

Effects of Voice Quality Improvement Program for Professional Voice Users with Functional Voice Disorders

Jingren Wang¹, Hyunju Park²

¹Adjunct Professor, Hansei University, Department of Performing-Art, ²Assistant Professor, Gachon University, Department of Language Pathology, South-Korea

Abstract

Background/Objectives: One of the most emphasized aspects in voice therapy is voice quality. We investigated the effect of our intervention program on improving voice quality and reducing vocal fatigue.

Method/Statistical Analysis: 10 musical actors/actresses with functional voice disorders were given eight training sessions once a week, and both subjective and objective evaluations of their voices were conducted before and after the training. K-SVHI and VFI were used to measure voice handicap index and voice fatigue index. Praat was used to measure the objective acoustic indices. To examine the statistical significance, a paired sample *t*-test was performed.

Findings: The result of subjective voice quality evaluation showed that both scores of voice handicap index and voice fatigue index were decreased. The objective voice evaluation results showed that the jitter (%) and shimmer(%) scores decreased while the harmonics to noise ratio (HNR) and the speaking fundamental frequency (SF0) scores increased. The lower the jitter and shimmer, the better the quality of voice, while the higher the HNR, the better the quality of voice. The difference between pretest and posttest scores was statistically significant except for the SF0. The reason for small changes in the SF0 seems to be that all participants of musical actor/actresses who skillfully use the voice were able to control their voice to maintain the frequency at a certain level.

Improvements/Applications: Our findings indicate that patients with functional voice disorders have problems ways to use their voice and showed that their voice quality and vocal fatigue can be improved by modifying and training four stages of voice production.

Keywords: *Functional Voice Disorders, Professional Voice Users, Voice Quality, Vocal Fatigue Index (VFI).*

Introduction

Professional voice users are a group of people who use a voice to maintain their jobs, including singers, actors, teachers, and salesmen etc.^[1]. They are interested in ways to preserve voice quality at high risk of being exposed to voice disorders. Musical actors/actresses among professional voice users are highly advanced

artists because they have to digest both theatrical and musical elements, produce short-term intensive voice and imitate the voices of various characters. In the process of playing their role, they are accompanied by muscle tension dysphonia due to incorrect posture, inefficient respiration, excessive muscle tension, and incomplete obstruction of the vocal folds and frequently exposed to functional voice disorders such as vocal nodule, Reinke's edema, and vocal polyp, as well as experiencing voice fatigue^[2]. Functional voice disorders are caused by the misuse and abuse of voice, not by organic or neurological reasons, and are a type of voice disorders that clinicians can easily recognize because they can visualize the larynx structure and function^[3].

Corresponding Author:

Hyunju Park

Assistant Professor, Gachon University, Department of Language Pathology, South-Korea
e-mail: phj8747@gachon.ac.kr

In order to properly assess voice disorders, objective measurements using voice analysis devices are necessary. However, according to the previous research, there may be less correlation between the expert’s objective evaluation of the voice quality and the voice user who perceives it when the voice quality is degraded^[4]. This is supported by the fact that there are many patients who seek an otolaryngologist with a complaint of globus sensation even in the absence of specific voice disorders^[6]. In order to properly evaluate voice disorders and to grasp treatment outcomes, not only objective evaluation but also subjective evaluation of voice users should be considered^[5,7,8]. Functional voice disorders aim primarily at correcting improper use of voice, not surgeries or medical interventions to restore normal phonation function, and direct treatment is known to be more effective in improving voice quality than indirect treatment^[9].

This study was to look at the results of subjective evaluation and objective examination after providing intervention through a series of voice quality improvement program designed by the researchers for professional voice users with functional voice disorders. To this end, we set up the following research questions. First, are there any significant differences in the voice disorder index and the vocal fatigue index before and after applying the voice quality improvement program? Second, are there any significant differences in the acoustic indices (SF0, jitter, shimmer, HNR) before and after applying the voice quality improvement program?

Method

The participants of this study were 10 musical actors/actresses living in Seoul and Gyeonggi area. They were all diagnosed with functional voice disorders by an otolaryngologist, and the specific types of voice disorders can be found in [Table 1]. The age ranged from 19 to 29 years with an average of 24, and the musical actors/actresses’ careers ranged from five months to seven years and six months variously.

Table 1. Information of participants

Sex	Age (Year)	Career (Year)	Type of Voice Disorders
Male	29	1.5	Muscle tension dysphonia
	19	2.5	Vocal nodule
	20	0.5	Chronic edema
	26	2.0	Chronic edema
	23	4.7	Vocal nodule

Sex	Age (Year)	Career (Year)	Type of Voice Disorders
Female	25	7.6	Irregular vocal cords mucous membrane
	25	4.8	Vocal nodule
	24	1.0	Vocal nodule
	24	6.5	Vocal nodule
	24	5.5	Vocal nodule

The data collection took about three months from June 11 to September 13, 2018. The orientation and the pre evaluation were conducted for all participants prior to proceeding with the intervention program. The program was implemented a total of 8 sessions for 60 minutes once a week. One week after the end of the program, the post evaluation for all of them was conducted. The specific research progress is as follows.

1. Developing and implementing the program: In

order to improve the voice quality of the participants, it was necessary to correct erroneous voice production ways and train vocalization according to the voice production principle. Only by approaching the fundamental problem of the interaction and movement of highly complex vocal organs can solve the inveterate problem of voice quality properly. Therefore, we divided into four steps such as posture, respiration, vocal folds contact, and voice quality based on the order of voice production, and then in order to improve the function of each step, a five-step voice quality improvement program was developed and applied to all participants as follows.

Step 1: Since the posture of the singer necessarily affects the respiratory function, the posture correction was performed during singing. Leaning against the wall, the head, shoulders and hips were attached to the wall, and the ears, shoulders and pelvis were aligned in a straight line when viewed from the side, and the jaws was pulled in the direction of the body so that the head was not bowed down.

Step 2: The degree of improvement of respiratory function was identified by implementing the respiratory measurements using simple instruments for measuring inspiratory capacity such as Medline’s Incentive Spirometer – 4,000ml Capacity and One-Way Valve so that the subject was able to recognize the respiratory function and participate actively in the training.

Step 3: If the respiratory function was judged to be degraded, Ultrabreathe (Tangent Healthcare, Ltd.) was

used to train the muscles involved in respiration. After the abdominal was inflated for effective movement of the diaphragm, it was directed to show the movement of the thorax.

Step 4: Hypofunctional voice disorders is characterized by disappearing vibration or stiffness of the vocal folds and by widening glottis chink. Therefore, vocal folds contact training such as vocalization was performed using a wooden tongue depressor to induce smooth and proper vocal folds contact and respiratory support. The vowels were induced to phonate correctly by snapping the wood tongue depressor with the teeth.

Step 5: As a way to improve acoustic characteristics and induce the right singing which is an important factor in voice quality, five steps were trained in sequence, such as Semi-Occluded Vocal Tract Exercises, SOVTEs to descend the larynx position and the opening of the throat which increased the voice quality by adjusting the length and width of the resonance cavity^[10]. SOVTEs used voiced consonant [v], [z], nasal consonant [m], [n], [ŋ], rounded vowel [o], [u], lip trill and tongue trill to close a part of the vocal tract, while the rest was relaxed by using physiological phenomenon such as yawn/sigh and was done by expanding the cross-sectional area of the resonance cavity. At this time, it was required to parallel to vocal folds contact training.

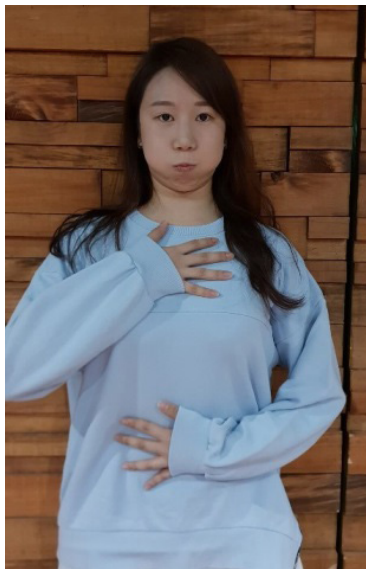


Figure 1. An Example of SOVTEs

2. Evaluation of voice quality

1. Subjective voice quality evaluation:

Subjective voice evaluation used two tools. First, The Korean Version of the Singing Voice

Handicap Index (K-SVHI)^[11] is a subjective evaluation that measures the effects of voice disorders on the quality of life in people such as singers who using voice. This tool has a total of 36 questions and is intended to assess the degree of effects on physical, emotional, economic and social areas with a five-point scale. Next the Vocal Fatigue Index (VFI)^[12] is used to assess the degree of vocal fatigue of participants felt. This tool has a total of 19 questions and consists of three parts. That is, it is divided into 11 questions related to the degree of vocal fatigue and avoidance of voice use, 5 questions related to physical discomfort due to vocal fatigue, and 3 questions related to improvement of symptom due to rest after voice use. VFI is also on a five-point scale.

Subjective voice evaluation allowed the participants to rate after reading the questions themselves. The reliability of the pre evaluation was measured by re-evaluating all participants two times before the intervention program. Although the tools had the same 5-point scale from 0 to 4, the total number of questions was different. So the first author summed these scores and converted them into percentages to measure the reliability of the pre evaluation as the difference between the two evaluations. As a result of it, the percentage error value of the total score of K-SVHI was 3.337% and the percentage error value of the VFI was 5.657%, indicating that the reliability of the pre evaluation data was high. Therefore, the first test data were used to compare with the post test data, in order to exclude the familiarity due to retest.

2. Objective voice quality evaluation: In this study, computer-based Praat (v.6.0.33) was used as the objective voice evaluation tool. The acoustic indices of interest to the authors were jitter(%), shimmer(%), harmonic to noise ratio(HNR, dB), and speaking fundamental frequency (SF0) which are commonly used in the objective voice evaluation^[4]. Jitter and shimmer are acoustic indexes mainly examining the stability of voice. Jitter shows the pitch, that is, irregularity in the frequency of voice production, and shimmer shows the loudness, that is, irregularity in the intensity of

voice production^[13]. It is used to objectively measure the periodicity of vocal folds vibration and to observe the presence or absence of voice disorders, severity, voice quality, and voice change of patients^[4,13]. HNR is an index of how much noise is mixed in a voice and is especially important when evaluating hoarse voices. To obtain these quantitative data, the first author recorded it by allowing the participants to phonate three times a/vowel for at least five seconds and analyzed the length of 1.5 seconds of it. In addition, since SF0 needs to get the mean value of the speaking frequency, the researcher made the subjects read the extracts from the first part of the ‘A Fall Admiration’ paragraph which is often used in voice evaluation and recorded the best results to analyze it^[14]. The microphone used was Supe Uni-Directional Condenser Microphone (320E) and the subjects were examined at a 45-degree angle while keeping the distance between the subjects and the microphone at 30cm in a closed room without noise.

- 3. Statistical processing:** To examine whether our program was effective for the participants, the improvement of the subjective voice quality or not was compared by pre-post K-SVHI score and VFI score and the improvement of the objective voice quality or not was compared with pre and post values for jitter, shimmer, HNR, and SF0. Statistical verification was implemented by paired sample *t*-test using Statistical Package for Social Sciences (SPSS, version 25), the mean and standard deviation (SD) of each result were compared and the significance level was set to 1%.

Results and Discussion

The result of the subjective evaluation after applying the intervention program showed that both K-SVHI score and VFI score were decreased. Both evaluations mean higher score is that the degree feeling the problem about their voice is worse and lower score is that the degree feeling the problem about their voice is less. As shown in [Table 2], the two evaluation scores were significantly lower than before applying the program and the difference between the pre and post scores was also statistically significant[K-SVHI ($t = 4.05, p < .01$), VFI ($t = 3.99, p < .01$)]. This means that the program has improved the voice problems and vocal fatigue of participants

Table 2. T-test results for subject evaluation score differences (N = 10)

Index	Pre/ post-	Score	Mean	SD	<i>t</i>
K-SVHI	Pre-	70.20	39.20	30.59	4.05 **
	Post-	31.00			
VFI	Pre-	35.60	16.20	12.86	3.99**
	Post-	19.40			

** $p < .01$

The objective evaluation results after applying the program showed that SF0 and HNR were higher than before applying the intervention program, and the jitter and the shimmer were lower than before applying the intervention program [Table 3]. The higher the HNR, the better the quality of voice, while the lower the jitter and shimmer, the better the quality of voice. As a result of statistically verifying the difference of pre and post test scores, SF0 did not show statistically significant difference, but jitter, shimmer and HNR showed statistically significant difference[sF0($t = -1.39, p > .01$), jitter ($t = 4.06, p < .01$), shimmer ($t = 4.26, p < .01$), HNR ($t = -4.96, p < .01$)]. This means that the voice quality of the participants has been objectively improved. However, it seems that there was no significant difference in SF0 to be due to intentionally maintaining a constant speaking fundamental frequency in the test before and after intervention because the participants were musical actors with relatively good voice control ability.

Table 3. T-test results for objective evaluation score differences (N = 10)

Index	Pre/ post-	Total score	Mean	SD	<i>t</i>
SF0	Pre-	165.48	-3.17	7.25	-1.39
	Post-	168.65			
Jitter (%)	Pre-	0.45	0.02	0.02	4.06**
	Post-	0.22			
Shimmer (%)	Pre-	4.06	2.14	1.59	4.26**
	Post-	1.92			
HNR (dB)	Pre-	17.91	- 5.88	3.75	-4.96**
	Post-	23.79			

** $p < .01$

Conclusion

The results of this study show that voice quality can be improved by modifying and training the existing inappropriate voice production method at each stage such as respiration, phonation, resonance, and articulation. In

particular, our program was designed to be easily used by anyone. K-SVHI and VFI as subjective evaluation tools and Praat as objective evaluation tools, are easy to download and use online and directions are also simple. Just as you adjust and train your lifestyle according to specific and efficient programs for your physical beauty or strength, naturally repeating the procedure presented in this study to daily life will be an appropriate training method to improve or maintain quality of voice.

Our study involved patients with various medical diagnoses, and our program has been shown to be effective for all of them, regardless of their cause or type. However, further research is needed since the difference in effects by the type of medical diagnosis was not identified due to the small number of participants. This study is meaningful to show that the voice quality of functional voice disorder patients can be improved by training the control ability of vocal organs through the program combined with classical vocal music phonation.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Nil

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