SEMIOCCLUDED VOCAL TRACT EXERCISES: LITERATURE REVIEW

Exercícios de trato vocal semiocluído: revisão de literatura

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ABSTRACT

This study has as its theme the exercise with semi-occluded vocal tract (SOVTE) and tries to summarize and to organize, through review of literature, information about physical and anatomophysiology notions underlying SOVTE and its different types, through description, clinical applicability, restrictions, time of performance, effects and effectiveness. The SOVTE is performed with vocal tract occlusion which modifies the acoustic impedance and generates retroflex resonance, which repels the vocal folds during vibration, reduces the risks of trauma and balances sub- and supraglottic pressure, with vocal economy; types: tongue and lips vibration; fricative sounds, prolonged /b/, humming, glottic firmness, lips constriction and tube-phonation; they are used in vocal disorders, including hipernasality, in warming and improving vocal practice; phonation in immerse tube with 15cm water should only be used in cases of hypokinetic dysphonia; there is no scientific definition regarding the runtime; the generated positive effects are the improvement of proprioception, of vocal perceptive-auditory and acoustic aspects, and of vocal tract changes; studies performed with magnetic resonance imaging and computed tomography verified vocal tract modifications after the tube-phonation technique, such as more extensive central area, firm closure of the velopharyngeal sphincter, decreased velopharyngeal sphincter area, vertical epiglottis, posterior tongue elevation, expansion of the cross-sectional oropharynx and oral cavity areas; studies about the effectiveness of SOVTE were not found.

KEYWORDS: Voice; Voice Training; Voice Quality

INTRODUCTION

Speech therapy with dysphonic patients is constituted of approaches involving orientations, psychodynamic and vocal training by using methods and vocal exercises[1-2].

Many authors have described the effects of exercises used on rehabilitation of dysphonia, such as lips and thongs vibration techniques, fricative sounds, /b/ prolonged, humming, glottal firmness, labial constriction and tube phonation[3-9]. This techniques have in common the fact of being executed using some kind of occlusion on vocal tract, therefore classified as Semioccluded Vocal Tract Exercises(OSVTE).

Usually, the OSVTE bring several benefits to patients from voice clinic because facilitate the source and filter interaction, reducing trauma risks during the vocal folds vibrations, once that the retroflex energy generated by such exercises allow the detachment of the vocal folds during the vibration[4-6.10.11]. The OSVTE have been using on cases of vocal disturbed e vocal warm up and even to vocal betterment in people without vocal disturbed[3.6.9.12].

Thus, this work aims, by literature review, to synthesize and organize information about physical

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notions and anatomy physiology subjacent to the OSVTE and its several types, with the description, clinical applicability, restrictions, execution time, effects and effectiveness.

METHODS

To obtain bibliographic data, it was executed a research on books, thesis, dissertations, monographs and articles of scientific journal in Portuguese, English and Spanish languages published by databases LILACS, PubMed, SciELO, Capes periodicals and MedLine. It were been analyzed several studies with publishing date between the years 2001 and 2011.

To this research, it was been used keywords: voice, vocal techniques, vocal therapy, vocal fold and dysphonia. It was evaluated and selected only the studies which titles, abstract or body, were consistent with the object of this study.

The analysis of the results was performed according to the data found for the study objectives, grouping them into two topics: physical and anatomical and physiological concepts involved in achieving SOVTE and description of the studies SOVTE. The discussion of each topic held in check the most relevant aspects, relating them to their sources.

LITERATURE REVIEW

From the methodology applied, thirty-four bibliographic references were selected, one dissertation, four national books, eight national articles, twenty international articles and presented papers in congress.

Physical and anatomophysiological notions involved in achieving SOVTE

The nonlinear theory of voice production suggests that the vocal tract, in addition to serve as a filter of the sound produced in the glottal source, also acts as a modifier of the patterns of vocal fold vibration by modifying the acoustic impedance of the vocal filter. In other words, a biofeedback between the source and the vocal filter and, thereby, increase the interaction between source and filtro[5, 6,11,13,14].

The impedance can be defined as the response of a passive system to some kind of excitement. A passive system is that one that does not provide power, only receives power from one source or another system and transmits it. Thus, it might be interpret the impedance, in general terms, as a system resistance to energy flow[15].

The impedance is composed by reactive and resistive components. The reactive component is associated with the exchange of energy between systems. A system has the ability to store energy and return it to the other system that supplied the same energy. This process characterizes the reactive behaviors that occur in the vocal tract, also known as retroflex resonance, energy returning to the glottis during the OSVTE execution[16]. The vocal tract consists of a system that traditionally receives and modifies energy produced by glottis and that, by the concept of retroflex resonance, transmits it back, due to narrowing of the vocal tract that occurs in OSVTE.

The resistive component of vocal production, in other words, the attrition between the friction of air and the vocal tract, is associated to power dissipation, occurring in form of heat or other energy. Furthermore, the resistive component is responsible for assisting the vibration of the vocal folds, because it changes the shape of the mucosal wave, increasing the transglottic sound pressure level generated due to retroflex resonance that reaches the vocal folds[9], being very important for application in vocal area[3].

Several authors refer to retroflex resonance as being very important to the voice, because it changes the pattern of vocal fold vibration and allows a more economic phonation[6, 9,11,17].

The resistive effect of the glottis can be explained as follows: when the vocal folds begin to separate from the start of oscillation, the air flow passes between them, pushing the supraglottic motionless air column. The inertia in the stationary air column increases the air pressure in the glottis, which removes even more the vocal folds[16].

Then, the lungs begin to exert greater pressure of air, increasing the subglottic pressure. As the column of air moves, the elastic recoil of the vocal folds creates a partial vacuum in the glottis, causing them to approximate again, interrupting the airflow (Bernoulli phenomenon)[16].

The sum of all the resistive and reactive components is called impedance. Thus, the resistance (resistive components) is the part of the impedance that is not dependent on frequency, but the density of the medium and, therefore, the speed of propagation of sound in the medium. The acoustic reactance (reactive component) is part of the impedance which is related to the frequency of the resulting movement (sound wave propagates), generated by the effect produced by the mass and elasticity of the material medium over the wave motion[16].

In vocal production, there are points that alter the acoustic impedance, the two main important are the glottis and vocal tract. The first one is defined as

the ratio between the subglottic air pressure and air flow that passes between the vocal folds, while the second one refers to the relation between the sound pressure of the vocal tract and the airflow resulting from itself[3, 11].

Many vocal effects related to the acoustic impedance of the vocal tract are still not fully clear in the literature, however, it is known that the increase impedance is beneficial to the voice in OSVTE[3, 6, 9, 11, 17].

In the vocal tract , impedance can be increased in two basic ways: by narrowing its diameter or increasing its length. Certain vocal exercises involve anterior constriction with semioccluded lips. This is the case of fricative sounds or stretching of the vocal tract, like phonation in resonation tubes[6 , 9 , 10 , 12, 18 to 20].

The increased impedance of the vocal tract, through the lips semiocclusion, acts as a protective mechanism of the glottis, as increased air pressure in the supraglottic region occurs which, consequently, raises the pressure in the glottal level. This tends to separate the vocal folds and reduce the impact when they come in medially contact, balancing the pressures in the glottis level and vocal tract (interaction between source and filter - retroflex resonance. The opposite mechanism occurs in the sounds where articulation are wide open, in which there is an increase on subglottic pressure and decreased supraglottic pressure, causing a higher effort on glottic level[3, 6, 10 - 12, 21].

Thus, authors emphasize that the goal of vocal training is to foster interaction between source and filter, as well as increase the sound pressure, the efficiency and the vocal economy[3, 4, 6, 17, 20].

The vocal tract is a system of curved walls and the distance between its walls is variable. Therefore, several standing waves of different frequencies will be established. The standing wave represents the frequencies that were reflected when they encounter a barrier, in the case of OSVTE, is the partial occlusion of vocal tract[1].

Resonance occurs in the vocal tract when the value of reactance is zero, and the impedance is restricted only to resistive components, when almost all the energy is dissipated in the vocal tract by several mechanisms of resistance, so that almost none energy is stored (impedance part reactive)[1].

When the sound wave is compatible with the dimensions and characteristics of the vocal tract, that is, when there is a perfect adjustment between the wave length and the dimensions of the tube, the sound wave excites the resonance effect. The set of emphasized sound waves called Formant (F), considered as resonance of the vocal tract[22, 23].

Research shows that changes occur in the vocal tract posture after OSVTE, which, consequently, modifies the resonance and other characteristics of the sound radiated by lips[24].

Based on the literature reviewed, there is a new theory which states the influence of the vocal filter over the glottal source, through the retroflex resonance by modifying the characteristics of vocal fold vibration by increasing the impedance of the vocal tract at the time of noise emission. This theory supports the concept of OSVTE.

Description of studies with OSVTE

The OSVTE are vocal exercises produced by the semiocclusion of the vocal tract, as occurs in the vibration of the lips and tongue, fricative sounds, extended / b / exercise, humming, glottal firmness, lip constriction, finger kazoo and tube phonation[3 - 9].

The literature indicates that OSVTE improve the proprioception by increasing fellings during and after exercises[3, 6, 9, 18, 19, 25, 26]. During the OSVTE, the first sensation is the pressure behind the narrowing point of the vocal tract, usually the lips, possibly related to the perception of the resistance to make the noise emission[3].

During the production of OSVTE, it is probably that it also occurs a narrowing of epilarynx, keeping it as a semiocclusion point in the vocal tract at the end of the technique. Thus, the effects may become more permanent, even when the patient begins to speak using a wide open articulation. For this preservation of positive effects in the voice occurs during normal speech, it is important that the patient can feel how the technique occurs[3].

During execution of OSVTE, subjects realize different vibrations and resonance in the orofacials structures and sometimes on the chest, further than pressure in the larynx. Such sensations have an important meaning in speech therapy, because they result in motivation to the patient, so he realizes changes in vocal production[25, 26].

After execution of OSVTE, some expected sensory effects to reduce the speaking pressure, glottal flow and, at the same time, voice rich in harmonics. It is expected that the subject can realize how the economic voice production occurs and go across to different situations where he makes use of the voice, as in everyday life, during speaking and singing[6, 18, 19].

In speech clinical practice, it can be noticed that most of the exercises used in voice therapy are OSVTE, and that, according to studies, such exercises have generated positive changes in the voice after its execution.

The OSVTE have been the focus of many studies, especially in recent years, seeking to clarify effects and runtime needed to promote vocal benefits[6 - 8, 27,28].

Through this literature review, the research conducted in recent years with OSVTE was identified. Thus, studies were organized into a figure (Figure 1), favoring the comparative analysis of methodologies, results and limitations of each one.

Paper	Authors	Techniques used	Training time with each technique	Results
Effects of fricative /Z/ voiced technique: a case analysis	Cielo, Siqueira, D'avila (2005)	Fricative voiced /Z/ technique	Two sets of 15 repetitions (approximately three minutes) with one minute of rest between them	After assessment there was reduction of glottal noise, improvement the harmonic-noise ratio, decreased quotient of contact between the vocal folds; improves the type of voice and resonance and subjective sense of voice clearer.
Vocal and laryngeal effects of voiced tongue vibration technique according to performance time	Menezes, Duprat, Costa (2005)	Voiced tongue vibration technique	Four steps: one minute and the other for two minutes	In auditory perceptual assessment, women's voice got better in the third minute. In men, the vocal changes occurred after the fifth minute of running. Unpleasant feelings and laryngeal signs such as hyperemia and mucus, increased proportionally to the increase of time of the technique execution in both sexes.
Voiced tongue vibration technique: aspects of learning, and the acoustic effects of vocal tract and face	Bueno et al. (2006)	Voiced tongue vibration technique	One and half minutes	There was softening the vocal attack, increasing the number of harmonics and significant improvement of spectrographic tracing. The vocal tract, vibration occurred at all laryngeal framework, with lowering of the larynx in some subjects.
High-speed registration of phonation-related glottal area variation during artificial lengthening of the vocal tract	Laukkanen et al. (2007)	Phonation in tubes (plastic with 2cm in diameter and different lengths -30, 60 and 100cm)	The study does not mention the time of the technique	It has been found that in longer tubes, a greater reduction of the fundamental frequency (f0). The time of glottal adduction was lower when compared to the shorter, suggesting that longer tubes require increased effort of clearing and increased activity of the expiratory muscles, subglottic pressure was higher and the signal amplitude of electroglottography was lower.
Using the technique of glottal firmness in horizontal partial laryngectomy supracricoid.	Vieira et al. (2008)	Glottal firmness	Two minutes	Improved voice quality and increased amplitude of vibration of the supraglottic structures.
Effects of a semioccluded vocal tract on laryngeal muscle activity and glottal adduction in a single female subject	Laukkanen et al. (2008)	Phonation in plastic and glass tubes with length of 14 to 55cm and diamater of 2,5 to 7mm	Five repetitions of each tube	It was found that the activity of these muscles was significantly higher during and after phonation into tubes and TA muscle activity was higher in closed vowels /i, u/ than the vowel /a/ during the technique execution.
The effect of a voiced lip trill on estimated glottal closed quotient	Gaskill, Erickson (2008)	Voiced lips vibration technique	One minute	During the technique, most subjects showed a reduction in the coefficient of glottal closure, with a more marked change in untrained subjects.
Investigation of the immediate effects of two semi-ocluded vocal tract exercises	Sampaio, Oliveira, Behlau (2008)	Phonation into a straw exercise (plastic, com 8,7cm in length and 1,5mm in diameter) and finger kazoo	Each exercise lasting one minute was performed twice by subject	Vocal self-assessment, the most reported effects were more clear, strong voice and speech easier. And in perceptual analysis, the best vocal effects occurred after phonation straws. In addition to reduction of f0 after both exercises.

Paper	Authors	Techniques used	Training time with each technique	Results
Vocal and laryngeal modifications produced by the sonorous tongue vibration technique	Schwarz, Cielo (2009)	Voiced tongue vibration technique	Three sets of 15 repetitions with 30 seconds of absolute voice rest between them	A significant improvement of voice type, the vertical focus of resonance of the vocal quality, with a predominance of positive feelings. Significant increase of f0, improves aspects of spectrographic evaluation and decreased medial vestibule constriction.
Fricative hearing sound /ž/: vocal modifications	D'Avila, Cielo, Siqueira (2010)	Fricative voiced /Z/ technique	Two sets of 15 repetitions with 1 minute of absolute voice rest between them	Significant improvements in vocal self-assessment, as to the spectrograph, with greater definition of harmonics and formants, noise reduction and greater regularity of the trace. Regarding the type of voice in the perceptual assessment, we showed some relationship between filter, source and vocal subjective sensations, although changes were not observed in the acoustic measures of glottal source and electroglottography.
Comparative analysis of the closed quotient for lip and tongue trills in relation to the sustained vowel /□/	Cordeiro et al. (2010)	Voiced tongue and lips vibration technique	A repeat in grave intensity and repetition of acute intensity of each exercise (Voiced lips vibration technique and fricative voiced)	The quotient of glottal closure was higher in individuals who had more time to vocal training. The authors emphasize the importance of interaction between mechanical source and filter, considering the benefit on reduction of overhead during the adduction of the vocal folds.
Vocal performance evaluation before and after the voiced tongue vibration technique	Azevedo et al. (2010)	Voiced tongue vibration technique	Three steps: one, three and five minutes	With a minute of the technique, there was an increase in vocal intensity and, with three minutes there was a significant increase in f0. No differences in other acoustic parameters for the periods analyzed.
Immediate effect of sounded blowing exercise in the elderly voice	Siracusa et al. (2011)	Sounded blowing exercise	One minute	Best voice after exercise in perceptual analysis.
The Relationship Between Tongue Trill Performance Duration and Vocal Changes in Dysphonic Women	Menezes et al. (2011)	Voiced tongue vibration technique	Four steps: one, three, five and seven minutes	The best voice was considered better after five minutes of the technique. After seven minutes, there was an increased vocal tension and a decrease in voice quality.
The effect of phonation into a straw on the vocal tract adjustments and formant frequencies. A preliminary MRI study on a single subject completed with acoustic results	Laukkanen et al. (2011)	Phonation into tube (plastic, 15cm in length and 5mm in diameter)	Realization of phonation into tubes twice	Increase and decrease of F2 F3, F4 and F5. The differences between the frequencies F1-F2, F3-F4, F4-F5 also decreased, the sound pressure level (SPL) increased. In the other study subjects, the changes were minors compared to the above subject, and the changes of NPS were not significant. The increased F3, and F4 significantly decreased after the implementation of the technique, and the difference between F3-F4 also decreased significantly. Regarding MRI, found that during the technique, the central area of the vocal tract was more extended compared with the position in the vowel /a/ before the technique.

Paper	Authors	Techniques used	Training time with each technique	Results
Vocal tract changes caused by phonation into a tube: a case study using computer tomography and finite-element modeling	Vampola et al. (2011)	Phonation into tube (glass, 27cm in length and 8-9mm in diameter)	Five minutes	There was an elevation of the soft palate during the execution of the technique, remaining after implementation, the space of the vocal tract increased considerably after the technique, the position of the tongue also changed during and after the the technique execution, presenting higher in the posterior region, furthermore, there was expansion of cross-sectional areas of the oropharynx and oral cavity.
Immediate effects of the phonation into a straw exercise	Costa et al., 2011	Phonation into a straw exercise	One minute	The vocal self-assessment showed positive effects, significantly predominating on the negative (voice easier and better) in both groups. Acoustic analysis and visual evaluation of the larynx, there were no significant changes, the authors suggest that such no changes may be related to insufficient runtime, in addition, the lesion group was very heterogeneous, with different kinds of laryngeal lesions.

Figure 1 – Studies description of OSVTE

Based on a study, it is verified that research on the technique of phonation in tubes were initiated in the 1960s, in Finland, by Professor Sovijärv, pioneer on using of phonation in resonance tubes. Sovijärv conducted a study with 700 patients and obtained positive results. The Finnish teacher used phonation in tubes initially with children who had hypernasal voice type and, then, began to use it with singers who had disphony[25].

It is verified, despite studies are being conducted with OSVTE for some time, that still there is no consensus in the literature regarding its effects on voice at all. Regarding the performance of the exercises, the main doubts in speech clinical practice concern to the execution time of the exercises and how many times a week they should be performed.

In a study of 30 subjects, 15 females and 15 males, without vocal complaints and laryngeal affections, the sonorous tongue vibration (STV) was performed in four stages. The first with the execution time of one minute, and the remaining stages performed in two minutes. It was executed an evaluation of Videolaryngostroboscopy and voice auditory-perception, and subjects reported subjective sensations felt after execution. In perceptual evaluation, women performed better results in the third minute, and men's vocal improvement appeared after the fifth minute of running. Unpleasant feelings and laryngoscopic signs such as hyperemia and mucus, increased proportionally to the time of execution of the technique in both groups[29].

Another study also found the ideal runtime STV necessary to interfere on short term perturbation, f0 and sound pressure in 43 female subjects, comparing the results of acoustic analysis to the execution time of one, three and five minutes on this technique. The results revealed that three minutes are sufficient to alter f0, one minute is sufficient to increase the sound pressure, and the parameters of variability of the frequency jitter and shimmer, irregularity and no differences between the analyzed periods.

A study used images of the vocal tract through nasofibrolaryngoscopic examination, while running STV, besides verifying the acoustic and auditory-perceptive aspects of voice. After a minute and a half, no changes of the pitch were verified, but there was softening on vocal attack, increasing the number of harmonics and significant improvement of the trace in the spectrogram. In vocal tract, there was vibration of the whole larynx framework, with lowering of the larynx in some subjects, due to the slight variation in the tone used during the performance of technique[30].

In research conducted with women without vocal complaints and laryngeal disorders, with the STV technique performed on three sets of 15 repetitions, each repetition time was measured in seconds and

summed (for each subject) to highlight the practice time of the technique. It was found significant improvement on voice type, the vertical focus of resonance, the vocal quality, with a predominance of positive sensations referred by the subjects, but without changes in laryngeal images related to the glottal closure, amplitude and symmetry of vocal fold vibration. There was also a significant increase of f0, improvement on the aspects of spectrographic evaluation and improvement of medial vestibule constriction according to the increase on time of the technique. This indicates that this technique causes changes on the glottal source and the resonantal filter[7].

It was conducted a case study with a 27 years woman without vocal complaints and laryngeal disorders, using the technique of fricative sound / Z / in two sets of 15 repetitions (approximately three minutes), with a minute of complete rest between them. After electroglottographycal assessment, auditory-perceptive and vocal self-assessment, a reduction of glottal noise were verified, improved of the harmonic-noise ratio, decreased of the quotient of contact between the vocal folds; improved on the type of voice and resonance, and subjective sense of a cleaner voice. The authors suggest that such changes may occur due to the mobilization of the vocal folds mucous membrane with higher vibrating frequency, decreasing the glottal noise, and that it has generated muscle normotensive and decreased medial contact between the vocal folds, causing less phonatory stress[31].

After using the sound fricative / Z /, in ten women without vocal or laryngeal changes, there were statistically significant improvements in vocal self-evaluation and spectroscopy, with greater definition of harmonics and formants, noise reduction and greater regularity on the stroke. Regarding the type of voice, in the perceptive-auditory assessment, it showed some relationship between filter, source and vocal subjective sensations, although changes were not observed in the acoustic measures of glottal source and electroglottography[32].

In recent years, it has also increased the number of studies performed with the resonance tubes, proposed by Sovijärv 1969[25]. During his research, Sovijärv used various sizes of pipes, differing in length and diameter. From this he found that the thickness of the glass should be 1 mm, the inner diameter 8mm to children and 9mm to adults; and the length should be 24 to 26cm to children and 28cm to adults[24, 26]. These findings were based on studies of x -ray over the bifurcation area of the trachea to the teeth, doubling the value of this lenght[25].

Currently, phonation in tubes is described in the literature by three ways; it may be with the Sovijärv glass tube (with different diameters and lengths, depending on the intended goal) with one end immersed in a container full of water. Another way is a plastic tube with a small diameter and length, which is held between teeth, parallel to the ground, and finally, using a latex tube with one end immersed in water, all forms producing an elongation of vocal tract[10].

Through vocal self-assessment, auditory-perceptive evaluation and acoustic analysis of voice, a study compared the effects of finger kazoo technique and phonation with a straw in women without laryngeal disorders. The results showed that the most frequently reported sensations in both techniques were: lighter voice, strong and easier speech. In auditory-perceptive analysis, most post-speech excerpts was considered better, both in the vowel / e / as in connected speech. In the acoustic analysis, there was a reduction of f0 after both exercises[6].

The decrease of f0 in this study could be explained by the possible lowering of the larynx during the execution of both techniques. The authors note that these results may relate to the reduction of tension, in the vocal tract adjustments and reatance[6, 12].

The phonation on water pipes containers can be made using the tube immersed at different depths, as the laryngeal or vocal problem presented by the patient. The pressure exerted by the water is related to the depth, so the greater the depth at the pipe is, the greater the pressure and resistance of the emission will be. Thus, in the case of hypokinetic dysphonia, it is recommended that the tube be immersed 15cm below the surface, and the sounded blowing is short and performed more times. In the case of voice processing or diseases, such as vocal nodules, voice bands and chronic laryngitis, for example, the pipe must be submerged 2cm below the surface, and the sounded blow being kept by a longer time.

Another study was performed with an adult female without vocal complaints and laryngeal disorder, in which it was analyzed the electrical activity of the laryngeal muscles thyroarytenoid (TA), cricothyroid (CT) and lateral cricoarytenoid (CAL) by electromyography, before, during and after the phonation in plastic tubes and glass with a length of 14 to 55cm and a diameter of 2.5 to 7 mm. It was found that the activity of these muscles was significantly higher during and after phonation into tubes and TA muscle activity was higher in closed vowels / i / an / u / than the vowel / a / during the execution of the technique[10].

Research was carried out with a 48 years old woman, with no laryngeal disease, in order to verify the changes of the vocal tract by magnetic resonance

imaging (MRI) and acoustic vocal analysis, after two repetitions of the plastic tube phonation technique with 15cm long and 5mm diameter and five minutes after. Ten female performed only acoustic analysis for comparison[9].

The subject who performed MRI and acoustic analysis showed a slight increase in frequency of F3, while F2, F4 and F5 decreased; the differences between the frequencies of F2 to F1, F4 to F3 and F5 to F4 also decreased after the technique; the sound pressure level (SPL) increased, and f0 has not changed much. During the technique, on MRI, the central area of the vocal tract was more extended; the format of the language was similar to the position held at the vowel / u / emission; the velopharyngeal sphincter closed tightly, remaining in that position after the technique; and the epiglottis assumed a vertical position, remaining after the technique implementation[9].

In other subjects, the acoustic vocal changes were minor, and the frequency of F3 increased and F4 decreased significantly, the difference between F3 - F4 decreased significantly and the changes on NPS were not significantly different.

A case study with a 48 years old woman using phonation in glass tubes (27cm long and 8 to 9mm diameter), using computed tomography (CT) to verify the changes of the vocal tract during and after the technique. There was an elevation of the soft palate and elevation of the posterior region of the tongue during the technique, remaining that way after, in addition to increasing the space of the vocal tract and expansion of oropharynx cross-sectional areas and oral cavity after the technique[24].

Another study conducted electroglottography, high-speed images of the vocal folds with a rigid endoscope (high-speed) and measurement of air pressure during the technique of plastic tubes phonation (2cm in diameter and lengths of 30, 60 and 100cm), with three subjects who performed the technique in these three tubes. With the longer tube there was a greater reduction of f0, the time of glottal adduction was smaller, subglottic pressure was higher and eletroglottographyc signal amplitude was smaller when compared with the shorter, suggesting that the longer tubes require increased effort and increased activity of expiratory muscles[4].

The study examined the vocal modifications caused by a sequence of four types of exercises in phonation resonance tubes exercises of 0.3cm internal diameter and 22.8cm long on 24 dysphonic teachers. The first exercise was conducted with pitch phonation and loudness comfortable for the subject. The second was the production of ascending and descending glissando. The third used increments of air pressure using abdominal support, and the fourth was the production of the melody of the song “Happy Birthday”. Each exercise lasted two and a half minutes and the complete sequence was produced in ten minutes. It showed significant improvement in all acoustic parameters analyzed and the majority of subjects reported positive effects on voice after exercises[28].

Another research found the immediate effects of the implementation of the technique of phonation on straws in individuals with and without laryngeal injury, after one minute of technique. On vocal self-assessment, the significant majority reported positive effects in both groups. Acoustic analysis and visual evaluation of the larynx, there were no significant changes and the authors suggest this may be related to insufficient runtime and that the group with injuries was heterogeneous, with different types of laryngeal injuries[33].

Based on the studies found, it could be verified that there are more research done with VSL exercises and phonation into tubes. In studies with VSL, it was found the running in three series of 15[7], but also in minutes, with some studies aimed to verify the effect of exercise in relation to execution time[8, 29].

In the studies found in the literature regarding phonation into tubes, there is no consensus among authors about runtime or the number of repetitions. Furthermore, there are a few studies, each of them differs in how the technique should be implemented, ranging from: set to sound emission in glass tubes[24] or larger diameter plastic[9], smaller diameter plastic tubes[6, 33] and emission in larger diameter glass tubes or latex immersed in a recipient full of water[25].

For the review, it is verified that there is still lack of longitudinal studies that prove the effectiveness of OSVTE in patients with dysphonia. Moreover, in some studies, the research methodology is not presented sufficiently detailed and clear exposition of its results, limiting the possibilities for replication of the study and proof of results in different populations.

In the literature, only one study using MRI and CT to check changes in the vocal tract, during and after phonation into tubes were found. It is essential to emphasize the importance of these evaluations, because from them, it can view the changes to the vocal tract permitted by OSVTE, which can be correlated to other vocal avaliations[9, 24].

Based on this literature review, it could be verified that in all researches carried out with OSVTE, regardless of the runtime, positive vocal changes were observed. Among them it could be mention the voice improvements in self-perception[6, 7, 10, 31, 33], improvement in perceptual voice analysis in resonance, projection and type

of voice subjects[17, 27, 29, 34]; improvements in voice acoustic subjects, such as reduction of f0, after application of phonation into tubes technique, increasing f0 after the VSL, reduced noise and increased harmonic energy, improve on recordings spectrogram, increasing the number of harmonics[6-9, 30]; in addition to subjects of changings on vocal tract, such as elevation of the soft palate and greater velopharyngeal sphincter closure, raising on the back of the tongue, enlargement of the oral and oropharyngeal cavities, verified by MRI and CT[9, 24].

Given such evidence, it is possible that OSVTE could be used on patients who had deviations on resonance, as hypernasality, deviations of f0, and with those who need to make heating and vocal improvement.

CONCLUSION

All OSVTE are made with some kind of closure in the vocal tract by modifying the acoustic impedance of the vocal filter and increasing interaction between source and filter, since the retroflex energy generated by partial occlusion of the vocal tract provides the enlargement of vocal folds during vibration. This reduces the risk of trauma and balances the sub and supraglottic pressures, with consequent vocal economy.

The OSVTE can be used in voice disorders, including hypernasality, heating and vocal improvement.

It was found restriction only on speech exercises with tubes in containers with water about their depth, it was pointed out that the 15cm tube immersed in a container with water could only be used in cases of hypokinetic dysphonia.

It was found that there is no scientific definition on the ideal runtime to produce positive effects in each OSVTE. Some authors use three sets of 15 repetitions, while others use the time in minutes, ranging from one to seven minutes.

It was found also that the majority of studies show positive effects generated by OSVTE, such as improving proprioception and vocal self-control, the auditive-perceptive vocal aspects, the resonance subjects, projection and type of voice, acoustic vocal subjects as reduction or increase of f0, reduced noise and increased harmonic energy, improve recordings spectrogram, increasing the number of harmonics.

Only two items performed with MRI and CT were found in which changes were found in the vocal tract, such as enlargement of the central area, firm closure and reduction of the velopharyngeal sphincter region, up righting of the epiglottis, lifting the back of the tongue and expansion of the cross-sectional areas of the oral cavity and oropharynx.

However, no studies concerning the efficacy OSVTE were found.

Among vibration techniques of lips and tongue, fricative sounds, / b / Extended, humming, glottal firmness, lip constriction and phonation into tubes, the most studied techniques were sonorous vibration of the tongue or lips and technique of phonation into tubes. However, it is difficult to compare its results based on the different study designs in each study.

RESUMO

Este trabalho tem como tema os exercícios de trato vocal semiocluído (ETVSO) e procura sintetizar e organizar, por meio de revisão de literatura, informações sobre noções físicas e de anatomofisiologia subjacentes aos ETVSO e seus diferentes tipos, com descrição, aplicabilidades clínicas, restrições, tempo de realização, efeitos e eficácia. Os ETVSO são realizados com alguma oclusão no trato vocal que modifica a impedância acústica e gera ressonância retroflexa, afastando as pregas vocais na vibração, reduzindo os riscos de trauma e equilibrando as pressões sub e supraglótica, com economia vocal; tipos: vibração de lábios e de língua, sons fricativos, /b/ prolongado, *humming,* firmeza glótica, constrição labial e fonação em tubos; são utilizados em distúrbios vocais, incluindo a hipernasalidade, no aquecimento e aperfeiçoamento vocal; a fonação com tubo imerso a 15cm em água somente deve ser utilizada em disfonias hipocinéticas; não há definição científica quanto ao tempo de execução; os efeitos positivos gerados são a melhora da propriocepção, dos aspectos vocais perceptivo-auditivos e acústicos e mudanças no trato vocal; os estudos realizados com ressonância magnética e tomografia computadorizada verificaram modificações no trato vocal após a técnica de fonação em tubos, tais como área central mais alargada, firme fechamento do esfíncter velofaríngeo, diminuição da região do esfíncter velofaríngeo, epiglote em posição vertical, língua mais elevada posteriormente, expansão das áreas transversais da orofaringe e da cavidade oral; não foram encontrados estudos sobre eficácia dos ETVSO.

DESCRITORES: Voz; Treinamento da Voz; Qualidade da Voz

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