Analysis of voice quality parameters in patients with vestibular voice

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ABSTRACT:

Introduction: Vestibular voice includes participation of larynx structures which are absent in physiological process. Vestibular phonation may be desired when vocal folds are damaged as in paralytic dysphonia, or undesired in marginal hyperfunction. Vestibular voice may result from psychogenic dysphonia – phononeurosis. The aim of the study is perceptive evaluation of vestibular voice, objective larynx visualization, acoustic and aerodynamic examination.

Material and methods: The study included 40 patients: 20 with vestibular voice, 20 with euphonic voice. Voice quality has been evaluated using perceptual GRBAS scale. Endoscopic and stroboscopic larynx examination used Endo-STROB-EL-Xion GmbH with visual track. High-Speed Digital Imaging (HSDI) and High Speed (HS) camera registered true vocal folds vibrations. Acoustic evaluation of voice with DiagNoScope Specjalista, DiagNova Technologies included analysis of F0, Jitter, Shimmer, NHR, nonharmonic components. MPT has been analyzed.

Results: In examined group, hoarseness (95%), roughness (75%) and voice strain (55%) have been recorded. Endoscopy revealed edema of vestibular folds with dilation of vessels covering glottis. Stroboscopy and HSDI confirmed coexistence of hyperfunctional (95%) or paralytic (5%) dysphonia. Acoustic assessment revealed increase in Jitter, Shimmer, NHR and decrease in F0 and MPT.

Conclusions: The vestibular voice is observed most frequently in women with hyperfunctional dysphonia (phononeuroses) or in paralytic dysphonia. Visualisation techniques confirm the coexistence of vestibular folds hypertrophy and edema with vibration disorders. In the perceptual assessment, vestibular voice was hoarse, rough and strained. Acoustic examination showed increase of Jitter, Shimmer, NHR, presence of nonharmonic components and decrease of F0 and MPT.

KEYWORDS: vestibular voice, videolaryngostroboscopy, High Speed Digital Imaging, acoustic analysis

INTRODUCTION

In the process of verbal communication, the larynx and correctly vibrating vocal folds play the key role. The physiological (euphonic) voice is created by vocal folds with the participation of resonating cavities, articulation organs and the respiratory system. The mucous membrane covering vocal folds is susceptible to irritants of the upper respiratory tract, which leads to edema. The edematous changes usually concern the superficial layer of lamina propria of the mucous membrane covering the vocal folds, which causes laryngeal edema, but may affect all anatomical structures of the larynx [4, 5]. The unchanged mucous membrane enables precise vibration of vocal folds and the preservation of its stratified structure guarantees the existence of euphonic voice.

The most common irritant of the upper respiratory tract is tobacco smoke. A frequent cause of laryngeal vibration disorders is neurogenic conditions, occurring in paralytic dysphonia, e.g. after strumectomy. Symptoms of paralytic dysphonia depend on its clinical form. The main symptom may be hoarseness, shortness of breath, coughing and choking while swallowing. Voice disorders (dysphonia) are caused by the irregularity of the vibrations of vocal folds and the lack of glottal closure. Lack of proper vibration of vocal folds with glottal insufficiency may lead to the occurrence of compensation mechanisms involving other larynx structures. The process of voice production may also occur with the use of vestibular folds, which physiologically do not participate in phonation.

Substitute voice is created – a true vestibular voice, desired (vox ventricularis), which differs from the vestibular pseudovoice, undesired resulting from extreme hyperfunction. The vestibular voice is low, flat, rough, hoarse and the phonation causes fatigue. The coexistence of mucosal edema covering vestibular folds additionally deepens the existing dysphonia. Imaging technique plays an important role in the diagnostics of laryngeal pathology, allowing the evaluation of the mobility of vocal folds. For this purpose, endoscopy and stroboscopy of the larynx with a visual track is used. Only the High Speed Digital Imaging (HSDI) technique enables the evaluation of true vibrations of vocal folds. It also allows an objective assessment of the glottal closure and assessment of the degree of phonic paresis on the basis of the Open Quotient (OQ) value.

Acoustic evaluation is also an objective method that allows to assess the quality of voice. The evaluation of Fundamental Frequen-
cy (F0), Jitter, Shimmer, NHR and non-harmonic components in narrowband spectrography indicates the severity of dysphonia.

In the examination of voice, the perceptual methods should not be omitted, as well as, easy to perform, maximum phonation time (MPT) assessment, which provide valuable information useful in diagnosis of dysphonia.

AIM

The aim of the study is to assess the quality of vestibular voice using the perceptual method, objective methods of visualization of the larynx, as well as acoustic and aerodynamic examination.

MATERIAL AND METHODS

The study included a group of 40 patients diagnosed at the Department of Clinical Phonaudiology and Logopedics, Medical University of Bialystok and treated at the Foniatic Outpatient Clinic of the University Hospital in Bialystok in 2017–2018. Patients were divided into 2 groups.

Group I – study group, included 20 patients with a vestibular voice. The average age of patients was 39 years and ranged from 21 to 56 years. All patients were emotionally dysregulated. In 19 (95%) subjects, the features of phononeurosis were found. One (5%) patient developed features of paralytic dysphonia. In this patient, edematous changes were also removed from, both, vocal folds and cysts from the area around the right arytenoid. All patients in Group I were not treated due to reflux disease or chronic inflammatory diseases of the upper respiratory tract. In Group I, 12 (60%) patients smoked; 6 (30%) used voice professionally, 14 (70%) performed physical work.

Group II – control group, consisted of healthy women who were nonsmokers and did not use voice professionally, age between 20 and 54; the average age was 32 years.

Subjective evaluation of voice quality was performed using the perceptual scale – GRBAS, assessing the severity of hoarseness, roughness of voice, its breathiness as well as asthenic or strained character of voice.

The endoscopic and stroboscopic assessment of the larynx was performed using the Endo-STROB-EL-Xion GmbH (Berlin) with visual track. In imaging of true vibrations of vocal folds, High Speed Digital Imaging (HSDI) was applied as well as High Speed (HS) camera – in the HRES Endocam 5562 system by Richard Wolf GmbH, allowing the recording of images at 4000 frames per second. In the examination, a rigid endoscope with 90° optics from the same producer was used. The evaluation of vocal fold vibrations was performed during the phonation of vowel „i”. The playback function enabled a 2-sec. recorded sequence to be analyzed over a period of over 8 minutes.

Acoustic analysis of voice was performed using the Diagnoscope Spezialista, DiagNova Technologies, analyzing the following parameters: F0, Jitter, Shimmer, NHR and the presence of nonharmonic components in narrowband spectrography. In the assessment of aerodynamic activity of the larynx, the maximum phonation time (MPT) was analyzed, giving the values obtained in seconds. The statistical analysis of the obtained results was performed based on the Mann-Whitney test, assuming statistical significance at P < 0.05.

RESULTS

In Group I – all patients reported voice fatigue, hoarseness intensifying in stressful situations and persisting while singing as well as dryness of the mucous membrane of the throat and larynx.

In Group II – patients reported the existence of periodic hoarseness associated only with the coexisting infection of the upper respiratory tract.

In Group I, in GRBAS scale, hoarseness was observed in 19 (95%), roughness in 15 (75%), voice strain in 11 (55%) patients. Asthenic voice and breathiness were not recorded. On auscultation, there was intensified hoarseness of a permanent character, persisting also while singing as well as voice fatigue and grunting caused by the accumulation of dense mucus disturbing phonation. The voice was low, produced with great effort.

In Group II, according to GRBAS scale, hoarseness, roughness or asthenic voice or breathiness were not recorded. Slight increase in voice strain was observed in 2 (10%) patients.

In Group I, bilateral vestibular fold hypertrophy with edema and dilation of vessels of the mucous membrane were revealed. Vestibular folds were closed during phonation, disturbing the assessment of vocal fold mobility (Fig. 1a.). In 10 (50%) patients glottal retinopathy was recorded. In the stroboscopic examination and HSDI, irregular, asymmetric vibrations with a reduced amplitude with bilateral limitation of the Mucosal Wave (MW) with the triangle type of insufficiency in the posterior part of the glottis were observed. Evaluation of the glottis in the anterior and middle part was impossible due to hypertrophy of vestibular folds, which also disrupted the determination of Open Quotient (OQ) (Fig. 1b.).

In Group I, in patient with vestibular voice after strumectomy, a partial assessment of the mobility of vocal folds revealed the existence of paresis of the right vocal fold without glottal closure in the posterior part, a subject only to visual evaluation. During breathing, the right vocal fold did not obtain intermedia position. Apart from vestibular phonation, paralysis of the right vocal fold with bilateral mucosal limitation (MW) was observed, especially on the right side. The vibrations of vocal folds were asynchronous, irregular and asymmetric (Fig. 2a., Fig. 2b.).

In Group II, the pathology of vocal organ was not stated. In 15 (75%) patients, a physiological MW was observed and 5 (15%) patients had a mild asymmetry. Total glottal closure was found in 18 (90%) patients and in 2 (10%) – the C-type paresis. The average value of OQ was 0.527 in the anterior part, 0.53 in the middle, and 0.7 in the posterior part of the glottis.
In Group I, voice acoustic analysis (Diagnosope Specjalista, DiagNova Technologies) revealed decrease in F0 and the presence of nonharmonic components in the low frequency levels of formants and intensified noise component in the high frequency range. The increase in jitter, shimmer and NHR above the normative values was recorded in both, paralytic and hyperfunctional dysphonia (Fig. 3., Fig. 4.). In group II, analyzed parameters achieved normal values. In Group I, average MPT value was 13.95 seconds, in Group II – 22.2 seconds.

**DISCUSSION**

In production of vestibular voice, muscles and larynx structures are involved, which physiologically do not participate in phonation. This is one of compensatory, sphincter mechanisms. The vestibular voice may be a desired compensation when the vocal folds are damaged and their vibration is disrupted. In the examined group, 1 patient revealed this type of compensatory mechanism. Vestibular voice, frequently, is the result of marginal hyperfunction in functional dysphonia, which was recorded in 19 (95%) patients. A frequently observed clinical form of psychogenic dysphonia (phononeurosis) is hyperfunctional dysphonia as observed in the remaining patients from the examined group. A characteristic feature of vestibular voice is its deepening, which is associated with reduced speed of vibration and increased mass of vestibular folds [3, 11, 14, 15]. In addition, the vestibular voice is characterized by monotony, fatigability, feeling of pain and accumulation of mucus in the throat. Pauses in phonation, leading to aphony are also observed [3, 5, 11, 14, 15].

The etiology of the vestibular voice is diverse. According to many authors, it may be a compensation mechanism resulting in substitution voice in vocal fold dysfunctions associated with, for example, vocal fold paralysis, surgical treatment of the larynx with resection of the vocal folds (cordectomy) [10, 12, 14]. Vestibular voice may be an expression of extreme hyperfunction in functional dysphonia [12]. Many authors have found psychogenic vestibular phonation [1, 10]. In the examined material, the vestibular voice was a result of vocal fold dysfunction after strumectomy, psychogenic factors and hyperfunction of the vocal organ.

Maryn et al. [10] distinguished 4 types of vestibular voice: type I – compensatory, associated with damage to vocal folds; type II – non-compensatory, resulting from overuse of voice with hyperkinesis; type III – psychoemotional, induced by stress and psychogenic factors; type IV – idiopathic, in which etiology is unrecognized. Due to the similarity of voice quality disorders, it is difficult to differentiate between vestibular voice and Spasmodic Dysphonia (SD). SD is a chronic disease of the vocal organ, where the paradoxical movements of vocal folds result from involuntary (uncontrolled) contractions of laryngeal muscles, disturbing the formation of euphonic voice. Voice in adductor dysphonia is created with an effort, with pressure and periods of aphonia as well as disturbances of pitch and volume of the laryngeal tone control [2]. Symptoms may be completely or partially alleviated during singing, whispering and laughing, while intensifying in situations of stress, fatigue and anxiety. In both dysphonias, pauses in phonation are observed but in the vestibular voice, hoarseness is permanent and also occurs while singing which was observed in the examined group of patients [13]. According to many authors, vestibular voice diagnosis should be complex, including perceptual evaluation, visualization and acoustic assessment [3, 5, 11, 14, 15]. The most effective method in the diagnosis of aperiodic and asynchronous vibrations is the unique High Speed Digital Imaging technique. Precise assessment of true vibrations of vocal folds (in contrast to stroboscopic illusion) is a guarantee for a reliable and accurate diagnosis, which is associated with implementation of proper therapy and rehabilitation [7, 8, 9]. The presence of nonharmonic components in the examined group, in high frequency levels of formants, generated a noise component in the glottal region, which resulted in hoarseness and disturbed voice tone. Maryn et al. [10] recorded low F0 frequency, jitter increase and reduced MPT in patients with vestibular voice. Similar results were obtained in the examined group. According to Maryn et al. [10], vestibular dysphonia requires interdisciplinary therapy using voice therapy, psychotherapy, injection of botulinum toxin.

**Tab. I. Statistical analysis of MPT - Mann-Whitney test**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>NUMBER OF OBSERVATIONS</th>
<th>MINIMUM [s]</th>
<th>MAXIMUM [s]</th>
<th>AVERAGE [s]</th>
<th>STANDARD DEVIATION</th>
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<td>19</td>
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<td>26</td>
<td>22,2</td>
<td>2,238</td>
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</table>

**Table 1.** Statistical analysis of MPT - Mann-Whitney test

**Fig. 1.** Endoscopic image of larynx in patient from Group I with vestibular voice and hyperfunctional dysphonia. A – Endo-STROB-EL-Xion GmbH (Berlin), B – HSDI, Wolf.

**Fig. 2.** Endoscopic image of larynx of a patient from Group I with hypertrophy and edema of the vestibular folds with coexisting paralytic. A – Endo-STROB-EL-Xion GmbH (Berlin), B – HSDI, Wolf.

CONCLUSIONS

1. Vestibular voice occurs most commonly in women with hyperfunctional dysphonia in the course of phononeurosis or compensation in paralytic dysphonia.

REFERENCES


