Laryngeal and Pharyngeal Activity During Semioccluded Vocal Tract Postures in Subjects Diagnosed With Hyperfunctional Dysphonia

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Summary: High vertical laryngeal position (VLP), pharyngeal constriction, and laryngeal compression are common features associated with hyperfunctional voice disorders. The present study aimed to observe the effect on these variables of different semioccluded vocal tract postures in 20 subjects diagnosed with hyperfunctional dysphonia. During observation with flexible endoscope, each participant was asked to produce eight different semioccluded exercises: lip trills, hand-over-mouth technique, phonation into four different tubes, and tube phonation into water using two different depth levels. Participants were required to produce each exercise at three loudness levels: habitual, soft, and loud. To determine the VLP, anterior-to-posterior (A-P) compression, and pharyngeal width, a human evaluation test with three blinded laryngologists was conducted. Judges rated the three endoscopic variables using a five-point Likert scale. An intraclass correlation coefficient to assess intrarater and interrater agreement was performed. A multivariate linear regression model considering VLP, pharyngeal width, and A-P laryngeal compression as outcomes and phonatory tasks and intensity levels as predictive variables were carried out. Correlation analysis between variables was also conducted. Results indicate that all variables differ significantly. Therefore, VLP, A-P constriction, and pharyngeal width changed differently throughout the eight semioccluded postures. All semioccluded techniques produced a lower VLP, narrower aryepiglottic opening, and a wider pharynx than resting position. More prominent changes were obtained with a tube into the water and narrow tube into the air. VLP significantly correlated with pharyngeal width and A-P laryngeal compression. Moreover, pharyngeal width significantly correlated with A-P laryngeal compression.

Key Words: Semiocclusion–Vocal tract–Voice therapy–Hyperfunction–Dysphonia–Aryepiglottic narrowing–Vertical laryngeal position–Pharyngeal width.

INTRODUCTION

It is generally agreed among clinicians and voice scientists that the vertical laryngeal position (VLP) is an important aspect of voice production in both normal and pathological voices.[1,2] It seems that several factors affect the VLP, such as phonetic features,[3,4] lung volume,[5] voice technique,[6,7] pitch control,[6] respiratory technique,[8] and vocal loudness.[9]

A high laryngeal position is commonly associated with voices that have a strong component of muscle tension, especially in patients diagnosed with hyperfunctional voice disorders. Commonly, the abnormally high tension in extrinsic laryngeal muscles may cause a high position of the larynx.[10–12] Therefore, a lowering of the elevated larynx is usually an important goal in clinical voice therapy and classical singing pedagogy.[1,13–19] Several vocal exercises have been reported as useful therapeutic and training tools to lower the larynx. The yawn-sigh technique is one of the most popular among voice pathologists and voice teachers.[14] Other exercises are the prolonged consonant /b:/,[15] soft and aspirate vocal onset,[16] and laryngeal manipulation.[17–19]

VLP has both acoustic and physiological implications. An upward movement of the larynx from its resting position shortens vocal tract length, which raises all formant frequencies; this, in turn, produces a brighter vocal quality.[20,21] The low position of the larynx produces the opposite acoustic effect. The VLP also has important effects on the biomechanical properties of the vocal folds. A high VLP stiffens the vocal fold tissues, therefore increasing fundamental frequency and potentially changing the folds' vibratory pattern. Furthermore, high VLP usually facilitates a tight vocal fold adduction as part of the valving laryngeal function for airway protection.[20,21] Moreover, Titze[22] reported that vocal folds are likely to be thicker when the larynx is lowered. Thus, the cover of vocal folds loosens and the medial surfaces make a better glottal closure. When this occurs, a greater maximum flow declination rate is produced, which contributes to the increased vocal intensity without additional vocal effort.

Another common feature treated by voice therapists in patients diagnosed with muscle tension is the relaxation and opening of the pharyngeal area. This is also an important goal of singing pedagogy. Exercises to produce an open throat have been one of the most used tools to produce freedom or lack of tension in the area of the throat, resulting in a lack of constriction and a better voice quality in both normal and pathological voices.[13,23,24] Most teachers include the use of the open throat technique as an important feature in singing training, especially in classical singing. The purpose of these types of exercises is described by voice trainers to be a way of maximizing pharyngeal space and/or achieving abduction of the ventricular folds.[13] Titze[25] as well as Titze and Story[26]

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described a “wide pharynx” as an acoustic enhancement to the first formant and to the overall sound. An open throat production has perceptually been described as a rounded, free, effortless, and warm sound.[27]

Supraglottic activity refers to the movements and configurations of structures above the vocal folds. There are two types of supraglottic activity: (1) anterior-to-posterior (A-P) laryngeal compression (aryepiglottic narrowing), which occurs when the arytenoid cartilages approximate the petiole of the epiglottis and (2) medial constriction, which refers to adduction of the false vocal folds.[28,29] Supraglottic activity has been commonly classified as a sign of nonorganic hyperfunctional dysphonia by clinicians.[30] In addition, for many years, the development of several benign lesions on the vocal fold surface has been assumed to be related to hyperfunctional behavior or phonotrauma.[31] On the other hand, some studies show that supraglottic activity could be present in subjects with normal voice.[28,29,32] In fact, both A-P and medial compression have been found to be normal and even desirable laryngeal behaviors in singing[7,33–36] and speaking among professional voice users.[37]

The present study aimed to observe and compare the effect of eight semioccluded vocal tract postures on VLP, A-P laryngeal compression, and pharyngeal width in a group of subjects diagnosed with hyperfunctional dysphonia.

METHODS

Participants

This study was approved by the research ethics committee at the School of Communication Disorders of the University of Valparaiso, Chile. Informed consent was obtained from 28 adult subjects (19 women and 9 men). The average age of this subject set was 26 years, with a range of 20–28 years old. Inclusion criteria for this study included (1) no previous voice therapy or voice training and (2) diagnosis of hyperfunctional dysphonia without any vocal fold lesions. Individuals with a history of smoking were excluded from this study. Although 28 subjects were recruited, seven of them did not meet the inclusion criteria. Therefore, only 21 were included in the analysis. Participants were asked to undergo flexible laryngoscopy to corroborate laryngeal diagnosis and to perform the phonatory tasks. The initial diagnosis was made by a laryngologist with more than 20 years of experience in voice disorders. All participants reported at least 1 year of voice problems.

Laryngoscopic procedure

At the beginning of the examination, participants were asked to sit upright in a comfortable chair. Assessment of the laryngeal and pharyngeal activity was carried out through endoscopic examination with a flexible fiberoptic endoscope (Olympus ENF type p4; Olympus, Center Valley, PA) connected to a video camera (Sony DCX-LS1 Sintek; Sony Corporation, New York, NY) and a Richard Wolf LP 4200 light source (Richard Wolf Medical Instrument Corporation, Vernon Hills, IL). Analog images were digitalized with Pinnacle Studio HD 10 software (Corel Corporation, Fremont, CA), and views were monitored on a color television monitor (Sony SSM-20L120). All examinations were performed without topical nasal anesthesia. The flexible endoscope was placed directly below the tip of the uvula, allowing a full view of the pharynx and larynx. This placement was fixed by securing the fiberscope against the alar cartilage of the nose with the laryngologist’s finger. A steady placement of the fiberscope is crucial because observation of laryngeal height adjustments and other laryngeal configurations can be affected by movement of the fiberscope. For the purposes of this study, three aspects were observed during laryngoscopic procedure: VLP, pharyngeal width, and A-P laryngeal compression.

Phonatory tasks

During the observation with the flexible endoscope, each participant was required to produce four different semioccluded vocal tract exercises at habitual speaking pitch: lip trill, hand-over-mouth technique, tube phonation into air, and tube phonation into water. All subjects performed these phonatory tasks twice. Participants were asked to perform tasks at their habitual speaking pitch to avoid variation (the effect of pitch on) in VLPs. Participants were asked to produce each exercise at three loudness levels: soft, moderate, and loud. Tube into water exercises were performed at only moderate loudness. The tube phonation tasks were performed using four different types of plastic commercial drinking (wide) and stirring (narrow) straws. Each participant was instructed to hold the straw with one hand, straight out from the mouth. The straw was maintained a few millimeters between the rounded lips, so that no air would leak from the mouth; the free end was kept either in the air or submerged under the water as an extension of the vocal tract. Careful control of pitch throughout the entire sequence was performed. An electronic keyboard was used to give and control the pitch, which was monitored auditorily. Pitch control is relevant because it may influence both laryngeal and pharyngeal activities. Each phonatory task was produced for a minimum of 7 seconds, and subjects were required to breathe normally between tasks to avoid the effect of lung volume on the laryngeal height. Before each semioccluded task, participants returned to a phonatory resting position to obtain baseline measures.

Each complete assessment session was accomplished in approximately 15 minutes with the following protocol:

1. Phonation into a long-wide tube (6 mm of inner diameter and 20 cm in length).
2. Phonation into a long-narrow tube (3 mm of inner diameter and 20 cm in length).
3. Phonation into a short-wide tube (6 mm of inner diameter and 10 cm in length).
4. Phonation into a short-narrow tube (3 mm of inner diameter and 10 cm in length).
5. Phonation into a long-wide tube submerged 3 cm below the water surface.
6. Phonation into a long-wide tube submerged 10 cm below the water surface.
7. Phonation using the hand-over-mouth technique.
8. Phonation with lip trill.

The order of the tasks in the protocol was not randomized.

Visual evaluation

To determine the VLP, A-P compression, and pharyngeal width, we conducted a human evaluation test with three blinded judges (2 men, 1 woman; mean age of 46 years with a range of 42–50 years). All judges were laryngologists with more than 4 years of experience in voice disorders. All audio signals were removed from video samples before performing the assessment to avoid the possible effect of voice quality on the judges' ratings. To standardize the rating parameters and rating scales, the three judges participated in a 1-hour training session in videolaryngoscopic examinations. Video samples from each subject were played to the judges, and they were instructed to rate the three endoscopic variables using a five-point Likert scale; for VLP (1 = very high and 5 = very low), A-P laryngeal compression (1 = very opened and 5 = very narrow), and pharyngeal width (1 = very narrow and 5 = very wide). The evaluation was performed in a quiet room. Ratings were completed in two sessions by all the raters. Each session lasted no more than 1 hour. All raters reported normal or corrected-to-normal vision. Fifteen percent of the samples were randomly repeated to assess the intrarater reliability. Judges were not aware of these repetitions.

Statistical analysis

Descriptive statistics were calculated for the variables, including mean and standard deviation. A multivariate linear regression model was used to obtain an intraclass correlation coefficient (ICC) to assess the judges' reliability (intrarater and interrater agreement) controlled by phonatory task and vocal loudness. Then, another multivariate linear regression model considering VLP, pharyngeal width, and A-P laryngeal compression as outcomes as well as phonatory tasks and its intensity as predictive variables (and its interactions if exist) was performed. Simple correlation analysis using Spearman rho between VLP, pharyngeal width, and A-P laryngeal constriction was also conducted. One-way analysis of variance for test differences between phonatory task scores was used. The analysis was performed using *Stata* 12.1 (StataCorp LP, College Station, TX) software. An alpha of .05 was used for the statistical procedures.

RESULTS

Table 1 shows the results from the intrarater reliability analysis. A good intrarater concordance was demonstrated for each judge. Moreover, the three blinded judges obtained a high agreement (interrater reliability) (ICC = 0.79 [0.66–0.87], $P < 0.0001$).

Table 2 and Figure 1 display the comparison between score averages by phonatory task for each variable (outcome). *P* values indicate that all variables were found to have a significant effect, and all of them differ significantly from each other ($P < 0.0001$). Therefore, VLP, A-P laryngeal compression, and pharyngeal width changed differently throughout the eight semioccluded postures.

TABLE 1.
Intrarater Reliability Analysis

Judge	ICC (95% Confidence Interval)	*P* Value
1	0.71 (0.61–0.86)	<0.0001
2	0.78 (0.67–0.88)	<0.0001
3	0.65 (0.54–0.79)	<0.0001

Results from the multivariate linear regression model including VLP, pharyngeal width, and A-P laryngeal constriction as outcomes as well as phonatory task and its intensity as predictive variables (and its interactions if they exist) are shown in Table 3.

VLP significantly correlates with pharyngeal width (rho = 0.578; $P < 0.0001$) and A-P laryngeal constriction (rho = 0.3364; $P < 0.0001$). Furthermore, pharyngeal width significantly correlates with A-P laryngeal constriction (rho = 0.18; $P = 0.001$).

DISCUSSION

The present study aimed to observe the effect of eight semioccluded vocal tract postures on VLP, A-P laryngeal compression, and pharyngeal width in a group of subjects diagnosed with hyperfunctional dysphonia. This is the first study designed to compare the effect of a large number of semioccluded vocal exercises and different loudness levels on pharyngeal and laryngeal activities. Result revealed that the effect on these variables is statistically significant throughout all phonatory tasks.

All semioccluded postures produced a decrease in VLP compared with the resting position. Phonation with tube into the water (10 and 3 cm below the surface) and phonation into a long-narrow tube produced the three lowest VLPs. Interestingly, the same three phonatory tasks caused the widest pharynx and the narrowest A-P laryngeal compression. In fact, the correlation analysis demonstrated a high correlation between all these dependent variables.

Sovijärvi et al[38] stated that one of the most relevant effects of tube phonation is the lowering of the larynx. The degree of this effect would be related to the length of the tube.[39–41] The same author pointed out that the goal is not necessarily to reach a very low larynx but to avoid a high VLP, especially in subjects with hyperfunctional laryngeal activity.[42]

Earlier investigations have demonstrated similar effects of tube phonation on VLP. In a computerized tomography study, Guzman et al[43] reported lowering of the larynx during both glass resonance tube and stirring straw phonation. This change remained during vowel production after tube and straw. In a -videofluorographic and dual-channel electroglottographic registration, Laukkanen et al[44] found a lower VLP compared with the resting position during other semioccluded vocal tract postures. The opposite effect of tube phonation on VLP has also been demonstrated.[45,46] Furthermore, two recent magnetic resonance imaging studies reported no changes on the VLP during phonation into a resonance tube and during voiced plosive consonants.[47,48]

It is important to highlight that no previous studies have reported the effect of semioccluded postures on VLP in subjects

TABLE 2.
Comparison Between Score Averages by Phonatory Task for Each Variable

	Phonatory Task (Mean, Standard Deviation)								
Variable	Long-Wide Tube	Long-Narrow Tube	Short-Wide Tube	Short-Narrow Tube	Tube Into the Water (3 cm)	Tube Into the Water (10 cm)	Hand Over Mouth	Lip Trill	*P* Value
VLP	3.96 (0.67)	4.38 (0.65)	3.71 (0.55)	4.17 (0.58)	4.28 (0.56)	4.80 (0.40)	3.73 (0.62)	3.47 (0.64)	<0.0001
Pharyngeal width	3.63 (0.65)	4.04 (0.79)	3.34 (0.57)	3.88 (0.59)	4.19 (0.51)	4.66 (0.57)	3.66 (0.67)	3.19 (0.56)	<0.0001
A-P laryngeal compression	3.25 (0.67)	3.52 (0.64)	3.23 (0.55)	3.49 (0.73)	3.80 (0.74)	4.04 (0.92)	3.19 (0.73)	3.38 (0.55)	<0.0001

diagnosed with nonorganic hyperfunctional dysphonia. A high VLP is commonly presented in patients with this vocal condition.[10–12] Because VLP significantly decreased in our participants, it can be concluded that semioccluded postures, especially tube submerged into the water and phonation into long-narrow tube (stirring straw), are suitable therapeutic tools for people with high VLP because of laryngeal muscle tension.

Muscle tension may be reflected in the pharyngeal activity as well, more specifically in pharyngeal narrowing. Findings from the present study revealed that all phonatory tasks produced a widening of the pharynx during exercising. Earlier studies have demonstrated similar outcomes on pharyngeal configuration.[47–49] Several changes were observed during both glass resonance tube and narrow straw phonation in a recent study.[43] The lower pharynx area, middle pharyngeal region, and A-P width of the hypopharynx increased during exercising compared with vowel phonation before the exercises. All these changes were larger during straw than tube phonation. Moreover, in a computed tomography and finite-element modeling investigation, the most dominant change in the vocal tract during phonation into the tube was caused by expansion of the cross-sectional area of the oropharynx.[49] An increase in the area of the junction between the pyriform sinuses and epilaryngeal tube was also observed. Hence, lengthening of the vocal tract may also have a positive effect on pharyngeal configuration in patients with hyperfunction. It may also be used as a vocal training exercise in normal individuals.

Two possible explanations could be reasonable for the effect on VLP and pharyngeal width of phonation with a tube submerged under the water and a long-narrow tube (stirring straw). First, oral pressure increases during these types of exercises.[43,50] In a previous study, acoustic impedance and mean supraglottal resistance were raised by phonating into different tubes (different in length and inner diameter) in the air and submerged under the water. The results showed that the oral pressure is higher when phonating into narrow straws (stirring straws) than wide straws (drinking straws) and even higher when straws are submerged under the water. Furthermore, the deeper the straw is under the water the higher the oral pressure.[50] These findings are in line with the results reported by Titze.[51] Guzman et al[43] also reported increased oral pressure during resonance tube and stirring straw phonation, being greater in the latter. Interestingly, in the present study, the lowest VLP and widest pharynx were observed during the most resistive phonatory tasks: phonation into a straw submerged under the water (3 and 10 cm) and phonation into a long-narrow tube (stirring straw). The other semioccluded postures also produced the same effect but with a lower degree. The increased oral pressure during semioccluded exercises may have directly pushed the larynx down and the pharyngeal walls laterally. Therefore, the first possible explanation would be a mechanical effect. The second explanation of the effect on VLP and pharyngeal widening of semiocclusions is the muscle relaxation. The pushing effect accomplished by oral pressure may produce a relaxation of the laryngeal and pharyngeal musculature, and this in turn may have produced a lowering of the larynx and widening of the pharynx.

Another interesting result from the present study was the aryepiglottic narrowing (A-P compression) found during all phonatory tasks. As occurred for the VLP and pharyngeal width, the A-P compression was also more prominent during phonation with a tube submerged under the water (3 and 10 cm) and during phonation with a long-narrow tube. Aryepigottic narrowing or A-P laryngeal compression has been described as both a sign of laryngeal hyperfunction[28,29] and also as a good and desirable feature in voice performers.[7,33–36] Sundberg[7] reported that the aryepiglottic narrowing contributes to the formation of the singer's formant, a cluster of the third, fourth, and fifth formants. This acoustic characteristic, typical in trained singers, may help singers obtain a louder and brighter voice quality because of a high concentration of acoustic energy around 3 kHz. These findings were later confirmed by Titze and Story.[26]

It not surprising that in the present study, VLP and A-P laryngeal compression were correlated. In this regard, Sundberg[7] has suggested that aryepiglottic narrowing can be reached by lowering of the larynx. According to the author, a low VLP is a way to obtain a high ratio between the cross-sectional area of the low pharynx and the epilaryngeal tube opening, which is the necessary setting to produce the singer's formant cluster. Nevertheless, this is not the only way to reach the high ratio. Earlier investigations have demonstrated that a spectral prominence near 3 kHz could also be obtained by other vocal tract strategies.[37,47,48]

A high correlation between pharyngeal width and A-P laryngeal compression was demonstrated in the present study as well. This means that when the pharynx widened, there was also a narrowing of the aryepiglottic sphincter. A greater ratio of inlet to the pharynx over the outlet of the epilarynx tube has previously been reported using magnetic resonance imaging and computerized tomography examinations when using artificial lengthening of the vocal tract.[43,47,48] This increased ratio would help to the formation of the singer/speaker's formant.[7,25] Related to this, in the three previous cited studies where a greater ratio was obtained,[43,47,48] a more evident spectral prominence around 2.5 kHz (singer's formant) was also reported. Therefore, it is feasible to assume that vocal tract semiocclusions may contribute to a high concentration of spectral energy at the singer's formant region because of an increment of the ratio between pharyngeal and epilaryngeal tube openings.

According to Titze and Story,[26] when a narrowed epilarynx (produced by an aryepiglottic narrowing) is combined with a wide pharynx, the acoustic load of the vocal tract is inertive for all possible values of fundamental frequencies. This produces strong interactions between the source and the filter. Specifically, the inertance of the vocal tract facilitates vocal fold vibration by lowering the oscillation threshold pressure. This effect may also be important for people with hyperfunctional dysphonia.

In the present study, all dependent variables demonstrated the greatest degree of change ($P < 0.001$) when phonating with loud voice. No significant changes were observed during soft and moderate loudness for pharyngeal width and A-P laryngeal compression. For VLP, all loudness levels caused a significantly lower larynx. However, as mentioned previously, the greatest change was seen during loud voice production. This is an interesting result that could be related to the degree of oral pressure produced during artificial lengthening and occlusions of the vocal tract. Therefore, this independent variable should be considered when using these types of exercises to modify the laryngeal and pharyngeal activities. In an earlier study, Yanagisawa et al[34] found similar results with regard to the effect of loudness on supraglottic activity. The authors reported that more aryepiglottic narrowing was obtained when loudness level increased across different singing voice qualities.

Because the order of the tasks in the protocol was not randomized, one could suspect that in fact only the first task had an effect, which then persisted across the other tasks. However,

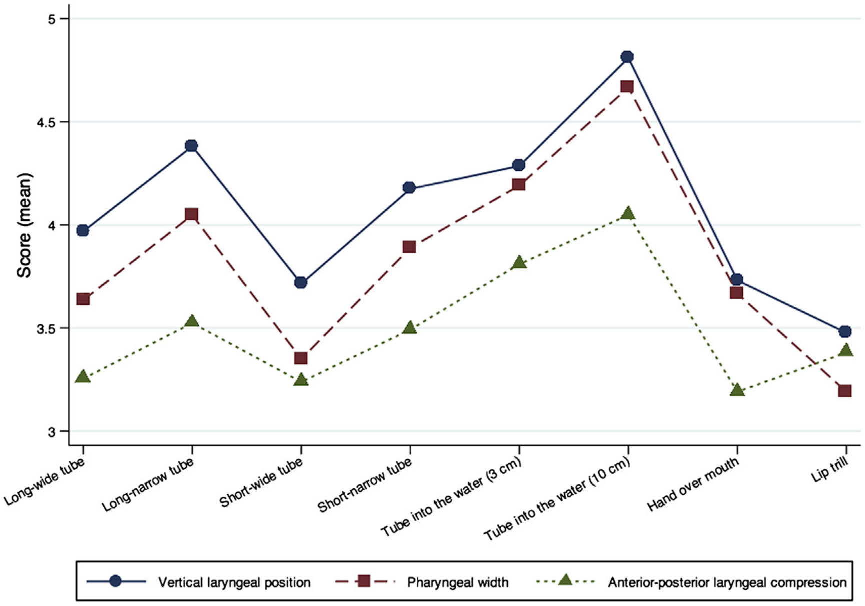

FIGURE 1. Comparison between score averages by phonatory task for each variable.

TABLE 3.
Multivariate Linear Regression Model Considering VLP, Pharyngeal Width, and A-P Laryngeal Constriction as Outcomes; and Phonatory Task and Its Intensity as Predictive Variables

VLP				Pharyngeal Width				A-P Laryngeal Constriction			
Variables	Coefficients (95% Confidence Interval)	*t*	*P* Value	Variables	Coefficients (95% Confidence Interval)	*t*	*P* Value	Variables	Coefficients (95% Confidence Interval)	*t*	*P* Value
Intensity											
Soft	0.21 (0.11, 0.28)	3.11	0.007	Soft	0.11 (−0.05, 0.18)	1.27	0.091 (NS)	Soft	0.10 (−0.08, 0.17)	1.13	0.238 (NS)
Habitual	0.23 (0.09, 0.38)	3.18	0.002	Habitual	0.14 (−0.01, 0.29)	1.84	0.067 (NS)	Habitual	0.11 (−0.04, 0.28)	1.42	0.157 (NS)
Loud	0.38 (0.24, 0.53)	5.20	<0.001	Loud	0.41 (0.25, 0.56)	5.30	<0.001	Loud	0.30 (0.13, 0.46)	3.60	<0.001
Phonatory task											
Long-wide tube	0.37 (0.19, 0.55)	3.60	<0.001	Long-wide tube	0.57 (0.25, 0.90)	3.69	<0.001	Long-wide tube	0.78 (0.45, 1.11)	4.62	<0.001
Long-narrow tube	0.41 (0.20, 0.62)	3.90	<0.001	Long-narrow tube	0.41 (0.19, 0.62)	3.75	<0.001	Long-narrow tube	0.26 (0.03, 0.50)	2.27	0.023
Short-wide tube	−0.25 (−0.20, −0.04)	−2.40	0.017	Short-wide tube	−0.28 (−0.50, −0.06)	−2.60	0.010	Short-wide tube	−0.01 (−0.24, 0.21)	−0.13	0.894 (NS)
Short-narrow tube	0.20 (−0.001, −0.41)	1.95	0.052	Short-narrow tube	0.25 (0.03, 0.47)	2.31	0.022	Short-narrow tube	0.23 (0.004, 0.47)	2.01	0.045
Tube into the water (3 cm)	0.28 (−0.017, −0.59)	1.85	0.065 (NS)	Tube into the water (3 cm)	0.59 (0.27, 0.91)	3.69	<0.001	Tube into the water (3 cm)	0.57 (0.23, 0.91)	3.30	0.001
Tube into the water (10 cm)	0.81 (0.50, 1.11)	5.21	<0.001	Tube into the water (10 cm)	1.07 (0.75, 1.39)	6.63	<0.001	Tube into the water (10 cm)	0.81 (0.47, 1.15)	4.67	<0.001
Hand over mouth	−0.23 (−0.44, −0.03)	−2.25	0.025	Hand over mouth	0.03 (−0.18, 0.24)	0.29	0.773 (NS)	Hand over mouth	−0.06 (−0.29, 0.16)	−0.54	0.593 (NS)
Lip trill	−0.49 (−0.70, −0.28)	−4.65	<0.001	Lip trill	−0.44 (−0.66, −0.22)	−4.04	<0.001	Lip trill	0.12 (−0.10, 0.36)	1.07	0.285 (NS)

Abbreviation: NS, not significant.

this is unlikely because of the degree of the effected change throughout the sequence in all participants. For instance, the task that showed the most prominent effect in all variables (tube submerged 10 cm into the water) was performed sixth in the sequence. Additionally, lip trills, which were carried out at the end of the sequence, showed the lowest degree of change in two of the three independent variables.

The present study may have some limitations. First, all the participants were diagnosed with hyperfunctional dysphonia, and none of the subjects with hypofunctional dysphonia were included. A different effect could be likely between these two groups. Second, only the short-term effect was assessed. Possible long-term changes remain unknown. Finally, quantitative imaging may be able to provide more accurate information regarding the VLP, pharyngeal width, and A-P compression during semioccluded postures.

CONCLUSION

VLP, A-P laryngeal compression, and pharyngeal width can be modified by semioccluded vocal tract exercises in subjects diagnosed with nonorganic hyperfunctional dysphonia. A low larynx, narrow aryepiglottic opening, and wide pharynx may be reached by using these types of exercises. Phonation into a tube submerged under the water and a stirring straw produce more prominent changes than the other examined semioccluded postures. Loud voice productions also demonstrated a greater degree of change than soft and moderate loudness levels. Two possible explanations arise for these findings: an increase in oral pressure (mechanical effect) and/or a relaxation of the laryngeal and pharyngeal musculature because of semiocclusions. The observed effect is only short term, and the retention of the effect remains unknown.

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