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Efficacy of straw phonation exercises with breathing exercises and indirect approaches for dysphonic adults with benign vocal fold lesions

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ABSTRACT

Background: The voice is essential to a people's daily life, especially in occupational voice users who are at risk for benign vocal fold lesions. It is important to use the proper vocal therapy techniques on a dysphonic patient who has benign vocal fold lesions in order to reduce behaviors that will aggravate the voice disorder and enhance behaviors that help improve voice quality.

Objectives: The purpose of this study was to evaluate the efficacy of straw phonation exercises with breathing exercises and indirect approaches in dysphonic adults with benign vocal fold lesions, including vocal nodules; vocal polyps, and vocal cysts.

Materials and methods: This study was a pilot study. Twelve participants who had benign vocal fold lesions received vocal hygiene guidance, abdominal breathing exercises, muscle relaxation, and straw phonation voice therapy. All participants received 8 weekly therapy sessions: 30 minutes per session. The vocal assessment data was collected before the first voice therapy session, and immediately after the eighth session, by subjective vocal assessment, and objective vocal assessment with Dr. Speech software version 5.

Results: The results after therapy showed significant improvements against the GIRBAS scales in terms of the subjective vocal assessment, in the values of SD F0, jitter, NNE, and MPT of the objective vocal assessment.

Conclusion: This result indicates straw phonation with breathing exercises and indirect approaches as being a worthwhile alternative method for voice therapy in dysphonic patients with benign vocal fold lesions.

Introduction

The important role of the voice is as the medium for communication in our society. Voices matter for sharing ideas, showing an individual's emotions, and representing a personality. Besides, voice use is important for some jobs, such as singers, teachers, salesmen, and so on.[1,2] If voice quality is abnormal, an effect on the people's interpersonal relationships, communication abilities, or working ability is revealed. Additionally, occupational voice users have a high risk of voice disorder because their vocal behaviors can lead to vocal hyperfunction and develop into benign vocal fold lesions.[1] Vocal hyperfunction has been explained as a hypertonic state of intrinsic and extrinsic laryngeal musculature. Examples of vocal hyperfunction are very common, acting as excessive talking, singing with poor

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technique, excessive throat clearing, or coughing. These behaviors may lead to swelling, and to edema of the vocal fold mucosa, and subsequent vocal fatigue. If a patient does indeed have vocal hyperfunctional behaviors, benign lesions will be found on the vocal fold mucosa.[1] To prevent the effect of voice disorders, people with benign vocal fold lesions should receive treatment. The most common treatment for voice disorders is voice therapy.[1,3]

The semi-occluded vocal tract (SOVT) exercise technique is one of the voice therapy techniques which has been developed from a vocal warm-up for singers and has more recently gained popularity in the rehabilitation of the voices of dysphonic patients.[4-7] The SOVT technique includes a group of sub-techniques. Straw phonation exercise is one of those sub-techniques.[4,5,8-12] The basis of the SOVT exercises is to bring about the occlusion of some or all parts of the anterior vocal tract during phonation. Some research about SOVT exercises has shown that some physical changes take place during or after doing exercises.[4,13,14] SOVT exercises are a process that focuses on source-filter interaction to give the acoustic power of voice.[11] The result of this process is the vocal economy which is the minimum degree of vocal folds impact stress to phonate the maximum acoustic output.[5,6,12,15,16] So, the SOVT exercise technique increases the vocal economy by increasing the inertive reactance in the vocal tract.[6,8,10,12,13,15-20] Then, acoustic energy is thrown back to the vocal fold, which makes the phonation threshold pressure lower, and eases phonation.[5, 10, 18, 21, 22] The greater supraglottal pressure was attained by the semi-occlusion, resulting in reduced transglottal pressure, in turn leading to small proportionately vibrational amplitude, and barely any abduction or adduction of the vocal folds.[7,10,12,22-24] Moreover, the subglottal pressure also increases. Phonation with high subglottal pressure reduces the risk of injury to the vocal fold mucosa, making the SOVT Exercises the ideal vocal warm-up.[7,12,18,22-24] SOVT Exercises are based on resonant voice theory, that users will feel the vibration at the mid-face area when there is phonation.[4,5,10,25,26] Even if there are many other sub-techniques, such as voiced fricatives, lip-rounded vowels, nasal consonants, lip trill, tongue trill, or humming, some studies have found straw phonation exercise results in widening the throat, and enhanced voice energy than other techniques.[27] Furthermore, straw phonation exercise is one of the most commonly used SOVT exercises among occupational voice users.[28]

Therefore, to reduce the risk of lesions' progression and to prevent any socially significant effects from voice disorders, patients with benign vocal fold lesions should have efficient and suitable voice therapy. Straw phonation exercise is a sub-technique for voice therapy to produce a voice which results in minimum vocal fold impact stress, so this exercise may be suitable for treatment of hyperfunctional voice users who exhibit benign vocal fold lesions. However, previous studies did not focus specifically on the efficacy of straw phonation in dysphonic adults with benign vocal fold lesions, in order to prove the efficacy of this technique in this type of voice disorder. As such, the objective of this study is to evaluate the efficacy of straw phonation in dysphonic adults with benign vocal fold lesions.

Materials and methods

This study was designed as a pilot study. The details were as follows.

Participants

From the number of new patients with benign vocal fold lesions who came to the Speech Clinic at Ramathibodi Hospital in 2017-2019, it was found that there was an average population of 32 people per year. The sample was determined to be 28 people by using table created by Krejcie and Morgan in 1970 for calculating sample size for a finite population. However, there were twelve participants in the current study when data was collected from November 2018 to October 2020, in addition to the COVID-19 outbreak, and some participants withdrew.

Twelve participants in this study were adults with benign vocal fold lesions, and hyperfunctional vocal behavior. These lesions included vocal nodules, vocal polyps, and vocal cysts. The participants comprised 11 females (91.66%) and 1 male (8.33%). The mean age of participants was 47 years old, SD=14.04 years; with age range =24-62 years old, none of whom having any hearing problem for conversation purposes. The mean onset of voice problem were 16.41 months, SD=34.04 months, and the mean daily voice uses were 3.41 hours, SD=1.37 hours. The diagnosis of all participants included 8 participants with vocal nodules, 3 participants with vocal polyp, and 1 participant with vocal cyst. None of the participants had ever received any voice therapy.

Data collection procedures

The data was collected after receiving approval from the Ethical Committee of the Ramathibodi Hospital, COA. No. MURA2018/819. The researcher would inform participants about the purpose of the study and explain the procedures to them. Subsequently, each accepted participant signed a consent form.

Assessments

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

Subjective Vocal Assessment

Voice samples of each participant were recorded before and after voice therapy by prolonging the vowel /a:/, counting 1-30, and reading the "Fon fah" passage, which includes all Thai consonant sounds. The participants' voice samples were blinded, and subsequently assessed in terms of GIRBAS scales by 3 speech language pathologists who had at least 20 years' experience in voice therapy. The subjective vocal assessment data had to have an agreement from 2 of 3 raters. GIRBAS scales included: values ranging from 0=no abnormality to 3=severe abnormality. The scale comprises 5 components: Grade

(G) is the overall vocal quality impression; Instability (I) is the fluctuation of voice quality over time; Roughness (R) is the auditory impression of irregular fluctuation of fundamental frequency; Breathiness (B) is the turbulent noise from some degree of air leakage whilst speaking; Asthenia (A) is the overall weakness or lack of power of the voice; and Strain (S) is the auditory impression of the voice produced with muscle tension or excess effort.[29-31]

Objective Vocal Assessment

Each participant was assessed by using the vocal assessment program of Dr. Speech Software version 5 (Designed by Daniel Z. Huang, Tiger DRS Inc, Shanghai, China). A participant sat in front of a microphone, 10 cm away from the microphone to the mouth. A participant was suggested to use their usual sound level while doing the assessment by prolonging the vowel /a:/ for as long as possible from one breath to assess maximum phonation time (MPT), and then again in 3 seconds, in order to assess each of the following acoustic parameters of voice: mean fundamental frequency (F0); standard deviations of F0 (SD F0); jitter; shimmer, and; the normalized noise energy (NNE).

Voice therapy sessions

After the assessment session, participants rested for 10 minutes, and then received the first session of voice therapy. The treatment period consisted of 8 sessions, a 30-minute session per week, and 20 minutes for a daily home program. Each therapy session included abdominal breathing exercises, muscle relaxation exercises, and straw phonation. For straw phonation, the method was adapted from the study of Kapsner-Smith *et al*. and Meerschman *et al*.,[5,26] the activities were added progressively in each therapy session, and all activities were straw phonations with the distal end in the air. In the first session, participants phonated /u:/ through a plastic straw of 22.5 cm in length, and 0.5 cm in diameter by placing the straw in the mouth, sealing the straw by the lips without air leaking from the nose or mouth, and focusing on the feeling of vibration in the mid-face. Then, for sessions 2-6, the activities would be added in each session as follows: (i) prolonging /u:/ with a combination of emphasis, and pitch glides, and making a pitch glide up – rest - and down, (ii) phonating /u:/ at separate pitch levels, without glides, (iii) phonating /u:/ when singing and reading sentences, without any articulation, following an intonation pattern, (iv) prolonging /u:/ with and without straw, and (v) reading short passages with and without straw. Session 7-8 would be a repeat of session 6.

After voice therapy in each session, participants were given homework to practice by themselves and to note any problems to discuss in the next session. At the last session, participants rested for 10 minutes after the therapy session, and then they were assessed again by using the same method as before the therapy assessment.

Data analysis

Vocal assessment data from before and after therapy were computed by utilizing the statistical package IBM SPSS Statistics 14. The results of the comparison of GIRBAS scales, before and after voice therapy, were calculated by using the Wilcoxon signed rank test.

Data from objective vocal assessment that included mean fundamental frequency (mean F0), standard deviation of fundamental frequency (SD F0), jitter as perturbation of fundamental frequency, shimmer as perturbation of amplitude, maximum phonation time (MPT), and normalized noise energy (NNE) were compared before and after therapy by using the Wilcoxon signed rank test. Level of significance was set at 0.05.

Results

Results of the subjective vocal assessment and objective vocal assessment were shown as follows.

Subjective vocal assessment

From the comparison of GIRBAS scales before and after therapy by using the Wilcoxon signed rank test, the results show that there is a statistically significant difference, in terms of the p-values being <0.05; G (p=0.046), I (p=0.008), R (p=0.008), B (p=0.035), A (p=0.005), S (p=0.020). So, all severity levels of GIRBAS scales were significantly reduced after therapy. (Table 1)

Table 1 Comparison of results of the subjective vocal assessment (GIRBAS scales) before and after therapy by Wilcoxon signed rank test.

Straw phonation voice therapy				
	Before	**After**	**Z**	***p* value**
	median (QD)	median (QD)		
G (grade of overall severity)	1.00 (0.50)	1.00 (0.00)	-2.000	0.046*
I (instability)	1.00 (0.50)	0.00 (0.37)	-2.646	0.008*
R (roughness)	2.00 (0.50)	1.00 (0.37)	-2.640	0.008*
B (Breathiness)	2.00 (0.87)	1.00 (0.37)	-2.828	0.035*
A (Asthenia)	1.00 (1.00)	0.00 (0.50)	-2.111	0.005*
S (Strain)	1.00 (0.50)	0.00 (0.37)	-2.333	0.020*

**Significant at p<0.05*

Objective vocal assessment

Table 2 shows the comparison of voice parameters from the objective vocal assessment. The results of the Wilcoxon signed rank test show that there were statistically significant differences between before and after therapy of SD F0 (p=0.003), jitter (p=0.014), NNE (p=0.004), and MPT (p=0.010).

Discussion

Results of straw phonation exercises with breathing exercises and indirect approaches in the current study

Table 2 Comparison of the results of objective vocal assessment (voice parameters) before and after therapy by Wilcoxon signed rank test.

Straw phonation voice therapy				
Parameter	Before	After	Z	*p* value
	median (QD)	median (QD)		
Mean F0	200.47 (21.57)	199.43 (18.59)	-0.314	0.754
SD F0	3.56 (1.28)	1.56 (0.35)	-2.981	0.003*
Jitter	0.29 (0.39)	0.22 (0.05)	-2.447	0.014*
Shimmer	1.88 (1.87)	1.49 (0.24)	-1.334	0.182
NNE	-7.43 (2.84)	-13.22 (2.63)	-2.903	0.004*
MPT	5.60 (1.52)	6.43 (1.12)	-2.589	0.010*

**Significant at p<0.05*

were evident to be an effective method for patients with benign vocal fold lesions after 8 sessions of voice therapy with at least 4 days of home program during each week. These results also agree with the principle of SOVT exercise technique. For the subjective vocal assessment, all results of GIRBAS scales showed there to be statistically significant differences in scales between before and after therapy. The similarity of the results to those from the study by Peas *et al*.[32] may be attributable to the participants in the study, who were dysphonic adults. Although the study of Peas *et al.* assessed the immediate effects of voice therapy, this consistency indicated that the straw phonation was effective for better voice quality immediately after exercises and after 8 weeks of continuous therapy. Moreover, in the study of Peas *et al*., the voice sample was a natural speech sample, such as the counting number.[32] As in the current study, the counting 1-30 and reading the passage, which were used in a subjective vocal assessment, were natural speech samples, so the effectiveness of the therapy would be shown. Furthermore, the straw phonation with the distal end in the air in the current study was similar to the study of Guzman *et al*.,[25] they found that the results of the straw phonation with the distal end in the air from an auditory-perceptual assessment showed a significant improvement. Thus, it could be speculated that the straw phonation with the distal end in the air, enables auditory self-monitoring, as the participants are able to hear themselves clearly while doing tasks. Then, the auditory monitoring would lead to the improvement of voice quality.[25] However, the results of Fadel *et al*.[33] who studied the immediate effect of SOVT exercise with LaxVox tube in singers, showed that there was no difference in the results of the perceptual assessment. The different results may be due to the participants who were singers without any voice disorders, and the duration of treatment was too short to show any effectiveness.

Meanwhile, the objective vocal assessment revealed the changes in voice parameters - after therapy in SD F0, jitter, NNE, and MPT - to be statistically significant. For SD F0, which should be less than 3.0 in the vocal assessment program of Dr. Speech software, a significant reduction represented a positive effect on the voice parameters, which might affect the voice quality after therapy. Likewise, the reduction in jitter meant the frequency variations of participants' vocal fold vibration were reduced, and this affected the better voice quality.[1] Furthermore, Fadel *et al*.[33] mentioned that the straw phonation was a therapeutic option for voice disorder cases, and it brought about smoother and more efficient mobility of the vocal folds by increasing activity of the thyroarytenoid muscle instead of that of the cricoarytenoid lateralis muscle.[12] As regards NNE, or noise in voice production, normal sound should be accompanied by minimal noise.[1] The similarity of results with Peas *et al.,*[32] Fadel *et al*.[33] and Guzman was evident in the reduction of noise in voice production after straw phonation.[34] The goal of straw phonation exercises was to improve voice production efficiency, with the process focusing on source-filter interaction to provide acoustic power of voice,[35] and possibly be effective in reducing noise in voice production. In this current study, NNE was reduced significantly. That is, the noise in production, which affects the voice quality of participants, was reduced after straw phonation voice therapy. It also corresponds to the study of Guzman *et al*.[34] The result of which was that the breathy voice quality, which represented the noise in voice production, decreased significantly. These results may be due to better control of airflow, which is required to perform straw phonation.[32] Nonetheless, Guzman *et al*. noted that this change could be found after a sudden set of exercises and after several weeks of therapy in the participants who were patients with hyperfunctional voice disorders.[34] For MPT, the finding of this study was that it increased significantly after having undertaken the therapy, such that participants could produce longer phonations after straw phonation voice therapy. However, the result of MPT in this study was contrary to the MPT finding of Meerschman *et al.,*[26] there was no significant difference between the before and after straw phonation in healthy participants. Meerschman *et al*. informed that the MPT of their participants might be in a normal range before therapy.

Nevertheless, there were two voice parameters in the current study that had no significant difference before and after therapy. They were mean F0, and shimmer. Each did exhibit a tendency to decrease when comparing the median before and after therapy. For shimmer, eight participants were found to have shimmer that was within the norm of Dr. Speech software's vocal assessment program before and after therapy, but four were found to be abnormal before therapy. However, three of them were found to have normal shimmer after therapy. It was noticed that another individual who had abnormal shimmer before and after therapy tended to have reduced shimmer afterwards. Meanwhile, the F0 before therapy was found to be higher than normal in one male participant in this study. But after therapy, it was found that the F0 decreased but still did not reach the normal criteria. Before therapy, 5 of the 11 female participants had F0 that were within the acceptable range for their age and sex. The other 4 had F0 that were below average, while 2 had F0 that were above average. Three female participants

with F0 below the acceptable range had their F0raised to the acceptable range, while one female participant with F0 above the acceptable range had her F0 decrease to a level that was nearly within the acceptable range. The F0 of female participants who had previously been within the normal range had slightly decreased but remained within the range. As a result, overall F0 trend decreases. The decreasing F0 in the current study was similar to that from the study of Laukkanen *et al*.[36] which mentioned that the decreasing F0 was accompanied by comfortable and easy phonation. In contrast to the study of Fadel *et al.*[33] they found that the F0 significantly increased in female participants. They noted that the increase in F0 occurred post-SOVT exercises with high pitched sound technique by gliding and ascending scales. So, the cricothyroid muscle, which regulated the fundamental frequency, was activated during the exercise.[33] Even though the current study comprised with some sessions with pitch sound techniques, the pitch sound techniques comprised with ascending and descending scales. Also, participants of this study were dysphonic adults, and the exercise was eight weekly sessions. But the participants in the study of Fadel *et al.* were healthy singers, and their results were assessed immediately after SOVT exercise.

Conclusion

The results of the current study have shown the efficacy of straw phonation with breathing exercises and indirect approach after therapy in the GIRBAS scales and in the values of SD F0, jitter, NNE, and MPT. Thus, this may indicate straw phonation as being another worthwhile alternative method for voice therapy in dysphonic patients with benign vocal fold lesions and the therapeutic results can be seen within a period of 8 weeks. Patients have been practicing continually during the whole course of therapy and should also be practicing by themselves at home. However, the participants also received some behavioral voice therapy methods. There is also the possibility that the participants would have better voice quality as a result of side voice therapy.

The COVID-19 pandemic had interfered with this data collection; thus, the number of research participants was limited. This study was nonetheless designed as a pilot study. For further studies, the data should be collected from a greater number of participants and compared the results from both genders of participants and should collect the physical characteristics of the vocal cords, in order to be able to study the significant changes in the lesion on the vocal folds. The comparison among other voice therapy techniques should be studied in order to achieve a comprehensive comparison of results for voice quality.

Ethic approval

The data was collected after receiving approval from the Ethical Committee of the Ramathibodi Hospital, COA. No. MURA2018/819.

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