SOUND PRESSURE LEVEL AND MAXIMUM PHONATION TIME AFTER *FINGER KAZOO* TECHNIQUE

Pressão sonora e tempo máximo de fonação após a técnica de finger kazoo

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ABSTRACT

Purpose: to determine the modal sound pressure level (SPL) and maximum phonation time (MPT) /a/ adult woman without vocal complaints or laryngeals disorders, before, immediately after and five minutes after the execution of the technique of *Finger kazoo (FK)*. **Method:** collection of the MPT /a/, measure of fundamental frequency (f0) and its standard deviation, and measuring the modal SPL, 32 woman between 18 and 40 years of age without vocal complaints or laryngeal disorder before (M1), after three sets of 15 repetitions of FK (M2), and five minutes after silence (M3). Spearman, Tukey and Friedman tests. **Results:** increase of modal NPS M2 (significance), and M3, increased of MPT /a/ in M2 and M3. **Conclusion:** in the studied group of adult woman without vocal complains or laryngeal disorders, there was a higher in the modal NPS immediately after three sets of 15 repetitions of the FK technique, showing that the technique can influence the sound pressure the loudness and vocal projection.

KEYWORDS: Voice; Phonation; Voice Quality; Larynx; Voice Training

INTRODUCTION

The vocal emission is an extremely common event, which is part of day-to day the majority of people that appearing to be simple, but presents very complex physiology. The vocal folds are structures with different biomechanical characteristics and able to assume various forms generating unlimited sound possibilities [1,2].

Parameters and measures related to voice production such as frequency, length of vocal emission and sound pressure may suffer fine adjustments according to the pattern of vocal fold vibration. Some factors such as subglottic air pressure, air flow transglottic, glottal resistance, contraction of the intrinsic muscles of the larynx, pattern of glottal adduction, vibration mass, rigidity and elasticity of the vocal folds and acoustic coupling of the cavities above and below the vocal folds operating simultaneously during phonation[1,3-6].

Deviations of these aspects may conduce to vocal distortions and are present in several dysphonia, causing impairment in voice quality and many dysphonia are closely related to sound pressure level disorders (SPL), changing the usual loudness[1,7].

Under normal situations, the control of the SPL is determined by glottal resistance, a result of the inertia of the vocal folds and the contraction of the adductor muscles that increases tension and the

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proximity toward the midline[3,8], and the modifications in the subglottic airway pressure in respiratory level [8-10].

The respiratory support also interferes on measurement of maximum phonation time (MPT) commonly used in speech therapy clinic to determine the vocal efficiency, degree of dysphonia and even to check the effects of vocal techniques over voice [11,12]. Furthermore, it is noninvasive measurement, quick and practice [7,10].

For the treatment and improvement of voice, the Speech-Language Pathologist provides a series of vocal techniques, among them the finger kazoo technique (FK), semi-occluded vocal tract exercise (SOVTE) which causes constriction in the vocal tract with increase of glottal pressure and supraglottic, which tends to depart the vocal folds, reducing the impact force between them during phonation[5,13,14]. The FK technique presents effects such as the improvement of the resonance in the vocal tract, increased intensity of the formant tracking, greater vocal stability[12] and improves the perception of voice[12,13].

This study aimed to verify the SPL, considering its modal value, and MPT /a/ of adult women, without vocal complaints or laryngeal affections, before, immediately after and five minutes after the execution of the FK technique.

METHOD

This study is an analytical observational cross-sectional type of quantitative character, being the present research approved by the Research Ethics Committee of the home institution (016945/2010-76). The subjects were informed about the study and were invited to read and sign the consent form, as recommended by the standard 196/96 of the National Committee for Research Ethics – CONEP/1996.

Subjects who sought a school clinic of Speech-Language Pathology to perform the vocal improvement were the target population of this study and, for the composition of the sample, have adopted the following inclusion criteria: from April 2009 to July 2010; signing the Informed Consent Form, female, aged between 18 and 40 years (to exclude subjects with possible vocal disorders of voice change or aging) 3,10,11,14,15, and absence of laryngeal disorders [5,7,10,12,15].

Exclusion criteria were: vocal complaints [5,14,15]; report of any neurological disease, endocrine, psychiatric, gastric, respiratory to influence the practice of a technical or assessment procedures, or hormonal changes (pregnancy, menstrual period, or premenstrual) [3,14,15]; colds, respiratory allergies on the day of the evaluations; habits of alcohol and tobacco [3,7,15]; speech therapy treatment and/ or previous otorhinolaryngological; prior knowledge of FK or disability in its execution [3,7,14]; hearing loss[11,12,15]; be a singer; develop changes in the stomatognathic system to influence evaluations or performance of the FK [3,8,12,14,15].

It was conducted an initial interview based on the criteria of inclusion and exclusion, and after, otorhinolaryngological evaluation, including visual inspection of the larynx; evaluation of stomatognathic system and its functions; and hearing screening with swept pure tones by air conduction at 500, 1000, 2000 and 4000Hz to 25dB in acoustically prepared booth with audiometer Fonix FA 12 Digital.

During the sampling, performed 42 voluntary, but among them, one was excluded for being in menstrual period on the day the evaluations, one for being a singer, four of them by presenting laryngeal disease (swelling of the vocal folds, microweb, sulcus vocalis, nodules), one for hearing loss and three for not having attended all evaluations. Thus, the sample consisted in 32 adult women, who were blinded about to the research objectives.

The data collection occurred in an acoustically treated room (noise below 50dBSPL) [3,7,8,12]. In orthostatic position, the volunteers performed a deep inhalation and issued the vowel /a:/ in MPT and habitual pitch and loudness. The time of emission was clocked in seconds to establish the MPT /a/ of each volunteer [3,8,10,12,15,16].

The SPL was assessed with the *Instrutherm* sound pressure meter, Dec-480 model, positioned on the side of the body at 11,82 inches of the labial commissure of the individual, during the emission of the vowel /a:/, considering the modal value [5,6,16].

Once the meters of sound pressure is highly sensitive and humans naturally to sustain a vowel, have small variations in height and sound pressure, the meter records quickly changes of the values of sound pressure according to these small variations. The scientific work that used the SPL variable consulted and used in the present study do not mention which the value of the SPL considered for each subject.

In this study, for increased reliability of the values of SPL, it was decided to consider the value of modal SPL, meaning, the mode for NPS of each subject to later calculate the group average. The mode is the value that has the largest number of observations. In this study, the most frequent value of SPL during sustained vowel /a/ of the same subject (for NPS mode or modal SPL) value was considered as SPL that subject.

The emission of the vowel /a:/ was also used for the analysis of acoustic measures of fundamental frequency (f0) and f0 standard deviation (STD) of the voice through the *Multi-Dimensional Voice Program Advanced* (MDVPA) program by *Kay Pentax*®, with a sampling rate 44KHz and 16bits. It eliminated the vocal attack and was considered the shortest time of all the supports by the group for the analysis window that was four seconds. The emission remainder was discarded for the decreases of amplitude and frequency common in prolonged emissions not interfere in the analysis of data [3,7,10,12].

The f0 measures were analyzed, because involuntary oscillations of f0 during the emission of /a:/ could influence the 5,6 SPL, constituting a intervening variable.

Then the participants effected three series of 15 repetitions of MPT of FK [5,12,14,17]. The previous orientations to the execution were: produce a continuous blow with sound, with lips in the format of emission of the vowel /u/ in habitual loudness and pitch, without inflate the cheeks, with tongue relaxed and positioned on the floor of the mouth, positioning the index finger vertically over the lips, touching them lightly, without pressure them, as used in gesture for silence. The correct practice involved the generation of noise or friction secondary corresponding to the flow of air in contact with the index finger[12,13,18].

The technique was performed with the subjects seated in a comfortable way, with the spine and cervical region properly positioned, with an angle of 90 ° between the chin and neck, absence of exaggerated contraction of the muscles of the shoulder girdle and the supra-hyoid region, with the feet flat on the floor, keeping the constant rhythm between one repetition and another, without using the expiratory reserve air. They should also use the diaphragmatic breathing/abdominal breathing and avoid the fluctuation or variation of pitch and/or loudness [12].

The orientations and demonstrations of the technique execution were provided by a Speech-Language Pathologist who accompanied the whole collection and investigated the conditions of each participant to correct practice, according to the model and homogeneously [3,12,13,15].

After each series of 15 repetitions of FK, was performed the passive repose of 30 seconds (total absence of any vocalization). During the implementation of the technique, it was allowed the participants to ingest 0,05gal of water [12,14,19], not considered the intervening variable, once the tissue hydration occurs in a systemic way taking hours to reach the larynx through the bloodstream and glands [3,12].

Completed the three series of FK, the participants emitted again the vowel /a:/, MPT by timing and measuring the modal SPL, keeping the same procedures preceding the production of the technique. From that moment, the participants remained seated and in absolute silence during five minutes and, after this interval, they emitted again the vowel /a:/ performing the measurements of f0, f0 STD, MPT and modal SPL [13].

After investigated the normality of variables, was applied the post hoc test of Tukey to compare the modal SPL average of the three moments and the Friedman test to detect differences between MPT and f0 of the three moments, since there was no statistically significant value in comparison. It was used the Spearman test for correlating the modal SPL and the f0 in three stages. The level of significance adopted was 5%.

RESULTS

Table 1 shows the descriptive analysis of the variables modal SPL and MPT /a/. It was observed higher mean values, of both modal SPL as MPT /a/ in M2.

Table 2, it is possible to verify a significant difference modal SPL of group comparing M1 and M2.

Table 3, it is found that have no significant difference MPT /a/ in the three time points analyzed.

Table 4 shows that there was no significant correlation between the modal SPL and f0 after FK technique.

Table 1 – Descriptive analysis of the variables modal SPL and MPT /a/

	Minimum value of group	Maximum value of group	Average of group	Standard deviation
Modal SPL (dB) M1	54,2	75,9	64,66	5,35
Modal SPL (dB) M2	56,0	82,8	68,32	6,44
Modal SPL (dB) M3	53,3	79,1	66,27	7,10
MPT /a/ (s) M1	4,47	22,61	11,95	3,58
MPT /a/ (s) M2	6,0	20,4	12,61	3,58
MPT /a/ (s) M3	5,57	19,19	12,53	3,90

MFT – maximum phonation time
M – moment

Table 2 – Difference of modal SPL of group at the three analyzed

		Difference between the average modal SPL in group at time analyzed (dB)	Standard deviation (dB)	p-value
M1	M2	3,65	0,94	0,001*
M2	M3	2,05	0,94	0,084
M1	M3	1,60	0,94	0,214

*significant values – Teste Tukey
M – moment

Table 3 – MPT/a/ average, f0 and STD of group at the three moment analyzed

	Avarage	Standard deviation	p-value
MPT/a/ (s) M1	11,95	3,58	
MPT/a/ (s) M2	12,61	3,58	0,846
MPT/a/ (s) M3	12,53	3,90	
f0 (Hz) M1	207,95	22,11	
f0 (Hz) M2	217,80	30,61	0,084
f0 (Hz) M3	216,07	26,30	
STD (Hz) M1	3,25	1,52	
STD (Hz) M2	4,38	4,78	0,518
STD (Hz) M3	3,63	1,49	

* significant values – Friedman Test
f0 – fundamental frequency
STD – standard deviation of f0
MPT – maximum phonation time
M – moment

Table 4 – Correlation between NPS modal and the measures of f0 at the three moment analyzed

	r	p-value
NPS modal & f0 - M1	0,37	0,0331*
NPS modal & f0 - M2	-0,00	0,9864
NPS modal & f0 - M3	0,26	0,1444

* Significant values – Spearman Correlation Test
f0 – fundamental frequency
NPS – sound pressure level
M – moment

DISCUSSION

In this study, have been measured MPT /a/ and modal SPL of women without vocal complaints or laryngeal affections after performing three series of 15 repetitions at MPT of the technique FK, having a significant increase in SPL modal immediately after FK (M2), remaining increased, although not significantly, after five minutes of absolute silence (M3) (Table 2), in agreement with the scarce literature on SOVTE [5,14].

The modifications in expiratory flow, related to the increase or decrease in sound pressure, may modify the vibration pattern of the vocal folds and vice versa, having a positive correlation between SPL and f0 [5,6]. Thus, measures of f0 were performed with the aim of verify if the natural and involuntary modifications of the f0 during the sustained emission of /a/ in this research could influence significantly the SPL, constituting the intervening variable in the analysis of the effect of FK technique over the modal SPL.

It was verified that there was no significant correlation between modal SPL and f0 after the execution of FK technique (Table 4), evidencing that the modal SPL results obtained are due to the effect of FK and not the influence of involuntary oscillations of f0 during the collections of /a:/ (Table 2).

In research with adult women, SPL was increased after three and five minutes of the sonorous tongue vibration, which is also a SOVTE as the FK[14]. Another work about the sonorous tongue vibration, with men and women opera singers, verified increased of maximum SPL after technical [5], reinforcing the findings of increase in the modal SPL after the FK, technical to group of SOVTE.

The control of SPL of the voice is related to the three levels of vocal production. At level respiratory, SPL may be increased by increasing the aerodynamic power. At the glottal level, an increase in SPL may occur when the contraction of the adductor muscles of the larynx increases the resistance to air flow and the closed phase of the glottal cycle. It also interferes at the respiratory level, causing the subglottic airway pressure increases to overcome the blockage of glottic [1,3,11,16,20,21].

At the supraglottic level, articulation or resonant, the increase in SPL is related to vocal tract resonance with important effects on the distribution of acoustic energy, such that the sound produced at the glottis is modulated according to the configuration of the vocal tract, resulting in vocal projection [3,7,8,11,16,22].

Research that examined the effects of FK technique in women using acoustic spectrogram analysis showed significantly increased of darkening of tracing after FK [12], whereas the literature relate the darkening of the spectrographic tracing with the sound pressure [23,24].

The literature shows that the process of increasing the acoustic impedance in the vocal tract due to the lips semi-occluded and the increase of airway pressure at supraglottic level and glottic (resonance retroflex), characteristic of SOVTE, generates economic vocalization, with less effort and greater efficiency [3,12,13,25], fact that may be illustrated by the significant increase in modal SPL after FK (Table 2). It is possible that the FK technique have generated increase in the glottal resistance, resulting in SPL higher and vocal efficiency, without overload the vocal folds [12].

This study also shows an immediate increase in the values of MPT /a/ after the FK (M2), although not significant, while remaining five minutes after (M3) (Table 1 and 3), suggesting that the production of three series of the 15 repetitions in the MPT of the FK technique influence the control and the neuromuscular coordination respiratory and laryngeal, as well as the proprioceptive the phonation sensations, improving the pneumo-phono-articulatory coordination as a whole, according to which recommends the literature about SOVTE [3,12,13,16,25,26], exerting a positive effect on the SPL and the MPT.

The findings of this study converge with those of a study of patients with Parkinson's disease in which, after treatment with wind instrument, activity of intense exercitation to the respiratory system that causes an increase in expiratory pressure, there was a vital capacity increase, as well as SPL and MPT [11].

Due to the increase of MPT /a/ have no statistical significance, are suggested longitudinal studies to confirm this effect and to ensure that the periodic practice with FK technique would result a significant increase.

CONCLUSION

At the adult women surveyed, present an increase in modal SPL immediately after three series of the 15 repetitions of the FK technique, showing that the technique may influence positively the sound pressure, the loudness and vocal projection.

RESUMO

Objetivo: verificar o nível de pressão sonora (NPS) modal e o tempo máximo de fonação (TMF) de /a/ de mulheres adultas, sem queixas vocais ou afecções laríngeas, antes, imediatamente após e cinco minutos após a execução da técnica de *finger kazoo* (FK). **Método:** coleta do TMF/a/, medida da frequência fundamental (f0) e seu desvio-padrão e do NPS modal, de 32 mulheres entre 18 e 40 anos de idade sem queixas vocais ou afecções laríngeas antes (M1), imediatamente após três séries de 15 repetições do FK (M2), e cinco minutos após silêncio (M3). Testes *Spearman, Tukey* e *Friedman*. **Resultados:** aumento do NPS modal em M2 (com significância) e em M3; aumento de TMF/a/ em M2 e M3. **Conclusão:** no grupo pesquisado de mulheres adultas sem queixas vocais ou afecções laríngeas, houve aumento do NPS modal imediatamente após três séries de 15 repetições da técnica de FK, mostrando que a técnica pode influenciar a pressão sonora, a *loudness* e a projeção vocal.

DESCRITORES: Voz; Fonação; Qualidade da Voz; Laringe; Treinamento da Voz

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