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Vocal function exercises for normal voice: With and without semi-occlusion

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Abstract

Purpose: This study examined the effect of varying degrees of vocal tract (VT) occlusion used during Vocal Function Exercises (VFEs) on attainment of maximum phonation time (MPT) goals in normal voice. Greater VT occlusion was expected to result in increased MPT. The overarching goal was to determine whether the semi-occluded vocal tract (SOVT) posture used during VFEs could be modified while preserving efficacy.

Method: Twenty-six females ages 18–30 participated in this pre-post longitudinal group study. Participants were randomly assigned to three experimental groups and completed a six-week VFE protocol. The first group performed exercises using the prescribed SOVT posture; the second group used the vowel /o/; group three used the vowel /a/. The primary outcome measure was MPT as performed on the exercise tasks using the assigned vocal tract posture.

Result: MPT significantly improved in the prescribed SOVT group, but did not significantly improve in the modified /o/ and /a/ groups.

Conclusion: The SOVT posture used during VFEs is modifiable to a small extent without significantly undermining efficacy. Changes in MPT are less robust with reduced VT occlusion. Research in a clinical population is warranted.

Keywords

semi-occluded vocal tract; maximum phonation time; efficacy

Introduction

Semi-occluded vocal tract (SOVT) postures as described in the literature include a number of variations such as straw phonation, tube phonation, lip trills, tongue trills, y-buzz, hand over mouth and voiced bilabial fricatives, among others (Kapsner-Smith, Hunter, Kirkham, Cox, & Titze, 2015). Evidence-based voice therapy techniques including Resonant Voice Therapy, Accent Method and Vocal Function Exercises (VFEs) employ an SOVT in some form (Kapsner-Smith et al., 2015). SOVT postures are theorised to heighten the interaction

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between the glottic source and the supraglottic geometry, allowing the vocal folds to work more effectively with the vocal tract. When the vocal tract is partially occluded, air pressures above and between the vocal folds increase and maintain the approximated vocal folds in a slightly separated position (Kapsner-Smith et al., 2015; Titze, 2006). This phenomenon is partially attributed to the buildup of positive intraoral pressure resulting from vocal tract semi-occlusion. Increased intraoral pressure acts on the superior surface of the vocal folds to maintain a slightly abducted position, forming a nearly rectangular-shaped glottis (Titze, 1988; Titze, 2014). With the vocal folds almost parallel, vocal economy is maximised during phonation (Berry et al., 2001; Verdolini, Druker, Palmer, & Samawi, 1998). Thus, the goal of an SOVT posture is to achieve greater vocal output while minimising vocal fold stress and physical effort (Croake, Andreatta, & Stemple, 2016; Verdolini et al., 1998).

It is unclear from the literature whether a specific form of vocal tract semi-occlusion is superior to another. A randomised controlled trial by Kapsner-Smith et al. (2015) compared SOVT approaches and provides some insight into the utility and role of an SOVT posture in therapeutic programmes. The study compared VFEs to phonation through flow-resistant tubes (FRT) in individuals with dysphonia (Kapsner-Smith et al., 2015). The authors demonstrated FRT were not inferior to VFEs in improving voice-related quality of life. It appeared that both SOVT interventions were efficacious, however, the precise contribution of an SOVT is unclear, since both interventions contained a number of additional therapeutic components (e.g. pitch variation, sustained tasks, loudness variation and home practice).

In VFEs, the prescribed (traditional) SOVT posture involves an expanded pharynx with the lips tightly rounded to create a narrow aperture, such that sympathetic vibration can be sensed on the lips (Croake et al., 2016) (Figure 1). Each of the four exercises within the VFE protocol involves a form of vocal tract semi-occlusion (Roy et al., 2001; Stemple, Lee, D'Amico, & Pickup, 1994). The first exercise is a warm-up that involves sustaining the vowel /i/ for as long as possible with extreme forward focus using nasal resonance. The other three exercises use an SOVT posture formed by expanding the pharynx and narrowing the lips (Roy et al., 2001; Stemple et al., 1994). While the prescribed SOVT used in VFEs is thought to be a key component of the therapy protocol, individual elements of the VFE protocol have not been systematically examined, and it is unclear which element(s) of VFEs underlie the programme's efficacy.

Other studies have investigated VFEs with protocol modifications that altered the integrity of the prescribed SOVT posture outlined by Stemple et al. (1994) and Roy et al. (2001). In a retrospective single-subject case study by Radhakrishnan and Scheidt (2012), a modified form of the VFE programme was implemented in a participant with presbylaryngeus. The first modification involved replacing the prescribed SOVT posture with the vowel/o/, thereby lessening the degree of semi-occlusion by an unknown amount. In addition to the modification in vocal tract posture, the participant was instructed to ascend in pitch slightly with each trial on the fourth exercise rather than use specific musical pitches as outlined by Stemple et al. (1994). Despite VFE protocol modifications, the participant demonstrated improvement on measures of quality of life, perceptual, acoustic, and electroglottographic assessments following six weeks of VFEs. A second study evaluated the effects of VFEs on muscle tension dysphonia in two groups of Vietnamese tonal speakers in a single-blinded,

randomised control experiment (Nguyen & Kenny, 2009). For both groups, the prescribed SOVT posture was modified by using Vietnamese, rather than English, vowels. In the first exercise, the Vietnamese vowel /i/ was used. It is unknown whether this vowel was nasalised to facilitate semi-occlusion of the vocal tract. In exercises two, three and four, the Vietnamese vowel /ô/ was used, which the authors describe as slightly higher than the English vowel /o/. The authors hypothesised that the change in vowel should have maintained the intended vocal tract shape and should have been easier to achieve than the SOVT posture originally described by Stemple et al. (1994). Significant improvements in acoustic and perceptual outcome measures were identified after four weeks of modified VFEs. In both studies, the prescribed SOVT posture was modified in conjunction with other components of the VFE programme, making it difficult to determine the precise effect of the modification.

Thus, while there is evidence to suggest that VFEs are efficacious in improving the disordered (Berg, Hapner, Klein, & Johns, 2008; Gelfer & Van Dong, 2013; Gillivan-Murphy, Drinnan, O'Dwyer, Ridha, & Carding, 2006; Gorman, Weinrich, Lee, & Stemple, 2008; Jafari et al., 2017; Kaneko et al., 2015; Kapsner-Smith et al., 2015; Kumar, Sharma, Vir, & Panda, 2016; Lim, Kim, Kwon, & Park, 2009; Nguyen & Kenny, 2009; Pasa, Oates, & Dacakis, 2007; Patel, Bless, & Thibeault, 2011; Pedrosa, Pontes, Pontes, Behlau, & Peccin, 2016; Radhakrishnan & Mathisen, 2016; Radhakrishnan & Scheidt, 2012; Roy et al., 2003; Roy et al., 2001; Sauder, Roy, Tanner, Houtz, & Smith, 2010; Sharma, De, Martin, & Pracy, 2009; Tanner, Sauder, Thibeault, Dromey, & Smith, 2010; Tay, Phyland, & Oates, 2012; Teixeira & Behlau, 2015; Ziegler, Verdolini Abbott, Johns, Klein, & Hapner, 2014), normal (Ellis & Beltyukova, 2011; Stemple et al., 1994), and well-trained voice (Guzman, Angulo, Munoz, & Mayerhoff, 2013; Sabol, Lee, & Stemple, 1995), the precise mechanism of physiologic change underlying VFE efficacy remains an open question. Furthermore, it is unclear whether the prescribed SOVT posture is an essential component of VFE efficacy, or whether other vocal tract postures are capable of achieving similar results. Modifications to the traditional VFE protocol may undermine, maintain, or improve VFE efficacy, but should be systematically studied. Roy (2012) pointed out that speech-language pathologists rightfully adjust voice therapy protocols to best suit individual patients, but there is little evidence to inform clinical practice as to how these adjustments affect treatment fidelity.

In this study, the standard VFE protocol was defined according to the Stemple et al. (1994) and Roy et al. (2001) studies. VFEs consist of a set of four exercises. The first exercise is referred to as a warm-up exercise and involves sustaining a nasalised /i/ for as long as possible on F4 for women. The second, third and fourth exercises require producing the speech sound /o/ using an SOVT posture formed by expanding the pharynx and narrowing the labial aperture so that sympathetic vibration is felt on the lips. The second exercise is an upward pitch glide on /o/ using the prescribed SOVT posture. The third exercise is a downward glide performed in the same way. The goal of the VFE glides is to traverse the vocal range without a pitch break. The fourth exercise involves sustaining five musical notes, C4-G4 for women, for as long as possible on the vowel /o/ using the SOVT posture. All exercises should be completed as softly as possible and should be practiced two times each, twice daily. Each exercise is completed twice consecutively, so that the full exercise regimen would be two warm-ups on /i/, two upward glides, two downward glides, and then two

sustained Cs, two sustained Ds, and so forth. Individuals are typically asked to record their practices using a written log and demonstrate increasing maximum phonation time (MPT) as the programme progresses.

The purpose of this study was to modify a single element of the standard VFE protocol as described by Stemple et al. (1994) and Roy et al. (2001) and determine its contribution to VFE efficacy. This report is the second study in a series of on-going research designed to determine the effects of specific constituent VFE components (Bane, Angadi, Dressler, Andreatta, & Stemple, 2017). This study investigated the effect of three vocal tract postures that differed by degree of occlusion on achievement of MPT goals in a cohort of adult females with normal voice. It was hypothesised that greater vocal tract occlusion would result in greater increases in MPT.

Method

Participants

The Institutional Review Board at the University of Kentucky approved recruitment, intervention, and data collection procedures. A total of 26 participants completed the study and met the following inclusion criteria: female, ages 18–30, non-smokers, and hearing within functional limits. Sex and age requirements were set based on the use of a convenience sample. Functional hearing was defined as the ability to participate in experimental tasks. A year or more of classical vocal training, history of uncontrolled asthma and presence of vocal fold pathology identified by laryngeal visualisation constituted exclusion from the investigation. To reiterate, a population of normal speakers was used for this study. Since vocal wellness exists on a continuum including the disordered, normal and well-trained voice, it is possible to enhance the normal voice (Stemple, 2005).

Study protocol

Study participants were randomised to one of three experimental groups that completed VFEs employing varying degrees of vocal tract occlusion: the traditionally prescribed SOVT, /o/, or /a/. The first group ($n = 9$) used the traditional SOVT posture prescribed for VFEs with the greatest degree of semi-occlusion, the second group ($n = 8$) used a modified /o/ posture with partial occlusion, and the third group ($n = 9$) used a modified /a/ posture, without any significant vocal tract occlusion. After informed consent was obtained, participants were educated regarding vocally harmful behaviours. Participants verbally agreed to abstain from harmful vocal behaviours throughout the study period, however, compliance with this agreement was not tracked.

Baseline measures consisted of completion of the Voice-Related Quality of Life (V-RQOL) scale (Hogikyan & Sethuraman, 1999), the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) overall score (Kempster, Gerratt, Verdolini Abbott, Barmkmeier-Kraemer, & Hillman, 2009) and a maximum airflow volume task (MAV). MAV was defined as the maximum volume of air exhaled from the lungs after maximum inhalation. To confirm normalcy of laryngeal structure and function, laryngeal visualisation was completed by one of five speech-language pathologists with experience in voice evaluation using a

KayPENTAX High-Definition Digital Stroboscopy System 9310HD. Characterisation of laryngeal visualisation was binary, either abnormal or normal. When unusual findings arose (e.g. mass lesions, erythema, or oedema), a second speech-language pathologist was consulted for consensus and the individual was excluded from the study. A total of five potential participants were excluded from the study due to identification of abnormal laryngeal structure. These individuals did not provide further baseline data and were referred to an ear, nose and throat doctor for further management. The V-RQOL was completed to confirm normal self-assessed vocal quality. The CAPE-V, an auditory-perceptual evaluation of voice, was completed by a speech-language pathologist and confirmed normalcy of perceived voice quality. MAV was collected using a KayPENTAX Phonatory Aerodynamic System 6600. MAV indices were divided by an airflow rate of 80 mL-s to determine the individual's MPT goal (e.g. 4000 mL/80 mL-s = 50 s). The MPT goal calculation was recommended in conjunction with the VFE protocol by Stemple and Hapner (2014). The denominator of 80 mL-s approximates the lower, more efficient end of the range for normal airflow rate described by Hirano (1981). The MPT goal is a global measure of an individual's physiologic capacity for maximum phonation.

Upon completion of baseline data, participants met with research assistants (RAs) to learn the VFE protocol described by Stemple et al. (1994) and Roy et al. (2001) with the assigned vocal tract posture modification. All five RAs were students in the College of Health Sciences without prior experience implementing voice therapy techniques. RAs received group and individual training from a speech-language pathologist with extensive experience in voice prior to initiation of the study. After learning the VFE protocol from the RA, the supervising speech-language pathologist confirmed the appropriate technique with the participant and obtained baseline MPT measures. In this study, MPT constituted the primary outcome measure and was collected on sustained VFE tasks using the assigned vocal tract posture.

Once baseline MPT was collected, participants were supplied with practice log sheets and a practice video corresponding to their assigned vocal tract posture. The directions on the practice sheet reflected the assigned technique for use during each of the four VFEs. The practice video was of a female speech-language pathologist performing VFEs using the appropriate vocal tract posture. The video contained verbal instructions, target musical pitches and a visual and aural example of the speech-language pathologist completing the exercises so that the participant would be able to complete daily practice along with the video as a guide.

All participants practised VFEs twice daily for six weeks. Practice reminders were sent twice daily via email. The traditional SOVT posture group completed the VFE protocol as prescribed by Stemple et al. (1994) and Roy et al. (2001) using the SOVT postures formed by nasalisation of the vowel /i/ on the first VFE task and an expanded pharynx with a narrow lip aperture to create /o/ on the second, third and fourth VFE tasks. The modified /o/ group completed VFEs with a reduced degree of vocal tract semi-occlusion as compared to the prescribed SOVT posture. The first exercise was the sustained vowel /i/ (non-nasalised), and exercises two through four were completed on the vowel /o/. Participants were instructed to round their lips, but not very tightly, so there was no sympathetic vibration of the lips.

The /a/ group completed VFEs with an even greater reduction in the degree of vocal tract semi-occlusion as compared to the prescribed SOVT posture. The first exercise was the sustained vowel /i/ (nonnasalised), and exercises two through four were completed on the vowel /a/. Participants were instructed to relax the mandible and produce a comfortable /a/ without lip rounding.

In addition to home practice, participants returned for weekly maintenance sessions with the RAs. These sessions included adjustments in technique with the help of the supervising speech-language pathologists, collection of practice log sheets and timing weekly MPT. Thus, when the participant arrived for a weekly session, she completed one of her practices for the day, and this MPT was timed by the RA. One of the five speech-language pathologists with experience using VFEs monitored 20% of all RA-conducted sessions, and an additional 20% were monitored by a second-year graduate student with practical knowledge of VFEs.

There was some concern that use of the vowel /a/ may result in hyperfunctioning of the laryngeal mechanism. Therefore, to monitor for potential harmful effects associated with changes in vocal tract posture, laryngeal visualisation was completed for all participants after six weeks of exercises. Evidence of harmful effects was defined as observable mass lesion, erythema, or oedema. Speech-language pathologists performing laryngeal visualisation throughout the study were blinded to group assignment. No evidence of harmful effects was observed during laryngeal visualisations for any experimental group during the study. MPT was again collected during the last practice session with the RA. At this time, home practice and weekly sessions with RAs were discontinued. One month later, participants returned to the lab to record a final MPT measure.

Data analysis

Since MPT goal varied by individual, raw data were used to calculate the percentage of MPT goal attained. For example, a participant with an MPT goal of 40 s and a baseline MPT of 20 s was said to have attained 50% of their MPT goal at baseline. Assumptions for one-way ANOVAs were met, and one-way ANOVAs were used to verify equivalency of groups at baseline.

For the primary outcome measure of MPT, post hoc paired sample t-tests with a Bonferroni correction compared the difference in MPT over time for each group. Due to small sample size, Hedges' g effect sizes were calculated to compare the modified /o/ group to the traditional SOVT group and the modified /a/ group to the traditional SOVT group.

Compliance was tabulated as the number of practice sessions missed using weekly practice log sheets. Imperfect compliance did not result in missing data points since RAs collected MPT during weekly sessions and at follow-up. Tracking missed practices allowed for descriptive comparison of compliance among the three experimental groups.

Result

Homogeneity assumptions were met at baseline for age and MPT. Paired t-tests demonstrated significantly increased MPT for the traditional SOVT group after six weeks and at one-month follow-up. Neither of the modified groups, the /o/ and /a/ groups, demonstrated statistically significant differences in percentage of MPT goal attained over time; however, the /o/ group demonstrated increased MPT that approached statistical significance after six weeks of VFEs even after application of the rigorous Bonferroni correction ($\alpha = 0.0056$). The modified /a/ group failed to improve MPT significantly (Table 1). Many participants did not achieve their MPT goal within the six-week study period, however the important finding was not the number of individuals who achieved goal. Rather, our interest was in the improvement in MPT that could be made within six weeks, given a particular vocal tract posture.

A Hedges' g effect size of 0.08 was obtained for the modified /o/ and traditional SOVT groups, indicating a small effect of the SOVT posture on MPT compared to the modified /o/ posture. An effect size of 0.82 was obtained for the /a/ and traditional SOVT groups, indicating a large effect of the traditional SOVT posture on MPT compared to the modified/a/ posture (Table 2).

Discussion

All three experimental groups improved their MPT from baseline over the course of six weeks of VFE practice, although only the traditional group improved significantly. Reduced semi-occlusion in the /o/ group improved MPT, though to a lesser extent than the prescribed SOVT posture for VFEs. Near elimination of vocal tract occlusion failed to sufficiently improve MPT in the /a/ group. A decline in MPT was observed for all groups with practice cessation after six weeks, although all groups maintained MPT above baseline. These findings are best summarised visually in Figure 2.

It is suspected that VFEs facilitate greater economy of voice production through the use of an SOVT. Given what is known about the physiologic underpinnings of an SOVT posture, reduced semi-occlusion may lessen the intraoral pressure, thereby failing to posture the arytenoids for economic vibration of the vocal folds (Titze, 2014; Verdolini et al., 1998). This rationale may explain why the modified/o/ group failed to improve MPT to the same extent as the traditional SOVT group, and why the modified/ a/ group fell even shorter of the SOVT “gold standard.”

This study implemented a dismantling approach (Borkovec & Miranda, 1999) by modifying a single aspect of the VFE protocol to begin identifying elements of VFEs responsible for efficacy. Modification of single components of the exercise protocol yields evidence as to the precise contribution of the modified element, in this case, vocal tract occlusion. Through systematic modification of single components of VFEs, research will better be able to identify the active ingredient, or mechanism of change, within the treatment protocol. Using this reduction methodology, elements that support or undermine VFE efficacy can be identified.

Since the modified /o/ vocal tract posture might be physiologically easier to achieve for certain individuals, it may be a viable alternative to the traditionally prescribed SOVT posture. Previous studies on voice therapy adherence have found that clients struggle with slow progress and independent execution of voice therapy techniques during practice, resulting in decreased adherence (van Leer & Connor, 2010). Definite conclusions about the effects of VFE modifications in a clinical population are not warranted on the basis of this study. However, VFEs were originally developed in the normal voice (Stemple et al., 1994) and studies of normal function form an important basis for clinical and research knowledge. If modification of the VFE protocol reduces frustration, improves motivation, and/or supports adherence, the cost of reduced vocal tract semi-occlusion may be ameliorated by other benefits. However, slower improvement with the use of a modified /o/ vocal tract posture may serve to increase frustration and decrease adherence.

Conclusion

In summary, varying the degree of vocal tract occlusion used during VFEs altered MPT in normal voice. The prescribed SOVT posture for VFEs was most efficacious and efficient. This study supports use of a modified /o/ vocal tract posture for increasing MPT with the caveat that the modified /o/ may not yield MPT improvement commensurate with the traditional SOVT posture. Significant modification of the prescribed SOVT posture to an extent that eliminates all vocal tract semi-occlusion may prevent individuals from improving their MPT, as demonstrated by the /a/ group. It appears that in this study, greater vocal tract semi-occlusion improved efficacy of VFEs in enhancing normal voice. Thus, vocal tract semi-occlusion is likely an active ingredient, or mechanism of change, within VFEs.

Limitations

The first limitation was that compliance with home practice was self-reported and therefore could not be verified. Aspects of this study's methodology, including practice sheets, daily practice reminders, practice video guides and weekly sessions with RAs were meant to address this limitation. Second, RAs, rather than experienced speech-language pathologists, completed weekly sessions. It is recognised that an RA may not be capable of motivating and shaping participant behaviour as effectively as a speech-language pathologist would. To address this limitation, 20% of weekly sessions with RAs were monitored by a speech-language pathologist, RAs were trained a priori, and baseline MPT was obtained by an experienced speech-language pathologist.

Future research

This study was the first to systematically examine the effects of varying semi-occlusion on efficacy of VFEs. Further investigation is required to determine the essential elements of the VFE protocol and to determine the most efficacious vocal tract posture to be implemented as a part of VFEs. Given the present study's finding that increased vocal tract semi-occlusion supported greater improvement in MPT, future studies may investigate whether increased semi-occlusion of the vocal tract beyond that prescribed by the VFE protocol is of additional benefit. Alternatively, use of the modified /o/ vocal tract configuration may warrant future investigation with additional changes to the VFE protocol to supplement exercise effects.

For example, the modified /o/ posture could be used in combination with extended practice or increased practice frequency. Future research should also consider alternate methods of compliance monitoring that can be verified by the researcher, along with larger sample sizes. Investigation in a clinical population is also warranted.

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References

- Bane M, Angadi V, Dressler E, Andreatta R, & Stemple J (2017). Vocal function exercises for normal voice: The effects of varying dosage. *International Journal of Speech Language Pathology*. doi: 10.1080/17549507.2017.1373858
- Berg EE, Hapner E, Klein A, & Johns MM III. (2008). Voice therapy improves quality of life in age-related dysphonia: A case-control study. *Journal of Voice*, 22, 70–74. doi:10.1016/j.jvoice.2006.09.002 [PubMed: 17070009]
- Berry DA, Verdolini K, Montequin DW, Hess MM, Chan RW, & Titze IR (2001). A quantitative output-cost ratio in voice production. *Journal of Speech, Language, and Hearing Research*, 44, 29–37. doi:10.1044/1092-4388(2001/003)
- Borkovec TD, & Miranda J (1999). Between-group outcome research and basic science. *Journal of Clinical Psychology*, 55, 147–158. doi:10.1002/(SICI)1097-4679(199902)55:25147::AID-JCLP243.0.CO;2-V [PubMed: 10100816]
- Croake DJ, Andreatta RD, & Stemple JC (2016). Immediate effects of the vocal function exercises semi-occluded mouth posture on glottal airflow parameters: A preliminary study. *Journal of Voice*, 31, 245.e9–245.e14. doi:10.1016/j.jvoice.2016.08.009
- Ellis LW, & Beltyukova SA (2011). Effects of compliance monitoring of vocal function exercises on voice outcome measures for normal voice. *Perceptual and Motor Skills*, 112, 729–736. doi: 10.2466/11.15.28.PMS.112.3.729-736 [PubMed: 21853762]
- Gelfer MP, & Van Dong BR (2013). A preliminary study on the use of vocal function exercises to improve voice in male-to-female transgender clients. *Journal of Voice*, 27, 321–334. doi:10.1016/j.jvoice.2012.07.008 [PubMed: 23159032]
- Gillivan-Murphy P, Drinnan MJ, O'dwyer TP, Ridha H, & Carding P (2006). The effectiveness of a voice treatment approach for teachers with self-reported voice problems. *Journal of Voice*, 20, 423–431. doi:10.1016/j.jvoice.2005.08.002 [PubMed: 16293396]
- Gorman S, Weinrich B, Lee L, & Stemple JC (2008). Aerodynamic changes as a result of vocal function exercises in elderly men. *The Laryngoscope*, 118, 1900–1903. doi:10.1097/MLG.0b013e31817f9822 [PubMed: 18622308]
- Guzman M, Angulo M, Munoz D, & Mayerhoff R (2013). Effect on long-term average spectrum of pop singers' vocal warm-up with vocal function exercises. *International Journal of Speech Language Pathology*, 15, 127–135. doi:10.3109/17549507.2012.702283 [PubMed: 22909150]
- Hirano M (1981). *Clinical examination of voice*. Wien, NY: Springer-Verlag.
- Hogikyan ND, & Sethuraman G (1999). Validation of an instrument to measure voice-related quality of life (V-RQOL). *Journal of Voice*, 13, 557–569. doi:10.1016/S0892-1997(99)80010-1 [PubMed: 10622521]
- Jafari N, Salehi A, Izadi F, Moghadam ST, Ebadi A, Dabirmoghadam P, ... Shahbazi M (2017). Vocal function exercises for muscle tension dysphonia: Auditory-perceptual evaluation and self-assessment rating. *Journal of Voice*, 31, 506.e25–506.e31. doi:10.1016/j.jvoice.2016.10.009
- Kaneko M, Hirano S, Tateya I, Kishimoto Y, Hiwatashi N, Fujiu-Kurachi M, & Ito J (2015). Multidimensional analysis on the effect of vocal function exercises on aged vocal fold atrophy. *Journal of Voice*, 29, 638–644. doi:10.1016/j.jvoice.2014.10.017 [PubMed: 25944293]

- Kapsner-Smith MR, Hunter EJ, Kirkham K, Cox K, & Titze IR (2015). A randomised controlled trial of two semi-occluded vocal tract voice therapy protocols. *Journal of Speech, Language, and Hearing Research*, 58, 535–549. doi:10.1044/2015_JSLHR-S-13-0231
- Kempster GB, Gerratt BR, Verdolini Abbott K, Barkmeier-Kraemer J, & Hillman RE (2009). Consensus auditory-perceptual evaluation of voice: A development of a standardised clinical protocol. *American Journal of Speech-Language Pathology*, 18, 124–132. doi: 10.1044/1058-0360(2008/08-0017) [PubMed: 18930908]
- Kumar R, Sharma P, Vir D, & Panda N (2016). Voice therapy outcomes in type-I sulcus vocalis: Case studies. *International Journal of Clinical and Experimental Otolaryngology*, 2, 42–44. doi: 10.19070/2572-732X-160009
- Lim H-J, Kim J-K, Kwon D-H, & Park J-Y (2009). The effect of vocal function exercise on voice improvement in patients with vocal nodules. *Journal of the Korean Society of Speech Sciences*, 1, 37–42. doi:10.1016/j.jvoice.2017.08.031
- Nguyen DD, & Kenny DT (2009). Randomised controlled trial of vocal function exercises on muscle tension dysphonia in Vietnamese female teachers. *Journal of Otolaryngology-Head & Neck Surgery*, 38, 261–278. doi:10.2310/7070.2009.080103 [PubMed: 19442378]
- Pasa G, Oates J, & Dacakis G (2007). The relative effectiveness of vocal hygiene training and vocal function exercises in preventing voice disorders in primary school teachers. *Logopedics Phoniatrics Vocology*, 32, 128–140. doi:10.1080/14015430701207774
- Patel RR, Bless DM, & Thibeault SL (2011). Boot camp: A novel intensive approach to voice therapy. *J Voice*, 25, 562–569. doi:10.1016/j.jvoice.2012.01.001 [PubMed: 20570107]
- Pedrosa V, Pontes A, Pontes P, Behlau M, & Peccin SM (2016). The effectiveness of the comprehensive voice rehabilitation programme compared with the vocal function exercises method in behavioural dysphonia: A randomised clinical trial. *Journal of Voice*, 30, 377e311–379. doi: 10.1016/j.jvoice.2015.03.013
- Radhakrishnan N, & Mathisen D (2016). Idiopathic subglottic stenosis: Surgical and therapeutic results in an adult woman. *International Journal of Clinical and Experimental Otolaryngology*, 2, 23–25. doi:10.1002/lary.26098
- Radhakrishnan N, & Scheidt T (2012). Modified vocal function exercises: A case report. *Logopedics Phoniatrics Vocology*, 37, 123–126. doi:10.3109/14015439.2012.664655
- Roy N (2012). Optimal dose-response relationships in voice therapy. *International Journal of Speech-Language Pathology*, 14, 419–423. doi:10.3109/17549507.2012.686119 [PubMed: 22574765]
- Roy N, Gray S, Simon M, Dove H, Corbin-Lewis K, & Stemple J (2001). An evaluation of the effects of two treatment approaches for teachers with voice disorders: A prospective randomised clinical trial. *Journal of Speech, Language, and Hearing Research*, 44, 286–296. doi: 10.1044/1092-4388(2001/023)
- Roy N, Weinrich B, Gray SD, Tanner K, Stemple JC, & Sapienza CM (2003). Three treatments for teachers with voice disorders: A randomised clinical trial. *Journal of Speech, Language, and Hearing Research*, 26, 670–688. doi:10.1044/1092-4388(2003/053)
- Sabol L, Lee L, & Stemple JC (1995). The value of vocal function exercises in the practice regimen of singers. *J Voice*, 9, 27–36. doi:10.1016/S0892-1997(05)80220-6 [PubMed: 7757147]
- Sauder C, Roy N, Tanner K, Houtz DR, & Smith ME (2010). Vocal function exercises for presbylaryngis: A multidimensional assessment of treatment outcomes. *Annals of Otolaryngology & Rhinology & Laryngology*, 119, 460–467. doi:10.1177/000348941011900706
- Sharma N, De M, Martin T, & Pracy P (2009). Laryngeal reconstruction following shrapnel injury in a British soldier: Case report. *The Journal of Laryngology & Otology*, 123, 253–256. doi:10.1017/S0022215108002120 [PubMed: 18384698]
- Stemple JC (2005). A holistic approach to voice therapy. *Seminars in Speech and Language*, 26, 131–137. doi:10.1055/s-2005-871209 [PubMed: 15918138]
- Stemple JC, Lee L, D'amico B, & Pickup B (1994). Efficacy of vocal function exercises as a method of improving voice production. *Journal of Voice*, 8, 271–278. doi:10.1016/S0892-1997(05)80299-1 [PubMed: 7987430]
- Stemple JC, & Hapner ER (2014). *Voice therapy: Clinical case studies* (4th ed.). San Diego, CA: Plural Publishing.

- Tanner K, Sauder C, Thibeault SL, Dromey C, & Smith ME (2010). Vocal fold bowing in elderly male monozygotic twins: A case study. *Journal of Voice*, 24, 470–476. doi:10.1016/j.jvoice.2008.10.010 [PubMed: 19664899]
- Tay EY, Phyland DJ, & Oates J (2012). The effect of vocal function exercises on the voices of aging community choral singers. *Journal of Voice*, 26, 672e619627. doi:10.1016/j.jvoice.2011.12.014
- Teixeira L, & Behlau M (2015). Comparison between vocal function exercises and voice amplification. *Journal of Voice*, 29, 718–726. doi:10.1016/j.jvoice.2014.12.012 [PubMed: 26296853]
- Titze IR (1988). The physics of small-amplitude oscillation of the vocal folds. *The Journal of the Acoustical Society of America*, 83, 1536–1552. doi:10.1121/1.395910 [PubMed: 3372869]
- Titze IR (2006). Voice training and therapy with a semi-occluded vocal tract: Rationale and scientific underpinnings. *Journal of Speech, Language, and Hearing Research*, 49, 448–459. doi: 10.1044/1092-4388(2006/035)
- Titze IR (2014). Bi-stable vocal fold adduction: A mechanism of modal-falsetto register shifts and mixed registration. *The Journal of the Acoustical Society of America*, 125, 2091–2101. doi: 10.1121/1.4868355
- van Leer E, & Connor NP (2010). Patient perceptions of voice therapy adherence. *Journal of Voice*, 24, 458–469. doi:10.1016/j.jvoice.2008.12.009 [PubMed: 19775866]
- Verdolini K, Druker DG, Palmer PM, & Samawi HJ (1998). Laryngeal adduction in resonant voice. *Journal of Voice*, 12, 315–327. doi:10.1016/S0892-1997(98)80021-0 [PubMed: 9763181]
- Ziegler A, Verdolini Abbott K, Johns M, Klein A, & Hapner ER (2014). Preliminary data on two voice therapy interventions in the treatment of presbyphonia. *The Laryngoscope*, 124, 1869–1876. doi: 10.1002/lary.24548 [PubMed: 24375313]

Figure 1.

Semi-occluded vocal tract posture for vocal function exercises. The required semi-occluded vocal tract posture used during vocal function exercises involves an expanded pharynx and a narrow lip aperture, which creates the shape of an inverted megaphone as shown on the left (Stemple & Hapner, 2014). The corresponding posture can be seen in the photograph on the right.

Figure 2.
Percentage of maximum phonation time goal attained by time and group.

Table 1.

Paired sample *t*-tests within groups effects for percentage of maximum phonation time goal attained.

Group	Time comparisons	Mean	Standard deviation	<i>p</i> -value
Traditional SOVT	Pre – post	35.78	7.24	10.65
	Post – 1 mo. after VFE	61.11	10.65	15.83
	Pre – 1 mo. after VFE	35.78	7.24	15.83
Modified /o/	Pre – post	37.63	12.67	19.31
	Post – 1 mo. after VFE	59.75	21.18	21.18
	Pre – 1 mo. after VFE	37.63	12.67	21.18
Modified /a/	Pre – post	35.67	13.71	19.92
	Post – 1 mo. after VFE	47.33	19.92	13.19
	Pre – 1 mo. after VFE	35.67	13.71	13.19

★ Denotes significance at *p* = 0.0056.

mo.: month.

Table 2.

Within groups effect sizes for percentage of maximum phonation time goal attained.

Comparison	Effect size (Hedges' g)	Interpretation	95% confidence interval
/o/- SOVT	0.08	Small	[-0.87, 1.04]
/a/- SOVT	0.82	Large	[-0.14, 1.78]