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Efficacy of the voice therapy protocol (VTP) for adult patients with unilateral vocal fold mobility impairment; a feasibility study

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ABSTRACT

Background: Unilateral vocal fold mobility impairment (UVFMI) causes dysphonia and/or dysphagia, which can significantly affect a patient's ability to communicate and perform regular daily life activities as well as the quality of life. Voice therapy offers a less invasive and more preferential method for patients. However, there are limitations concerning the integration of multiple therapy approaches. Voice therapy exercises with clear methodologies are required to plan and conduct therapy systematically, and frequency would be required for each exercise. Therefore, this study was conducted by applying the protocols of voice therapy in adult patients with unilateral vocal fold mobility impairment.

Objective: This feasibility study is a prospective cohort, pre-post single arm, designed to determine whether the voice therapy protocol (VTP) can enhance voice quality in adult patients with unilateral vocal fold mobility impairment (UVFMI) in a pilot study.

Materials and methods: All subjects received 12 sessions of voice therapy protocol, with each session conducted weekly for 45 minutes. The voice therapy protocol applied in this study consisted of vocal hygiene education, abdominal breathing exercises, vocal function exercises, pushing exercises, muscle relaxation exercises, and applied resonance voice therapy. The outcomes of protocols for voice therapy were measured before and after treatment using subjective voice assessments (GIRBAS scale) and objective voice assessments (Dr. Speech program and electro-glottography-EGG).

Results: Cases 2, 7, 10, 11, and 13 improved after receiving VTP. As for other participants, there are still some voice parameters that need to be monitored. Overall, it was found that the participants' voice parameters were changing within the acceptable range, with MPT, jitter, shimmer, and HNR values significantly different (p<0.05).

Conclusion: The findings of this study indicated that the voice therapy protocol was a worthwhile alternative and could be used to develop further treatment guidelines for adult patients with UVFMI at a speech clinic.

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Introduction

Unilateral vocal fold mobility impairment (UVFMI) is a condition in which one of the vocal folds suffers from paralysis or paresis, thus causing incomplete glottal closure while speaking.[1,2] This condition usually occurs because of damage to the vagus nerve (tenth cranial nerve; CN.X), which may be a consequence of trauma, iatrogenic

trauma,[3,4] tumor,[5] a viral or bacterial infection, neurotoxic drugs,[4,6] and/or neuritis or idiopathic diagnosis.[4,5,7] This impairment causes vocal abnormalities and/or dysphagia,[3,4,8,9] that significantly affects the patient's ability to communicate and perform regular daily life activities, including social interactions and professional employment, as well as their emotional and physical health.[10-12] Nouraei *et al*. reported that the incidence of adult unilateral vocal fold mobility impairment (UVFMI) in England is approximately 1.2%. The most common causes of UVFMI were idiopathic.[13] In Thailand, there hasn't been any research on the prevalence or incidence of this issue. A previous study found that patients with vocal impairment caused by nervous system abnormalities scored a very low Voice Handicap Index (VHI) compared with patients with vocal impairment from other causes.[10-12] It was also shown that they were more likely to develop a reduction in communication needs or experience difficulties in maintaining interpersonal relationships.[12]

Common symptoms among patients with UVFMI include hoarseness, breathy voice, variations in pitch and loudness, and intermittent diplophonia.[1,2,6,14-16] A breathy voice and reduced loudness of speech were shown to vary according to the emission of air between the glottis while talking. Hoarseness and diplophonia were also caused by the inability of the vocal folds to maintain normal tension within the affected fold, which resulted in asymmetric vocal fold vibrations.[14,17] Furthermore, patients usually exhibited exhaustion after extensive talking and needed more energy to maintain talking in a long conversation. Moreover, they could develop throat pain,[15,16] globus sensation, and neck discomfort.[9] These symptoms were caused by the patient's compensatory behavior to the incomplete folding of their vocal folds.[16,17] Particularly, hoarse voices, strained voices, and low-pitched sounds represented the leading symptoms that caused patients to seek recovery.[9]

Voice therapy presents a less invasive and more preferential method for patients; they would not be subjected to the aforementioned surgical risks.[18] This also offers advantageous results to the patients, such as glottal gap reduction,[9] improved vocal quality,[9,19-21] and quality of life,[19,20] and beneficial results that could last for years.[22] Therefore, voice therapy could be a treatment scheme to help patients recover without unnecessary surgery. Consequently, several techniques have been recommended for treating UVFP, including hard glottal attack exercises (HGA), pushing exercises, and lateral digital pressure. Many other approaches are available, including the head tilt method, half-swallow boom technique, vocal function exercise (VFE), abdominal breathing, head and neck relaxation, lip and tongue trill, resonant voice, accent method, head position, chin tuck, focus, tongue protrusion /i/, yawn-sigh, pitch shift up, and inhalation phonation.[14,23] Each exercise helps to adjust the structures and functions of a patient's vocalization mechanism, which would affect vocal quality.

Voice therapy has typically been conducted as a combination of exercises rather than just relying on a single method.[6,19,24] These practices have also been adopted by speech clinics in Thailand. Although several studies have combined multiple voice therapies that verified the positive treatment results of UVFP, distinguishing which therapies contributed effective results has yet to be determined. In addition, there are limitations to integrating multiple therapies, such as heterogeneity in voice therapy techniques and different methodologies that result in the heterogeneity and inconsistency of the study results. Hence, voice therapy exercises with clear methodologies are required to systematically plan and conduct which frequency would be required for each exercise.[20,22] However, there are no current systematic voice therapy protocols (VTP) for patients with UVFMI in Thailand. Therefore, the purpose of this feasibility study is to inquire if the VTP could improve voice quality for these patients before proceeding with the protocol in a future definitive randomized controlled trial (RCT) study.

Methods

Participants

This pilot study was conducted with 18 new patients diagnosed with unilateral vocal fold paralysis or paresis at the Outpatient Department (OPD) in the Department of Otolaryngology, Faculty of Medicine Ramathibodi Hospital, Mahidol University between October 2018 and November 2019. Purposive subject sampling was applied based on the diagnosis of the otolaryngologist. However, three participants left the study due to health problems, transportation inconvenience, and surgical procedures. Therefore, the study comprised 15 participants (13 females and two males aged between 37-72 years; an average of 58.8 years) who had normal speech, language, and cognitive perception ability and had not been diagnosed with any psychological disorders or neurological diseases, had no communicable-level hearing impairment, no vision problems, and had never previously received voice therapy. Patients being administered medication that affected changes in the laryngeal muscles, laryngeal tissue, and laryngeal functions or had been diagnosed with an allergy, asthma, lung diseases, or other respiratory tract diseases were excluded from the study.

Assessments

In this study, two types of vocal assessments were used, namely subjective vocal assessments and objective vocal assessments.

Subjective Vocal Assessment: Voice samples of each participant were recorded one time with a voice recorder, before and after voice therapy, by reading the Fonfa passage (similar to Rainbow passage), which includes all Thai consonant sounds. The audio files were randomized and recorded onto a compact disc. Subsequently, the files were assessed in terms of the GIRBAS scale by an experienced SLP who had a minimum of 10 years of experience in voice therapy treating patients with voice disorders. In order to perform auditory-perceptual assessments based on the GIRBAS scale (G = grade/degree of the voice disorder, I = instability,

R = roughness, B = breathiness, A = asthenia, and S = strain), the scoring for each parameter can be divided into 4 levels, with 0 = normal, 1 = slightly abnormal, 2 = moderately abnormal, and 3 = severely abnormal.[24] The severity of hoarseness could be inferred from parameter G (Grade), which indicated overall voice quality, thus integrating all the deviant components.[25]

Objective Vocal Assessments

Each participant was assessed using the vocal assessment program of Dr. Speech Software version 5 by Tiger DRS, Inc. The participants were seated 15 cm away from a microphone and performed a prolonged /a:/ sound after inhalation to find the f0, jitter, shimmer, and HNR. The assessment was repeated three times to identify the longest /a:/, selected to represent the patient's MPT. After that, the researcher attached EGG electrodes to the participant's neck around the thyroid cartilage and then prompted the participant to perform another prolonged /a:/ for three seconds to find the CQ.

The voice parameters with descriptions that were derived from objective assessment are presented in Table 1.

Table 1. Voice parameters and description.

Parameters			Norm	Abnormal status
Mean fundamental frequency (mean f0)[26]	An average of the rate of the vocal fold vibration.[25]	Age Male Female	51-60 years 115±6 Hz 191±9 Hz	increasing in value
Jitter[28]	The deviation of pitches or f0 from one cycle to another. In other words, the jitter reflects the abnormality of the vocal fold vibration.[27]		≤0.5%	increasing in value
Shimmer[28]	The deviation of the amplitude waveform from one cycle to another, which reflects the glottal resistance and mass lesion of the vocal folds. [27]		≤3.0%	increasing in value
Harmonic-to-noise ratio (HNR) [26]	The proportion between harmonic energy and noise energy that indicates the regularity of the overall voice signals. [27]	Age Male Female	51-60 years 19.94±0.86 dB 22.37±0.61 dB	decrease in value
Maximum phonation time (MPT) [29]	The aerodynamics analysis assesses the ability to control the respiratory function, laryngeal control, and glottal efficiency of the patients by producing the longest vowel sounds after inhalation.[1]		11.27±3.30 seconds	decrease in value
Closed quotient (CQ) [28]	The level of the vocal fold contacts, but not the glottal width. The CQ could determine the contact of the vocal fold from the hypoadducted "breathy" to hyperadducted "pressed" only.[28]		50-70%	decrease in value

Voice therapy protocol

This study was conducted by applying voice therapy protocols adopted from Kao *et al*.[20] It used voice therapies by the three systems for the physiologies of speech mechanisms, i.e., respiration, phonation, and resonation.[23] Although the study of Kao *et al*. conducted the voice therapy protocol and yielded positive outcomes, there would be limitations in adapting such protocols in the context of a study in Thailand, primarily due to differences in stature.[14]

The voice therapy protocol (VTP) consists of three stages. Each stage took four weeks, meaning the total duration was 12 weeks. Each session was performed once a week for a total of 45 minutes in each of 12 sessions. The stages of the voice therapy protocol (VTP) were as follows.

Stage 1: Appropriate respiratory system adjustment for vocalization (Weeks 1-4): abdominal breathing exercise and muscle relaxation exercise.

Stage 2: Strengthening of the phonatory system (Weeks 5-8): vocal function exercises, pushing exercises, and muscle relaxation exercises.

Stage 3: Appropriate resonation adjustment for vocalization (Weeks 9-12): applied resonant voice therapy (RVT).

Statistical analysis

The vocal assessment data from before and after therapy were computed by utilizing the statistical package IBM SPSS Statistics 22. The results of comparing the mean MPT, f0, jitter, shimmer, HNR, and CQ were analyzed. The data were analyzed using a Wilcoxon signed-rank test (significance level of $p<0.05$). Meanwhile, the GIRBAS were shown as descriptive data.

Results

The results of the vocal assessment that was performed on the 15 adult patients with unilateral vocal fold mobility impairment before therapy, case No. 11, had no abnormal voice and could keep her voice at a normal level until the end of therapy. An evaluation using the GIRBAS Scale after therapy, it was found that when the participants received the voice therapy protocol (VTP), cases No. 6, 7, 8, 12, 13, and 15 had improved G values. When analyzed by objective vocal assessment, it was found that the voice parameters of cases No. 7 and 13 had a better change, except for cases No. 6 and 15, which had higher f0, case No. 8, which had lower HNR values, and case No. 12, who had slightly lower MPT values. Cases No. 1, 2, 5, and 10 had G values unchanged at the moderate level of severity. When analyzed by objective vocal assessment, it was found that the voice parameters of cases No. 2 and 10 tended to improve, except for cases No. 1 and 5, which have a lower HNR value. Cases No. 3 and 4 had G values unchanged in mild severity. When analyzed by objective vocal assessment, it was found that the voice parameters of case No. 3 tended to improve, except for the CQ value, which decreased very low, and case No. 4, in which the f0 value is slightly higher than the normal range. Case No. 14 had an unchanged G value at the severe level. When analyzed by objective vocal assessment, it was found that the CQ value dropped below the normal range. Furthermore, it was found that after the VTP, case No. 9 had more abnormalities, with I, R, and B values and f0 and MPT values not very much changing (Table 2).

In summary, cases No. 2, 7, 10, 11, and 13 improved after receiving VTP. As for other participants, there were still some voice parameters that needed to be monitored. Overall, it was found that the participants' voice parameters were changing within the acceptable range, with MPT, jitter, shimmer, and HNR values significantly different (p<0.05) (Table 3).

Table 2. Demographic characteristics of the participants and speech parameters before and after therapy.

Case No.	F/M	E	O	C	G		I		R		B		A		S		MPT (s)		F0 (Hz)		Jitter (%)		Shimmer (%)		HNR (dB)		CQ (%)	
					Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	F	Ia	L	Bo	2	2	1	1	1	1	2	2	0	0	2	2	3.00	6.40	274.03	275.60	1.25	0.46	5.29	3.34	14.30	19.60	64.43	56.72
2	F	Ia	M	Lo	2	2	1	2	2	3	1	1	0	0	2	3	8.29	9.57	238.41	201.22	0.60	0.49	7.53	2.33	14.51	24.83	64.41	56.75
3	F	Id	M	Bo	1	1	0	1	0	1	1	1	0	0	1	1	6.69	8.28	174.81	158.79	0.16	0.15	1.13	0.74	28.91	31.77	64.31	35.01
4	M	Id	M	Lo	1	1	0	1	1	1	1	2	0	0	1	1	11.39	14.31	127.09	125.59	0.28	0.20	2.09	1.62	25.60	30.45	77.37	49.44
5	M	Id	M	Lo	2	2	1	0	3	3	2	2	0	0	1	1	7.62	10.07	144.86	126.45	0.41	0.35	4.12	2.96	17.72	20.48	44.73	42.09
6	F	Id	M	Lo	2	1	1	1	1	1	3	1	0	0	1	1	6.07	10.79	214.34	230.37	0.14	0.14	0.94	0.87	34.31	34.69	54.20	61.55
7	F	Id	M	Bo	1	0	0	0	1	0	0	0	0	0	1	0	5.77	7.91	162.76	186.00	0.20	0.15	1.95	1.04	24.94	30.16	62.76	53.33
8	F	Ia	L	Bo	3	2	3	1	3	3	3	3	0	0	3	3	3.21	7.40	284.57	278.34	2.15	0.44	7.74	5.89	10.45	15.85	61.71	55.26
9	F	Id	M	Lo	1	2	0	1	1	2	1	2	0	0	1	1	6.49	5.43	202.21	203.80	0.27	0.28	1.65	1.24	29.07	29.92	54.61	56.04
10	F	Id	M	Bo	2	2	1	1	2	3	2	2	0	0	2	1	2.80	7.58	164.35	168.63	0.25	0.36	2.50	2.14	27.31	25.43	42.25	53.66
11	F	Ne	L	Lo	0	0	0	0	0	0	0	0	0	0	0	0	5.17	11.72	199.83	185.89	0.32	0.19	1.16	1.75	30.47	27.10	49.78	59.51
12	F	Vi	L	Lo	2	1	1	1	3	2	2	1	0	0	1	1	5.09	4.78	213.23	230.68	0.40	0.18	4.17	2.75	20.74	22.40	48.98	53.63
13	F	Ia	L	Lo	2	1	1	0	3	1	3	0	0	0	2	1	5.45	12.02	180.58	183.52	0.37	0.15	1.76	0.90	24.24	27.21	46.03	66.33
14	F	Ia	L	Bo	3	3	2	3	3	3	3	2	0	0	3	3	2.53	5.50	190.02	163.15	0.47	0.24	3.56	2.50	23.79	25.90	73.94	43.42
15	F	En	M	Lo	3	1	2	1	3	1	3	1	0	0	3	2	4.31	14.07	216.34	260.10	0.32	0.11	2.08	1.96	25.81	24.86	44.00	65.43

Note: F: Female, M: Male, E: etiology, Ia: iatrogenic, Id: idiopathic, Ne: neuritis, Vi: viral infection, En: encephalopathy

O: Onset:< L: less than or equal to 6 months, M: more than six months, C: Configuration, Lo: longitudinal gap, Bo: bowing

Table 3. Comparison of the results for objective vocal assessment before and after VTP therapy.

Objective vocal assessment	Pre-Tx			Post-Tx			Z	*p* values	95%CI
	Min.	Max.	Median (IQR)	Min.	Max.	Median (IQR)			
MPT (s)	2.53	11.39	5.45 (3.48)	4.78	14.31	8.28 (5.32)	-3.23	0.00*	(1.86-4.77)
Mean f0 (Hz)	127.09	284.57	199.83 (51.99)	125.59	278.34	186.00 (67.53)	0.00	1.00	(-12.32-10.19)
Jitter (%)	0.14	2.15	0.32 (0.22)	0.11	0.49	0.20 (0.21)	-2.79	0.00*	(-0.40-(-0.05))
Shimmer (%)	0.94	7.74	2.09 (2.52)	0.74	5.89	1.96 (1.71)	-3.01	0.00*	(-1.42-(-0.39))
HNR (dB)	10.45	34.31	24.94 (11.19)	15.85	34.69	25.90 (7.76)	-2.38	0.01*	(0.61-4.13)
CQ (%)	42.25	77.37	54.61 (18.38)	35.01	66.33	55.26 (10.07)	-0.51	0.60	(-12.32-6.88)

*Note: Statistical analysis using the Wilcoxon signed-rank test, p<0.05**

Discussion

Case No. 11, who was the otolaryngologist diagnosed with vocal fold paralysis due to neuritis and had voice disorders. She might have recovered from the disease during the referral period from the otolaryngologist to the speech therapist. Therefore, it is possible that the participant had normal voice quality before therapy. However, she kept her voice normal until the end of therapy. This was probably because the participant received instruction on vocal hygiene before beginning the voice therapy protocol. Vocal hygiene prevents undesirable vocal behavior, facilitating the improvement of behaviors that might result in vocal fold trauma.[15,30]

Five participants (cases No. 2, 7, 10, 11 and 13) had improved voice outcomes after receiving VTP, indicating that the voice therapy protocol was systematically selected and organized voice approaches may help balance all three stages of speech mechanisms. Stage I adjusts the respiratory system for vocalization using abdominal breathing and muscle relaxation exercises. Treatment would first begin with the abdominal breathing exercise, as this would provide the general basis for vocalization. Moreover, insufficient air to produce speech would be a common problem for patients with vocal fold mobility impairment.[31] Therefore, the abdominal breathing exercise would help the participants maintain the appropriate subglottic pressure,[10] regulating the length of the utterance,[6] avoiding chest breathing, and vocalizing with residual air.[19] However, as participants already had limited breath support, they might exhibit tightening of the laryngeal muscles during the abdominal breathing exercises, affecting phonation and voice quality.[23] Consequently, participants should also be subsequently treated with muscle relaxation exercises. Stage 2 enhances the strengthening of the phonatory system consisting of VFEs, pushing exercises, and muscle relaxation exercises. Participants would perform a relaxed vocalization to relieve the tension of the supraglottic laryngeal muscles through a low-impact adductory power exercise. A pushing exercise would be conducted to increase the glottal closure. However, these steps require high exertion, and participants might experience supraglottic hyperfunction. Therefore, they would be encouraged to practice muscle relaxation exercises at the end of the treatment. After that, participants should be able to increase the strength of the phonatory systems. Stage 3: An appropriate resonation adjustment for vocalization could be done by employing applied resonant voice therapy (RVT), a form of holistic voice therapy that could assist patients in having forward resonance and easy phonation.[23] This would result in the reduction of the laryngeal hyperfunction.[32] Regular speech mechanisms would require all three stage systems to function together integrally. The abnormality of one or more systems could cause voice disorders.[23] However, other participants persisted in some voice parameters that still need to be monitored; there may be changes. So, intensive voice therapy and continuous therapy can help them have better voice quality.[33]

After receiving the voice therapy protocol, the group of participants had improved G values; there are also cases No. 6 and 15 that still have high f0 values. This may be because both cases had voice disorders for two years, causing the participants to engage in compensatory behavior to reduce the air leakage, resulting in a falsetto voice, which can be a high-pitched sound. As reported by the study of Patel and Parsram.[34] However, it's in contrast with the findings of Bielamowicz *et al.,* which reported that the f0 value decreased as dysphonia increased.[35] Case No. 8 had a low HNR value. This may be because the participant has had the severity of an abnormal voice of R, B, or S at a severe level before entering the program. This can be seen from the roughness (R) caused by irregular vibration cycles of the vocal folds due to the paralyzed vocal fold not moving or being limited. Breathiness (B) is the occurrence of air leaks during vocalization caused by incomplete glottal closure, causing a breathy voice, and strain (S) is an attempt to increase vocal effort, causing the participant to have compensatory behaviors, so the HNR value decreases. HNR is the proportion between harmonic and noise energy that indicates the regularity of the overall voice signals.[27] For UVFMI patients, the HNR value is low compared to normal people.[36] In case No. 8, the HNR value could increase if she received the VTP with more training sessions. In case No. 12, the MPT value decreased slightly because she had a common cold on the day of the therapy assessment. The larynx's mucous membrane is inflamed in this case due to upper respiratory tract infections. Incomplete glottal closure during phonation can be caused by the membranous covering swelling and going red, the vocal folds thickening, and the vocal fold mass becoming stiffer. Air flowed through the glottis, but the vocal folds were not fully adducted. The MPT decreases when glottal airflow increases.[14,37]

A group of the participants had G values unchanged in the severity of moderate; cases No. 1 and 5, which have a lower HNR value. In case No. 1, it may be due to the participant's abnormal voice quality (B, S) being moderately severe before therapy. As can be seen from air leaks during voicing caused by incomplete glottal closure, a breathy voice (B) and attempts to increase vocal effort cause compensatory behavior in the participant's voice (S). These are causing the participant to have a low HNR value. In case No. 1, gaining VTP with more training sessions may cause the HNR value to increase and the S value to decrease. For case No. 5, the HNR value was low, possibly because the participant had a problem with the level of glottal closure. Hypoadduction causes a breathy voice, which corresponds to the abnormal R at a severe level and B at a moderate level of severity before therapy.

A group of the participants had G values unchanged in the severity of mild; case No. 3 tends to improve in all values except for the CQ value, which decreased very low. It is highly likely that she still has glottic insufficiency. As for case No. 4, the f0 value was slightly higher than the normal range. This may be due to the patient being an elderly male whose mass of vocal folds decreases due to changes in the sex hormone estrogen, laryngeal cartilage, and muscle function that also change with age. Therefore,

in males, the f0 value rises with age.[38,39] In addition, the duration of voice disorders has been 1.6 years, causing the patient to have compensatory behavior to reduce air leaks, resulting in the tenseness of the vocal fold.

Case No. 14 had G values unchanged in the severity of severe. Her CQ dropped below the normal range. This may be due to aging, age 72.7 years, possibly having problems with presbylaryngis or aging voice, causing changes in the structure and function of the vocal folds such as vocal fold edge stiffness, atrophy, and bowing, which make the vocal folds unable to close together, resulting in still having glottic insufficiency.[40]

In addition, case No. 9 found more abnormalities after receiving VTP, with f0 and MPT values that did not change much and I, R, and B values that worsened. This may be due to the participant's aging, age 63, and presbylaryngis, causing changes in the structure and function of the vocal folds, such as vocal fold edge stiffness, atrophy, and bowing, which make the vocal folds unable to close together, resulting in still having glottic insufficiency which affects vocal parameters.[40] This is consistent with Vaca *et al.,* who reported that elderly patients had short phonation times, worse jitters, and worse GRBAS scores.[41]

This study used a small number of participants; therefore, its positive results can still be observed. Moreover, the selection and organization of voice therapy techniques, the duration of the therapy, and the number of sessions of voice therapy protocol are important.

Limitations and recommendations

To reach the protocol's efficiency, future research on this aspect should be investigated with a large sample size, using a control group for comparison, utilizing an extended duration of VTP, and following training at home.

Conclusions

Adult patients with unilateral vocal fold mobility impairment (UVFMI) benefit from the voice therapy protocol (VTP), which enhances voice quality. The results of this investigation may be used as preliminary evidence to help develop guidelines for a prospective intervention program.

Ethics approval

Data were collected after receiving approval from the Ethics Committee of Ramathibodi Hospital, COA. No. MURA2018/596.

References

[1] Colton RH, Casper JK, Leonard R. Understanding voice problems: a physiological perspective for diagnosis and treatment. 4th Edition. Philadelphia: Lippincott Williams&Wilkins; 2011.

[2] Kitzing P. Stroboscopy-a pertinent laryngological examination. J Otolaryngol. 1985; 14(3): 151-7.

[3] Bergamini G, Alicandri-Ciufelli M, Molteni G, Villari D, Luppi MP, Genovese E, *et al*. Therapy of unilateral vocal fold paralysis with polydimethylsiloxane injection laryngoplasty: our experience. J Voice. 2010; 24(1): 119-25. doi.org/10.1016/j.jvoice.2008. 05.003

[4] Sulica L, Blitzer A. Vocal fold paresis: evidence and controversies. Curr Opin Otolaryngol Head Neck Surg. 2007; 15(3): 159-62. doi.org/10.1097/MOO.0b013e32814b0875

[5] Sulica L. Vocal fold paresis: an evolving clinical concept. Curr Otorhinolaryngol Rep. 2013; 1(3): 158-62. doi.org/10.1007/s40136-013-0019-4

[6] D'Alatri L, Galla S, Rigante M, Antonelli O, Buldrini S, Marchese MR. Role of early voice therapy in patients affected by unilateral vocal fold paralysis. J Laryngol Otol. 2008; 122(9): 936-41. doi.org/10.1017/S0022215107000679

[7] Kelchner LN, Stemple JC, Gerdeman B, Borgne WL, Adam S. Etiology, pathophysiology, treatment choices, and voice results for unilateral adductor vocal fold paralysis: a 3-year retrospective. J Voice. 1999; 13(4): 592-601. doi.org/10.1016/s0892-1997(99)80013-7

[8] Walton C, Conway E, Blackshaw H, Carding P. Unilateral vocal fold paralysis: a systematic review of speech-language pathology management. J Voice. 2017; 31(4): 509 e7-e22. doi.org/10.1016/j.jvoice.2016.11.002

[9] El-Banna M, Youssef G. Early voice therapy in patients with unilateral vocal fold paralysis. Folia Phoniatr Logop. 2014; 66(6): 237-43. doi.org/10.1159/000369167

[10] Cantarella G, Viglione S, Forti S, Pignataro L. Voice therapy for laryngeal hemiplegia: the role of timing of initiation of therapy. J Rehabil Med. 2010; 42(5): 442-6. doi.org/10.2340/16501977-0540

[11] Harris G, O'Meara C, Pemberton C, Rough J, Darveniza P, Tisch S, *et al*. Vocal fold paresis - a debilitating and underdiagnosed condition. J Laryngol Otol. 2017; 131(S2): S48-S52. doi.org/10.1017/S0022215117000810

[12] Cohen SM, Dupont WD, Courey MS. Quality-of-life impact of non-neoplastic voice disorders: a meta-analysis. Ann Otol Rhinol Laryngol. 2006; 115: 128-34. doi.org/10.1177/000348940611500209

[13] Nouraei SA, Middleton SE, Butler CR, Sandhu GS. An estimation of the population incidence of adult unilateral vocal fold mobility impairment in England. Logoped Phoniatr Vocol. 2015; 40: 93-4. doi.org/10.3109/14015439.2014.902497

[14] Boone DR, McFarlane SC, Von Berg SL. The voice and voice therapy. 7th edition. Boston, MA: Allyn & Bacon; 2005.

[15] Rubin AD, Sataloff RT. Vocal fold paresis and paralysis. Otolaryngol Clin North Am. 2007; 40(5): 1109-31. doi.org/10.1016/j.otc.2007.05.012

[16] Koufman JA, Postma GN, Cummins MM, Blalock PD. Vocal fold paresis. Otolaryngol Head Neck Surg. 2000; 122(4): 537-41. doi.org/10.1067/mhn.2000.102574

[17] Stewart CF, Allen E. Voice therapy for unilateral vocal fold paralysis. In: Sulica L, Blitzer A, editors. Vocal fold paralysis. Germany: Springer; 2010. p. 87-93.

[18] Desjardins M, Halstead L, Cooke M, Bonilha HS. A systematic review of voice therapy: what "effectiveness" really implies. J Voice. 2017; 31(3): 392 e13-e32. doi.

org/10.1016/j.jvoice.2016.10.002
[19] Schindler A, Bottero A, Capaccio P, Ginocchio D, Adorni F, Ottaviani F. Vocal improvement after voice therapy in unilateral vocal fold paralysis. J Voice. 2008; 22(1): 113-8. doi.org/10.1016/j.jvoice.2006. 08.004
[20] Kao YC, Chen SH, Wang YT, Chu PY, Tan CT, Chang WD. Efficacy of voice therapy for patients with early unilateral adductor vocal fold paralysis. J Voice. 2017; 31(5): 567-75. doi.org/10.1016/j.jvoice.2017. 01.007
[21] Mattioli F, Menichetti M, Bergamini G, Molteni G, Alberici MP, Luppi MP, *et al*. Results of early versus intermediate or delayed voice therapy in patients with unilateral vocal fold paralysis: our experience in 171 patients. J Voice. 2015; 29(4): 455-8. doi.org/10.1016/j.jvoice.2014.09.027
[22] Busto-Crespo O, Uzcanga-Lacabe M, Abad-Marco A, Berasategui I, Garcia L, Maravi E, *et al*. Longitudinal voice outcomes after voice therapy in unilateral vocal fold paralysis. J Voice. 2016; 30(6): 767 e9-e15. doi.org/10.1016/j.jvoice.2015.10.018
[23] Stemple JC, Glaze LE, Klaben BG. Clinical voice pathology: theory and management. 3rd Edition. San Diego, CA: Singular Publishing Group; 2000.
[24] Mattioli F, Bergamini G, Alicandri-Ciufelli M, Molteni G, Luppi MP, Nizzoli F, *et al*. The role of early voice therapy in the incidence of motility recovery in unilateral vocal fold paralysis. Logoped Phoniatr Vocol. 2011; 36(1): 40-7. doi.org/10.3109/14015439. 2011.554433
[25] Felippe AC, Grillo MH, Grechi TH. Standardization of acoustic measures for normal voice patterns. Rev Bras Otorrinolaringol. 2006; 72(5): 659-64. doi.org/10.1016/s1808-8694(15)31023-5
[26] Smits I, Ceuppens P, De Bodt MS. A comparative study of acoustic voice measurements by means of Dr. Speech and Computerized Speech Lab. J Voice. 2005; 19(2): 187-96. doi.org/10.1016/j.jvoice. 2004.03.004
[27] Teixeira JP, Fernandes PO. Acoustic analysis of vocal dysphonia. Procedia Comput Sci. 2015; 64: 466-73. doi.org/10.1016/j.procs.2015.08.544
[28] Huang DZ, Lin S. Vocal assessment: user's manual. In: Tiger DRS I, Editor. 1995.
[29] Prathanee B, Watthanathon JI, Ruangjirachuporn PA. Phonation time, phonation volume and air flow rate in normal adults. J Med Assoc Thai. 1994; 77(12): 639-45.
[30] Stemple JC. A holistic approach to voice therapy. In Seminars in Speech and Language 2005. p. 131-7. doi.org/10.1055/s-2005-871209
[31] Schneider SL. Behavioral management of unilateral vocal fold paralysis and paresis. Perspect ASHA Spec Interest Groups. 2012; 22: 112-20. doi.org/10.1044/vvd22.3.112
[32] Miller S. Voice therapy for vocal fold paralysis. Otolaryngol Clin North Am. 2004; 37(1): 105-19. doi.org/10.1016/S0030-6665(03)00163-4
[33] Godoy J, Silverio K, Brasolotto A. Effectiveness of vocal therapy for the elderly when applying conventional and intensive approaches: a randomized clinical trial. J Voice. 2019;33(5):809-e19. doi.org/10.1016/j.jvoice.2018.03.017
[34] Patel R, Parsram KS. Acoustic analysis of subjects with vocal cord paralysis. Indian J Otolaryngol Head Neck Surg. 2005; 57: 48-51. doi.org/10.1007/BF02907629
[35] Bielamowicz S, Kreiman J, Gerratt BR, Dauer MS, Berke GS. Comparison of voice analysis systems for perturbation measurement. J Speech Hearing Res. 1996 ;39: 126-34. doi.org/10.1044/jshr.3901.126
[36] Jesus LM, Martinez J, Hall A, Ferreira A. Acoustic correlates of compensatory adjustments to the glottic and supraglottic structures in patients with unilateral vocal fold paralysis. Biomed Res Int. 2015. doi.org/10.1155/2015/704121
[37] Ng ML, Gilbert HR, Lerman JW. Some aerodynamic and acoustic characteristics of acute laryngitis. J Voice. 1997; 11(3): 356-63. doi.org/10.1016/s0892-1997(97)80015-x
[38] Stathopoulos ET, Huber JE, Sussman JE. Changes in acoustic characteristics of the voice across the life span: Measures from individuals 4-93 years of age. J Speech Hearing Res. 2011; 54: 1011-21. doi.org/10.1044/1092-4388(2010/10-0036)
[39] Gugatschka M, Kiesler K, Obermayer-Pietsch B, Schoekler B, Schmid C, Groselj-Strele A, Friedrich G. Sex hormones and the elderly male voice. J Voice. 2010; 24(3): 369-73. doi.org/10.1016/j.jvoice.2008.07.004
[40] Park J, Alnouri G, Eichorn D, Sataloff RT. Correlation between presbylarynx and laryngeal EMG. J Voice. 2022; 36(3):413-6. doi.org/10.1016/j.jvoice.2020.06.029
[41] Vaca M, Mora E, Cobeta I. The aging voice: influence of respiratory and laryngeal changes. Otolaryngol Head Neck Surg. 2015; 153(3): 409-13. doi.org/10.1177/0194599815592373