

## **Abstract**

The larynx is an organ fulfilling important life functions: ventilatory, phonatory and protective. Any pathological changes within the morphology of the larynx affect its particular functions, and their clinical picture is characterized by rich symptomatology in which voice disorders and ventilatory dysfunction dominate. Among laryngeal diseases causing voice and respiratory disorders is Reinke's Oedema (RO), belonging to benign vocal fold masses (BVFM). Smoking has been found to be the most important risk factor in the etiopathogenesis of RO. Among other factors are also hormonal disorders, laryngopharyngeal reflux disease, allergies and lack of voice hygiene. The edematous changes in lamina propria of the vocal folds are the result of long term exposure to the above mentioned factors. In advanced stages of RO (3<sup>rd</sup> and 4<sup>th</sup> stage according to Bart) narrowing of the glottis is observed, causing compromised ventilatory function (dyspnoea) and coexisting phonatory function disorders, that is dysphonia, manifesting itself as hoarseness of voice and lowering of voice.

Given the broadly understood concept of health introduced by the World Health Organization (WHO), particular attention should be paid to the patient's social, physical and mental well-being as well as his quality of life. For these reasons in the assessment of the effectiveness of the contemporary treatment methods, the importance of functional results is underlined, that is preserving vital functions of the treated organs. This trend is applied also in treatment of Reinke's Oedema. For this reason, phonosurgery improving both vital functions of the larynx is a treatment of choice in surgical treatment of patients with laryngeal pathology of BVFM type recommended by European Laryngological Society. Currently the preferred surgical method in advanced stages of RO is the phonosurgical mini-microflap technique. The present work constitutes the first conducted in Poland assessment of the phonatory and ventilatory function of the larynx in patients with RO after microsurgical treatment with the above mentioned technique in short-term and long-term observation.

## **Objectives**

The main objective of the research was the assessment of effectiveness of the mini-microflap surgical treatment in patients with Reinke's Oedema on the basis of phonatory and ventilatory function parameters.

The specific objectives included:

1. Assessment of phonatory function before and after phonosurgery in patients with Reinke's Oedema in 3<sup>rd</sup> and 4<sup>th</sup> stage of clinical advancement by means of instrumental and subjective methods.
2. Comparison of ventilatory capacity in patients with Reinke's Oedema in 3<sup>rd</sup> and 4<sup>th</sup> stage of clinical advancement on the basis of the analysis of ventilator parameters of spirometry.
3. Assessment of post-surgery phonatory and ventilator function of the larynx in patients with Reinke oedema who underwent mini-microflap syrgery in shoert term observation (1 month post surgery) and long-term observation (6 and 9 months post-surgery)
4. Determining whether there is a post-surgery correlation between phonatory and ventilatory parameters of the larynx indicating a positive impact of the mini-microflap phonosurgery technique on vital functions of the larynx in patients treated for Reinke's Oedema.

### **Material and methods**

The study included 31 subjects operated on in the Clinical Department of Otorhinolaryngology, Fryderyk Chopin Clinical Voivodeship Hospital No 1 in Rzeszów. The final study group included 20 patients who completed a full cycle of post-surgery check-ups in three time check-points: 1, 6 and 9 months post-surgery. There were 16 women (80%) and 4 men (20%) in the study group. Mean age was 53,2 years. Depending on the clinical advancement of RO, the patients were divided into a group of 3<sup>rd</sup> clinical advancement stage according to Bart (15 subjects) and 4<sup>th</sup> clinical advancement stage (5 subjects). In subjects with RO stage 4 the main reason for reporting for surgery was dyspnoea and in subjects with RO stage 3 the main symptoms were breathing disorders, hoarseness of voice and lowering of voice in women.

All the examined patients were active smokers. The patients were qualified for mini-microflap surgery after preliminary examination including laryngological examination with laryngovideostroboscopy (LVS) and assessment of phonatory and ventilatory function.

For the assessment of the phonatory function, apart from LVS, an objective method was applied: the measurement of the aerodynamic parameter - Maximum Phonation Time (MPT) and subjective methods- perceptual assessment and self-assessment of voice by means of Voice Handicap Index and Voice-Related Quality of Life questionnaires. For the assessment of the ventilatory function spirometry was used, assessing the most commonly used parameters: Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Maximum

Expiratory Flow (MEF 25, 50, 75), Peak Expiratory Flow (PEF), Forced Expiratory Flow in selected moments of forced expiration (FEV 25, 50, 75).

The applied surgical mini-microflap technique was intended to both decrease the mass of the vocal folds and broaden the glottis as well as to maintain layered, functional composition of the vocal fold in accordance with Hirano's body-cover principle. After the incision was made along the upper edge of the vocal fold and the lamina propria was carefully lifted, thick, mucous fluid was aspirated from Reinke's space. After the surgery a follow-up check-up was conducted in all study group patients in time check-points: 1 month, 6 months and 9 months post-surgery. The above mentioned parameters for the assessment of the phonatory function and ventilatory parameters were compared, by putting together the results obtained before the surgery and after the surgery in three time intervals,

The study was approved by the Bioethical Committee of the Regional Medical Chamber in Rzeszów (nr 66/ B/ 2016).

IBM SPSS Statistic version 24 was used to analyze the obtained results. The effectiveness of treatment was verified by means of Wilcoxon signed rank test for dependent samples. Correlation coefficient (Spearman's rho) was used for the analysis of dependence between the subjective and objective parameters assessing the phonatory and ventilatory function of the larynx. In designing linear regression charts between VHI and V-RQOL the statistics of coefficient of determination ( $R^2$ ) was used. The statistical significance was set on  $p < 0,05$  level.

## Results

In the course of the study it was demonstrated that treating Reinke's Oedema patients with mini-microflap phonosurgery technique is an effective and safe method, improving not only ventilatory parameters, but also the phonatory function of the larynx.

In the analysis of the results of laryngovideostroboscopy, which is the golden standard of imaging examinations of the function of the larynx, the improvement of the phonatory function was observed in 6<sup>th</sup> month post surgery, with the increase in the trend up till 9 months post-surgery. These results concerned all the assessed parameters in LVS: regularity of vocal fold vibration ( $p_6=0.014$ ,  $p_9<0.001$ ), amplitude of vocal fold vibration ( $p_6=0.004$ ,  $p_9<0.001$ ), the presence of mucosal wave ( $p_6<0.001$ ,  $p_9<0.001$ ) and configuration of glottal closure ( $p_6=0.003$ ,  $p_9<0.001$ ).

In the perceptual analysis conducted in the 1<sup>st</sup> month post-surgery, deterioration of voice quality was observed ( $p_1=0.002$ ). The improvement in voice quality was noted 6 months post

surgery, which may be explained by the long process of healing and returning the right structure of the vocal fold.

The research demonstrated a statistically significant improvement of the aerodynamic parameter (MPT) already 1 month after the surgery with the rising trend persisting in the long-term observation. On average there was an increase of 3.723 seconds during 1-month observation after the surgery ( $p_1 < 0.001$ ), 4.79 seconds in 6-months observation ( $p_6 < 0.001$ ) and 7.88 seconds in 9-months observation ( $p_9 < 0.001$ ). These observations are of clinical value, given that considerable changes in the Reinke's area of the vocal fold affect the time of vocal fold vibration, shortening it, which in the result decreases the effectiveness of the expiration during phonation. Maximum Phonation Time, as an aerodynamic parameter, is an important element of the vocal function assessment which indicates phonatory inefficiency of the larynx and respiratory-phonatory coordination disorder.

Analogically, significant improvement in short-term observation was noted analyzing the results of self-assessment of voice by means of VHI and V-RQOL questionnaires. The improvement concerned both the total VHI score VHI-T and all the subscales: physical - VHI-P, emotional - VHI-E, functional: - VHI-F with  $p_1 < 0.001$  significance.

The improvement persisted in long-term observation – VHI-T ( $p_6 < 0.001$ ,  $p_9 < 0.001$ ). Assessing the evaluation of the voice-related quality of life by means of V-RQOL, statistically significant improvement was demonstrated in both short- and long-term observation ( $p_1 < 0.001$ ,  $p_6 < 0.001$ ,  $p_9 < 0.001$ ). Given the substantial role of improvement of quality of life resulting from treatment, the obtained results of the voice-related quality of life as reported by patients were an important part of the assessment of the effectiveness of phonosurgical treatment. Applying the mini-microflap technique in patients with RO causes improvement in the vibratory function of the vocal folds, making them thinner and more suitable for phonatory maneuvers, which, in turn, improves the quality of voice after the surgery.

The improvement in most ventilatory parameters was observed already 1 month after the surgery. The improvement concerned the following parameters: Peak Expiratory Flow (PEF) ( $p_1 = 0.001$ ), Forced Expiratory Volume in the first second (FEV1) ( $p_1 = 0.024$ ), Maximum Expiratory Flow MEF 25% ( $p_1 = 0.025$ ) and MEF 75% ( $p_1 = 0.002$ ), and FEF 75% ( $p_1 = 0.025$ ).

In the assessment of ventilatory function the most significant improvement was observed for most ventilatory parameters 9 months post surgery: PEF ( $p_9 < 0.001$ ), FEV1 ( $p_9 = 0.024$ ), MEF 25% ( $p_9 < 0.001$ ), MEF 75% ( $p_9 < 0.001$ ), FEF 25% ( $p_9 < 0.001$ ), FEF75% ( $p_9 < 0.001$ ). It should be underlined that the value of PEF parameter, which is described in literature as an important parameter monitoring the effectiveness of procedures widening the

glottis, increased significantly already in the 1<sup>st</sup> month post surgery. The increase persisted in 6 and 9 months post surgery ( $p_6 < 0.001$ ,  $p_9 < 0.001$ ).

The relation between subjective and objective parameters assessing the phonatory function was analyzed with the use of correlation coefficient (Spearman's rho). Satisfactory correlations were observed between: maximum phonation time MPT and physical subscale of VHI - VHI-P in 9<sup>th</sup> month post surgery ( $r = -0.449$ ,  $p = 0.047$ ) and maximum phonation time MPT and voice-related quality of life VRQOL in 6<sup>th</sup> month post surgery ( $r = -0.511$ ,  $p_6 < 0.05$ ).

Analyzing the relation between the parameters of phonation and ventilation, a significant correlation was found between aerodynamic parameter of phonation MPT and ventilatory parameter PEF 1 month after the surgery ( $r = -0.496$ ,  $p = 0.026$ ).

This observation allows to draw conclusions that decreasing the mass of the vocal folds conducted by means of mini-microflap surgical technique and widening of the glottis improves aerodynamic conditions of phonation. The results obtained in follow-up examinations showed that using mini-microflap technique in microsurgical treatment of patients with RO fulfills the primary goal of phonosurgery improving the quality of voice, which was confirmed by instrumental and subjective methods of assessment.

## Conclusions

1. As a result of the conducted mini-microflap surgery in the study group of patients with Reinke Oedema an improvement in the phonatory function was observed, assessed by means of both subjective and instrumental methods in short-term and long-term observation.
2. Pre- and post-surgery comparative analysis showed improvement in ventilatory capacity in the study group patients as a result of the conducted mini-microflap surgery in terms of most assessed ventilatory parameters.
3. In short-term observation (1 month) an improvement in some phonatory and ventilatory parameters was observed; most parameters improved 6 months after the surgery and the improvement persisted in observation conducted 9 months after the surgery.
4. Comparative assessment of the phonatory and ventilatory function of the larynx showed post-surgery correlation between the phonatory parameter: Maximum Phonation Time (MPT) and ventilatory parameter: Peak Expiratory Flow (PEF), which indicates that the conducted surgery by means of mini-microflap technique widens the glottis and improves the phonatory and respiratory function of the larynx at the same time.

5. The use of mini-microflap phonosurgery technique in treatment of patients with Reinke's Oedema meets the priority principle of phonosurgery – the improvement of the voice quality.

*Katomyma una - sabat*