Chapter 26
What VSK reveals about phonation in Reinke’s edema
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Abstract

We evaluated open (OQ) and closed quotients (CQ) of vocal folds (VF) vibratory cycles at three locations (anterior, middle, and posterior glottis) using VSK lines in a cohort of patients with Reinke’s edema (RE). Mean values for OQ were 0.44 at the anterior (a), 0.46 at the middle (m), and 0.52 at posterior (p) locations. The CQ values were 0.56 (a), 0.54 (m), and 0.48 (p), respectively. Results for the whole glottis OQ and CQ were 0.48 and 0.52, respectively. Differences for OQ and CQ measured at each location were significant.

Keywords: Reinke’s edema, videostrobokymography, Yonekawa classification, glottal function, open and closed quotients (OQ, CQ)

Introduction

Reinke’s edema (RE) occurs predominantly in females and typically causes a drop in the fundamental frequency (F0) towards the male range [1-2]. Pathogenesis of RE is multifactorial and may involve smoking, laryngopharyngeal reflux, allergy, chronic voice abuse, unfavorable micro-climate in the workplace or home, hormonal changes, pregnancy, and menstrual periods [3-6]. Traditional laryngoscopy reveals swollen VF, in most cases bilaterally and often asymmetrically [7-9]. A more effective tool in examining RE is laryngovideostroboscopy (LVS) [2, 10]. When LVS is analyzed further with videostrobokymography (VSK), calculations of the glottal cycle’s OQ and CQ can be made [10]. In this chapter, we describe OQ and CQ of the glottal chink measured at three locations (anterior, middle, and posterior glottis) with VSK in a cohort of patients with RE.

Materials and methods

LVS and VSK recordings were obtained from a cohort of 14 men and 41 women (55 total) who presented with RE of both VF. The median age of this group was 53 years old and range was 20 to 80 years old. All patients were examined between 2010 and 2012 at the Audiology and Phoniatrics Clinic of the Institute of Physiology and Pathology of Hearing, Warszawa-Kajetany, Poland. All LVS recordings were conducted transorally during sustained phonation of the vowel /i/. A rigid scope was connected to a EndoSTROB DX 327 (Xion GmbH Berlin, Pankstrasse 8-10, Germany).

The severity and location of RE were classified according to the Yonekawa three stage scale [11]. Consequently, Stage 1 RE represented non-adhesive swellings present only on the superior surface of the VF. Stage 2 represented RE localized to the superior surface and the anterior parts of the VF free edges. Stage 3 was represented by the glottis in which the respiratory surface was limited only to the posterior part of the glottis due to severe swelling along the entire surface of the VF, while showing a concentric bulge [11].
VSK measurements were made from LVS recordings at 25 f/s and only from those patients from whom a clear view of the whole glottis could be monitored for a minimum of four seconds. The derived kymograms were based on anterior, medial, and posterior glottis demarcation lines. The OQ and CQ were calculated through a customized computer-based algorithm from these kymograms [12]. A student t-test was used for statistical analysis and for significant differences in the ratio of OQ and CQ in RE group. The level of statistical significance was set at p<0.05. The relationship between the stage of RE described on the Yonekawa scale and the value of OQ and CQ was analyzed with a correlation using Gini and Kendall tau coefficients.

Results

Edema location

LVS showed that RE was situated on the upper surface of the VF in 12 patients (Stage 1 according to Yonekawa), along the anterior third in 20 patients (Stage 2), and along the entire length of the VF in 23 cases (Stage 3). Five patients from the last group were excluded from the study because the massive edema of the VF (Figure 1) prevented obtaining an adequate LVS effect. In nine out of 18 patients from the same group (Stage 3), edema was situated mainly in the middle third causing a spindle-shape closure during phonation.

![Figure 1. View of glottis from a patient with severe Reinke’s edema of both VF. Kymogram could not be created because of severe irregularities in the stroboscopic examination.](image)

Analysis of OQ and CQ

The mean OQ values for all RE patients were: 0.44 (SD=0.2) at the anterior, 0.46 (SD=0.2) at the middle, and 0.52 (SD=0.2) at the posterior locations. The mean CQ values for the same locations were, respectively: 0.56 (SD=0.2), 0.54 (SD=0.2), and 0.48 (SD=0.22). Differences in OQ and CQ measured from the anterior, middle, and posterior third of the VF were statistically significant (p<0.01).

For the RE group, the mean values from areas without visible RE were: 0.6 (SD=0.04) for the OQ and 0.4 (SD=0.04) for the CQ. The mean values measured in areas with RE were: 0.48 (SD=0.14) for the OQ and 0.52 (SD=0.14) for CQ. The differences in OQ and in CQ values for the areas with and without RE were statistically significant (p<0.01).
Results depending on the stage of edema

The mean values of the parameters for patients divided into groups according to the Yonekawa classification are shown in Table 1. A trend between the OQ and CQ values and the Yonekawa stages was observed. In the Stage 1 group, no statistically significant differences were found. Statistical differences were found however for the Stage 2 and 3 groups, specifically with respect to the mean values of the parameters obtained for the whole glottis. Moreover, in the Stage 2 group, statistical differences were found for the anterior and middle third locations. In the Stage 3 group, statistically significant differences were found for the middle and posterior third locations. Figures 2-4 show kymograms from patients classified according to the Yonekawa three stages.

The correlation between the stage of edema on the Yonekawa classification and the mean values of OQ and CQ was 70%. We noted that the more severe the edema, the higher were the CQ and lower the OQ. The correlation between the Yonekawa stages and the values of OQ and CQ measured from the anterior, middle, and posterior third was 69%, 54%, and 50%, respectively.

The relation between the stage of edema on the Yonekawa classification and the mean values of OQ and CQ was 24% as described by the Gini coefficient and 47% in terms of Kendall tau (with a maximum possible 63%). The strongest correlation between the Yonekawa stages and OQ and CQ values was observed for the anterior third location: Gini index 34% and Kendall tau 49% (max 60%). Corresponding values measured for the middle third were: Gini index 19% and Kendall tau 34% (max 62%). For the posterior third were: Gini index 18% and Kendall tau 28% (max 63%).

Table 1. OQ and CQ from the anterior, middle, and posterior third of the glottis in the groups of patients sub-divided according to Yonekawa stages (subdivision based on Student’s t-test score) and in the control group.

<table>
<thead>
<tr>
<th>Edema degree</th>
<th>OQ mean value</th>
<th>CQ mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anterior third</td>
<td>Middle third</td>
</tr>
<tr>
<td>I</td>
<td>0.564 p=0.329</td>
<td>0.555 p=0.937</td>
</tr>
<tr>
<td>II</td>
<td>0.314 p=0.000</td>
<td>0.484 p=0.021</td>
</tr>
<tr>
<td>III</td>
<td>0.429 p=0.163</td>
<td>0.300 p=0.002</td>
</tr>
<tr>
<td>CONTROL GROUP</td>
<td>0.537</td>
<td>0.553</td>
</tr>
</tbody>
</table>
Figure 2. Kymograms from the anterior, middle, and posterior third of glottis with Stage 1 Reinke’s edema based on the Yonekawa scale.

Figure 3. Kymograms from the anterior, middle, and posterior third of a patient with Stage 2 Reinke’s edema on the Yonekawa scale.

Figure 4. Kymograms from the anterior, middle, and posterior third of a patient with Stage 3 Reinke’s edema on the Yonekawa scale.

Discussion and Conclusions

The results presented here are in agreement with the (rare) literature descriptions of glottic cycle characteristics in RE patients [10, 13]. The mean values of OQ measured by us were: 0.44 for the anterior, 0.46 for the middle, and 0.52 for the posterior third locations.

A relation between OQ and CQ values, the appearance, and the actual localization of swelling was also noticed. Among the patients with RE, the parameters statistically differentiated those areas with and without edema, including the finding that statistically significant differences in OQ and CQ were present between the three stages of RE patients classified by Yonekawa. Therefore, we conclude that LVS examination accurately describes RE swelling in terms of the Yonekawa stage classification.
VSK derived from LVS provides a useful complement to classical stroboscopy. VSK helps in objective differentiation and assists in differential diagnosis. Therefore, we feel that the OQ and the CQ values derived from VSK may be used to objectively assess patients before and after treatment.

Acknowledgments

This work was funded by The Institute of Physiology and Pathology of Hearing, Warszawa-Kajetany, Poland. We also thank Mr. Wiktor Krasnodebski for his help with the statistical analysis.

References
