, yra balsos lauko intensyvumo diapazonas (bendras teisingų prognozių procentas – 86,8). Ribinis reikšmingo parametro rodomo nustatytas pagal ROC krievą. Po antirefluksiino gydymo GERL LF pacientų balsas pokyčius nustatytas daugumos balsos lauko parametrų vidurkis. Įvados. Tyrimas parodė, kad sergančiųjų GERL LF balso galimybės, ypač dainuojamojo balsos, vertinamo balsos lauko metodu, yra susiaurėjusios palyginus su sveiko balso moterų analogūs rodmenimi. Kiekvienisas balsas vertinimas balso lauko metodu gali būti tikslingas objektyvizuojant tokių pacientų balsas pažeidimą ir stebint antirefluksiino gydymo veiksmingumą.

---

Adresas susirašinėti: N. Šiupšinskienė, KMU Ausų, nosies ir gerklės ligų klinika, Eivenių 2, 50009 Kaunas
El. paštas: norai_s@yahoo.com

Medicina (Kaunas) 2009; 45(12)
References


Received 29 June 2009, accepted 7 December 2009

Strausnys gautas 2009 06 29, priimtas 2009 12 07