Original Article

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Comparison of effects of finger kazoo and tube phonation techniques in women with normal voice

Comparação dos efeitos do *finger kazoo* e da fonação em tubo em mulheres com voz normal

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ABSTRACT

Purpose: To compare the voice before and after the finger kazoo and phonation into a glass tube immersed in water in women without vocal complaints or laryngeal affections. **Methods:** Forty-six women participated of the group that performed the finger kazoo and 12 of the group performed the phonation into a glass tube immersed in water. It was collected the vowel /a:/, before and after the techniques, for acoustic analysis through the Multi-Dimensional Voice Program Advanced and the Real Time Spectrogram; and auditory perceptual with RASATI scale. The techniques were performed on three series of the 15 repetitions, with 30 seconds of rest between them. **Results:** In comparison, phonation into a glass tube immersed in water showed significant improvement: definition of the first formant, subharmonic presence, smoothed pitch perturbation, variation of f0 and voice turbulence index; and the finger kazoo showed a significant reduction in the standard deviation of f0. The auditory perceptual analysis had no significant difference between groups. **Conclusion:** In comparison, phonation into a glass tube immersed in water provided more noticeable improvement in acoustic vocal aspects related to resonance, noise and stability than the finger kazoo.

Keywords: Voice; Voice quality; Voice training; Larynx; Speech acoustic

RESUMO

Objetivo: Comparar voz antes e após a execução do *finger kazoo* e de fonação em tubo de vidro imerso em água, em mulheres sem queixas vocais e com laringes sem alterações. **Métodos:** Participaram 46 mulheres no grupo que realizou a técnica *finger kazoo* e 12, no grupo que realizou a técnica de fonação em tubo de vidro imerso em água. Coletou-se a vogal /a:/, antes e imediatamente após a realização das técnicas, para análises acústicas, por meio do *Multi-Dimensional Voice Program Advanced* e do *Real Time Spectrogram*, e para análise perceptivo-auditiva, com a escala RASATI. As técnicas foram realizadas em três séries de 15 repetições, com repouso de 30 segundos entre elas. **Resultados:** Quando comparados os métodos, a fonação em tubo de vidro imerso em água mostrou melhora significativa da definição do primeiro formante, da presença de sub-harmônicos, do quociente de perturbação do *pitch* suavizado, da variação da frequência fundamental (f0) e do índice de turbulência da voz. O *finger kazoo* apresentou redução significativa do desvio padrão da f0. Na análise perceptivo-auditiva, não houve diferença significativa entre os grupos. **Conclusão:** A fonação em tubo de vidro imerso em água proporcionou melhora mais perceptível nos aspectos vocais acústicos relacionados à ressonância, ruído e estabilidade, do que o *finger kazoo*.

Descritores: Voz; Qualidade da voz; Treinamento da voz; Laringe; Acústica da fala

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INTRODUCTION

In vocal production, the vocal source and filter alter acoustic impedance, because of changes in physiological configurations of the vocal tract. So, both levels interfere with each other[1,2,3,4]. In phonotherapy, the increase of vocal tract impedance may occur in case of constriction or stretching. Constriction and discrete stretching occur in vocal exercises related to anterior constriction with semi-occluded lips, such as the finger kazoo (FK) technique. Higher artificial stretching may happen through phonation into resonance tubes with different lengths and diameter, such as phonation into glass tube immersed in water (FTVIA)[1,2,5,6,7,8,9,10,11,12,13,14,15].

Literature mentions several effects produced by training with these exercises with semi-occluded vocal tract (ESOVT). Among the effects, there are: reduction of phonatory pressure and of glottic airflow, increase of harmonic energy, changes in glottic aerial pulse way and in oscillatory characteristics of vocal folds, increment of sound pressure, and increase of vocal tract vibrations perception[2,14,15,16]. Another study verifies decrease in the first formant (F1) frequency. It would cause easier phonation, because of reduction of phonation threshold pressure and decrease of transglottic airflow, producing a voice full of harmonics. The ESOVT are used in therapy and improvement of speaking and sung voice, and also in cases of functional dysphonia (hyper and hypofunctional), organic (recurrent laryngeal nerve paralysis) and organofunctional[8,11].

FK is produced with narrow vocal tract constriction, lips semi-occlusion and airflow block with the index finger vertically positioned in front of the lips[2,9]. It is practiced with extended pharynx, relaxed tongue and mandible and protruding and rounding lips, by prolonging a voiced blowing, similar to the /u/ vowel. It generates a secondary sound, because of the contact between the airflow and the index finger, such as beetles' sounds, requiring proper air support to be maintained[2,9]. In FTVIA for hyperfunctional cases, the tube distal extremity should be immersed 2 cm into an acrylic recipient with water and, in the proximal extremity[10,17], as well as FK, it should be emitted voiced blowing with the /u/ vowel[2,9].

Although both techniques are classified as ESOVT, the performance of each technique and the mechanisms of vocal tract semi-occlusion are different. Thus, it seems not to be correct to generalize their effectiveness. As literature is still precarious about such techniques[1,2,9,10,14,15,17,18] and there is only one study[2] which compares the techniques, it is important to verify their effects and to compare them, to provide more accurate indication to patients.

In relation to FK, previous studies investigated the immediate effects of its performance in women with normal voice[2,9,19,20]. Three of them performed investigation through three series of 15 repetitions[9,19,20]. The first one evidenced significant increase of fundamental frequency, improve of amplitude variation (AV) and degree of subharmonics (DSH)[9]. The second one, presented significant increase of modal sound pressure level[19]. The last one, through spectrographic acoustic analysis, presented significant improvement of second, third and fourth formants, as well as of high frequencies. It presented also significant improvement of the definition of the second and third formants and of the harmonics, as well as gains in tracing regularity. In some aspects, they were maintained five minutes after the end of the exercised performance[20].

In relation to the comparison with ESOVT, a pioneer study compared the FK effects with the technique of phonation into tubes of lower diameter, showing that both methods improved vocal self-perception and reduction of fundamental frequency, but the perceptive-auditory evaluation indicated positive effects only in phonation into tubes[2].

The number of published articles about phonation into tubes has increased, and it may be verified that this technique provides positive results in several aspects related to voice[7,9,14,15]. A research investigated the immediate effect of a sequence of four exercises with phonation into tube (22.8 cm length and 3 mm diameter), performed with the following variations: usual pitch and loudness and with a melody into the tube. It was found significant difference in the parameters *Cepstrum, Jitter, Shimmer* and harmonics-to-noise ratio (HNR), between the moments before and after exercises. There was also prevalence of positive vocal sensations[7].

The immediate FTVIA effects were also researched with 25 dysphonic teachers, who performed the technique in a series of 10 repetitions, with immerse tube of 2 cm. Most of them mentioned sensation of better phonatory comfort and improvement of vocal quality, after performing the technique. In the perceptive-auditory vocal analysis, there was improvement of vocal instability in the samples of counting numbers, as well as reduction of sub harmonics, of noise in high frequencies and of f0[14].

The technique effectiveness was studied with 42 elderly subjects, both genders, who performed the following emissions into the tube: prolonged /b/, /u/ vowel, 'jjjuu', 'jjjiibbuu', 'jjiibbiiuu' and the melody of the song 'happy birthday'. It was used glass tubes from 8 mm to 9 mm of diameter and from 25 cm to 26 cm of length, immersed 5 cm into water. The therapy, lasting one hour, was performed once a week, for six weeks. There was significant improvement in all parameters of the vocal perceptive-auditory GRBASI scale, with exception of soprosity. In the vocal self-perception, most subjects reported decrease of complaints and symptoms and, in spirometry, there was significant increase of values[15].

Based on the aforementioned considerations, the present study had the purpose of comparing voice before and after the performance of the techniques finger kazoo and phonation into a glass tube immersed in water, in women without vocal complaints or laryngeal affections.

METHODS

This is an observational, cross-sectional, analytical, contemporary and quantitative research, approved by the Ethics Committee from *Universidade Federal de Santa Maria* (UFSM), Brazil, (number 016945/2010-76). All participants were informed about the study and signed the Free and Clarified Consent Term. The target population consisted of adult women, who participated in lectures about vocal health, from campaigns of Voice Day. They were invited, in case of interest, to evaluation in a Speech, Language and Hearing Sciences school clinic and, subsequently, to perform the evaluation and voice improvement.

To select the subjects, the following inclusion criteria were established: consent term signature; to be a female; aged from 18 to 40 years old (excluding, so, the period of voice changes in adolescence and hormonal alterations which occur with women, mainly after they are 40 years old, as well as laryngeal and vocal changes caused by aging process[21,22]); absence of laryngeal affections, according to otorhinolaryngological (ORL) evaluation and vocal complaints[9,20,21,22,23].

The exclusion criteria were: report of neurological, psychiatric, gastric chronic, respiratory chronic, endocrinological diseases or other systemic diseases, which could alter vocal performance or understanding of orders during the evaluations[9,10,20,21,22,23]; flu or respiratory allergies in the data collection day[9,10,20,22]; vocal complaints, which could signalize organic and/or functional vocal dysfunction[20,21]; history of laryngeal surgery and/or any surgical procedure of head or neck[10]; hormonal alterations caused by pregnancy or menstrual or pre-menstrual period, in the collection day, as they might alter vocal parameters; to be a smoker or alcoholic, because these are risk factors to develop laryngeal affections[9,10,20,22]; to be a subject who has already performed previous Speech, Language and Hearing and/or ORL treatment, excluding the possibility of presenting any vocal disorder or conditioning by training phono therapeutic techniques; knowledge about the used vocal techniques; hearing alterations, not to undermine self-monitoring of voice; presence of stomatognathic system alterations, which could interfere with the technique performance, or with voice evaluation[9,10,20,22].

For all the volunteers, it was applied a questionnaire, with information related to the mentioned criteria. It was performed ORL evaluation with laryngoscopy, in order to discard laryngeal affections, as well as evaluation of the stomatognathic system and audiometric screening (frequencies of 500, 1000, 2000 and 4000 Hz in 25 dB). The subjects who presented alterations in any of the evaluated aspects were excluded from the research and they were referred to more complete evaluations.

Both study groups (FTVIA and FK) were selected from two different research projects. One of them aims at verifying the FTVIA effects, and the other, the FK effects. Both researches occurred in different moments, but with identical methodology of data collection (with difference only in the chosen technique). For this reason, they presented different sizes, with different subjects in each group, with no necessity of matching the numbers, because both groups were independent[24].

For the FK data collection, there were 56 volunteers. Ten of them were excluded, one because of menstrual period, one who is a singer, one because she presents vocal folds edema, one because she demonstrated microweb, one with vocal furrow, one with vocal nodules, one with hearing loss, and three of them did not attend all the evaluations, resulting a group of 46 women (GFK).

For the FTVIA technique collection, there were 16 volunteers. Four of them were excluded because they presented laryngeal affections, one was excluded because of pre-menstrual period and one was a smoker, resulting in a group of 12 women (GFTVIA).

The volunteers of both groups were blinded in relation to the purposes of the initial researches and the data collection started in acoustically treated environment, with noise level lower than 50 dB, measured through sound pressure gauge (Instrutherm®, Dec- 480)[9,10,19,20,22]. They remained in orthostatic position and they emitted the vowel /a:/ in usual pitch and loudness for, at least, four seconds. The vocal emissions were recorded through digital recorder by Zoom®, model H4n (stereo microphone, unidirectional, 96 kHz, 16 bits, 50% of the entrance signal recording level), at an angle of 90º from the mouth[24] and distance of 4 cm from the microphone to the mouth[9,10,19,20,22]. The same emission was collected immediately after the performance of each technique.

The GFK participants were instructed to produce voiced blowing, emitting the /o:/ sound in usual loudness and pitch, without inflating the cheeks, with tongue in low position and relaxed, and the index finger in vertical position, touching the lips, without pressing them, such as in the gesture to ask for silence. During this production, it should occur a secondary friction sound, corresponding to the airflow in contact with the index finger[2,9,19,20].

To perform the FTVUA, the recipient size was standardized (12 cm width, 12 cm depth, 15 cm length), filled with water up to 9 cm height. In order to maintain the participants' correct posture, the recipient was adjusted (elevated) according to each participant's height, so the tube could be in the lips level and they did not need to bend forward during the technique performance[14]. A holder was adapted, also, from the glass tube to the water recipient, so the angle between the tube and the chin remained the same for all the participants, during the technique performance. The tube remained fixed to the support, with the distal tip submerged 2cm from the surface[1,10] and previously marked on the tube, according to Figure 1.

The GFTVIA subjects were instructed to put the proximal extremity of the tube (glass tube, 27 cm length, 1 mm thickness and 9 mm diameter)[5,10,12,20,21] between the lips and to produce the phoneme /u:/, being careful to maintain the lips sealed to avoid air escape between the lips and the tube.

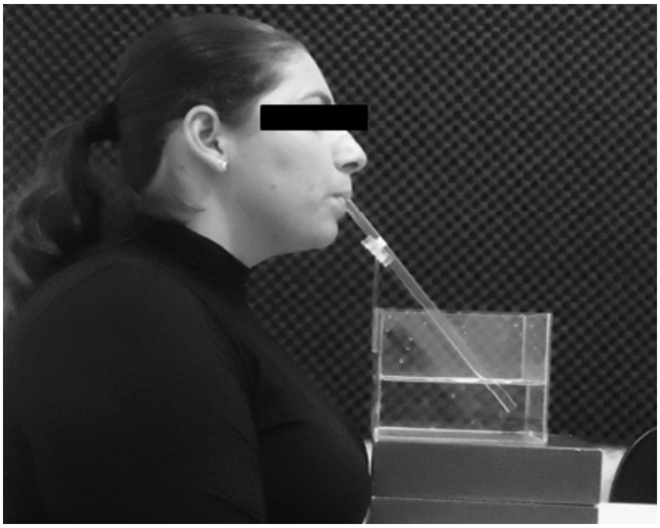

Figure 1. Example of phonation into glass tube immersed in water

Each emission of both techniques was performed up to the expiration end, without increasing muscular contraction of the shoulder girdle and of the suprahyoid region and in usual pitch and loudness. These aspects were visually monitored by the researchers, during data collection, as well as the performance of the technique, in correct and standardized way, for all volunteers(9,10,20).

The techniques were performed in three series of 15 repetitions and, between each series, there was passive rest of 30 s, when the volunteers remained in the same position, in silence(9,10,20,25). Along the time of technique performance, the women could ingest up to 250 ml of water(9,10,19,20), without intervening in the results, because systemic hydration takes some hours to reach the larynx(9,10,19,20).

For the voice acoustic analysis, it was omitted the vocal attack of the /a:/ production and, from this moment, the time of 3.5 s was considered as pattern for the analysis window, discarding the rest(2,9,10,19,20).

The voices were analyzed through the program *Multi-Dimensional Voice Program Advanced* (MDVPA), by Kay PENTAX®, with sample index of 44 kHz and 16 *bits*, extracting several measures, grouped according to the analyzed phenomenon: fundamental frequency measures: f0; f0 high (fhi); f0 low (flo); f0 standard deviation (STD); frequency perturbation measures: absolute jitter (Jita); Jitter percent (Jitt); relative average perturbation (RAP); pitch perturbation quotient (PPQ); smoothed pitch perturbation quotient (sPPQ); coefficient of f0 variation (vf0); measures of amplitude variation: dB shimmer (ShdB); shimmer percentual (Shim); amplitude perturbation quotient (APQ); smoothed amplitude perturbation quotient (sAPQ); Amplitude Coefficient of Variation (vAm); noise measures; noise-to-harmonics ratio (NHR); voice turbulence index (VTI); soft phonation index (SPI); voice breaks measures: degree of voice breaks (DVB); number of voice breaks (NVB); measures of unvoiced segments: number of unvoiced segments (NUV); degree of unvoiced segments (DUV); measures of subharmonic segments: degree of subharmonic segments (DSH); number of subharmonic segments (NSH)(9,10,22).

It was also performed the perceptive-auditory analysis, through the RASATI scale, based on the production of the vowel /a:/. The judges of each group received the randomized voices on a CD and they were guided to listen to the recordings through headsets, as many times as they needed, in silent environment.

For the spectography, it was used the program *Real Time Spectrogram* by Kay PENTAX®, in broadband filter: 100 points (646 Hz) and in narrowband filter: 1024 points (63.09 Hz), with sampling rate of 11 kHz and 16 *bits*(9,10,20,22).

In the analysis of the broadband filter (EBL), it was considered the following aspects: darkening of the formants F1, F2, F3, F4 tracing; darkening of the high frequencies tracing; darkening of the tracing of all spectography; presence of noise in all vocal spectography, as well as in the high frequencies; definition of tracings F1, F2, F3 and F4; tracing regularity(9,10,20).

In the analysis of the narrowband filter (EBE), the following aspects were considered: darkening of high frequencies tracing; darkening of tracing of all vocal spectography; presence of noise in all the vocal spectography, as well as in the high frequencies; definitions of the harmonic tracing; tracing regularity(9,10,20).

The spectrographic analysis was performed by three speech, hearing and language therapists for each group of techniques, using specific protocol(9,10,20). The EBL and the EBE were presented to the judges in pairs (before and after the performance of the techniques). Thus, the evaluation was performed comparing the first and the second spectrography(4,20). All the pairs were randomized and, then, it was performed the reliability calculation through the Kappa coefficient(20).

All the judges who participated in the study were blinded in relation to the purposes and methodology of the study and all of them presented experience of, at least, five years in the area of voice(9,10,20,22). The results were tabulated and were treated through the Mann-Whitney U test, to compare the effects of both techniques. The statistical analysis of the reliability among evaluators was performed through the Kappa coefficient.

RESULTS

For the perceptive-auditory evaluation, the reliability among evaluators resulted in 0.20 for the GFK and 0.31 for the GFTVIA and, in the spectrographic evaluation, the reliability among evaluators was 0.2 in the GFK and 0.35 in the GFTVIA(10,18).

DISCUSSION

In relation to the results of the research, there was higher F1 definition in the GFTVIA (Table 1). As the 'Fs' are more directly related to the vocal filter, these results suggest that the FTVIA causes more modifications in this region, when compared with

Table 1. Comparison of the broadband spectogram between the groups finger kazoo and phonation into glass tube immersed in water

	FK Group			FTVIA Group			p-value
	W	NA	I	W	NA	I	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Darkening tracing of F1	9 (19.57)	15 (32.61)	22 (47.83)	2 (16.67)	-	10 (83.33)	0.076
Darkening tracing of F2	7 (15.22)	18 (39.13)	21 (45.65)	2 (16.67)	-	10 (83.33)	0.067
Darkening tracing of F3	8 (17.39)	14 (30.43)	24 (52.17)	2 (16.67)	-	10 (83.33)	0.117
Darkening tracing of F4	7 (15.22)	15 (32.61)	24 (52.17)	3 (25.00)	1 (8.33)	8 (66.67)	0.653
Darkening tracing of the high f	10 (21.74)	9 (19.57)	27 (58.70)	2 (16.67)	1 (8.33)	9 (75.00)	0.362
Darkening tracing of the whole vocal spectrogram	10 (21.74)	11 (23.91)	25 (54.35)	2 (16.67)	-	10 (83.33)	0.129
Presence of noise in all vocal spectrogram	17 (36.96)	18 (39.13)	11 (23.91)	7 (58.33)	1 (8.33)	4 (33.33)	0.559
Presence of noise in the high f	16 (34.78)	23 (50.00)	7 (15.22)	5 (41.67)	3 (25.00)	4 (33.33)	0.732
F1 definition	5 (10.87)	28 (60.87)	13 (28.26)	2 (16.67)	1 (8.33)	9 (75.00)	0.028*
F2 definition	10 (21.74)	11 (23.91)	25 (54.35)	3 (25.00)	2 (16.67)	7 (58.33)	0.923
F3 definition	10 (21.74)	14 (30.43)	22 (47.82)	3 (25.00)	-	9 (75.00)	0.298
F4 definition	10 (21.74)	16 (34.78)	20 (43.48)	4 (33.33)	2 (16.67)	6 (50.00)	0.934
Tracing regularity	11 (23.91)	10 (21.74)	25 (54.35)	2 (16.67)	3 (25.00)	7 (58.33)	0.451

*Significant values with higher scores in the FTVIA group ($p<0.05$) – Mann-Whitney's U test

Subtitle: FK = finger kazoo; FTVIA = phonation into glass tubes immersed in water; W = worsening; NA = no alterations; I = improvements; f = frequency

Table 2. Comparison of narrowband spectrogram between the finger kazoo group and phonation into tubes immersed in water

	FK Group			FTVIA Group			p-value
	W	NA	I	W	NA	I	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Darkening tracing of the high f	9 (19.57)	13 (28.26)	24 (52.17)	2 (16.67)	4 (33.33)	6 (50.00)	0.983
Darkening tracing of the whole vocal spectrogram	8 (17.39)	17 (36.96)	21 (45.65)	2 (16.67)	-	10 (83.33)	0.064
Presence of noise among the harmonics	15 (32.61)	24 (52.17)	7 (15.22)	7 (58.33)	3 (25.00)	2 (16.67)	0.228
Presence of noise in the high f	15 (32.61)	25 (54.35)	6 (13.04)	5 (41.67)	5 (41.67)	2 (16.67)	0.750
Substitution of harmonics by noise in all vocal spectrogram	7 (15.22)	22 (47.83)	17 (36.96)	5 (41.67)	-	7 (58.33)	0.106
Substitution of harmonics by noise in the high f	4 (8.70)	25 (54.35)	17 (36.96)	6 (50.00)	-	6 (50.00)	0.298
Harmonics definition	12 (26.09)	9 (19.57)	25 (54.35)	2 (16.67)	-	10 (83.33)	0.118
Tracing regularity	9 (19.57)	14 (30.43)	23 (50.00)	2 (16.67)	3 (25.00)	7 (58.33)	0.635
Number of harmonics	15 (32.61)	9 (19.57)	22 (47.83)	3 (25.00)	-	9 (75.00)	0.190
Presence of subharmonics	2 (4.35)	40 (86.96)	4 (8.70)	-	8 (66.67)	4 (33.33)	0.005*

*Significant values with higher scores in the FTVIA group ($p<0.05$) – Mann-Whitney's U test

Subtitle: FK = finger kazoo; FTVIA = phonation into glass tubes immersed in water; W = worsening; NA = no alterations; I = improvements; f = frequency

the FK technique. Literature shows that F1 is related to mouth opening and tongue height in the oral cavity, and, in general, the formants are regions of amplitude increase of some groups of harmonics, associated with vocal resonance[21,23].

In two case studies which used phonation into glass tube and computed tomography to verify vocal tract changes, it was observed elevation of the velum and of the tongue posterior region, during and after technique performance. Besides, the technique increased the vocal tract space and expanded the transversal areas of the oropharynx and of the oral cavity, after the performance[12,18]. One of the studies[18] found, as acoustic evaluation result, increase of sound pressure in the singer's formant region after the technique, evidencing that the technique provides changes in the 'Fs'

In the EBE, the presence of subharmonics showed significant difference, also in favor of GFTVIA. However, most

Table 3. Comparison of the perceptive-auditory vocal evaluation (RASATI) between the groups finger kazoo and phonation into tubes immersed in water

	FK Group			FTVIA Group			p-value
	W	NA	I	W	NA	I	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Hoarseness	5	35	6	1	10	1	0.884
Roughness	0	46	0	0	12	0	1
Soprosity	7	27	12	3	5	3	0.627
Asthenia	5	39	2	0	12	0	0.541
Tension	1	42	3	0	12	0	0.599
Instability	3	32	11	1	10	1	0.083

Mann-Whitney's U test ($p<0.05$)

Subtitle: FK = finger kazoo; FTVIA = phonation into glass tubes immersed in water; W = worsening; NA = no alterations; I = improvements

Table 4. Comparison of the vocal acoustic analysis with glottic source (MDVPA) between the groups finger kazoo and phonation into tubes immersed in water

	FK Group		FTVIA Group		p-value
	Average of total gain (before and after technique)	n	Average of total gain (before and after technique)	n	
f0	7.325	46	2.793	12	0.318
Fhi	8.291	46	-3.534	12	0.0653
fl0	2.466	46	6.960	12	0.672
STD	-42.295	46	-1.271	12	0.039*
Jita	3.189	46	-11.479	12	0.172
Jitt	0.101	46	-0.263	12	0.124
RAP	0.058	46	-0.158	12	0.124
PPQ	0.074	46	-0.146	12	0.111
sPPQ	0.101	46	-0.302	12	0.028**
vf0	0.308	46	-0.656	12	0.023**
ShdB	-0.032	46	-0.032	12	0.946
Shim	-0.351	46	-0.342	12	0.938
APQ	-0.273	46	-0.272	12	0.672
SAPQ	-0.499	46	-397.212	12	0.551
vAm	-1.61	46	-2.202	12	0.908
NHR	-0.007	46	-0.027	12	0.089
VTI	0.667	46	-0.011	12	0.036**
SPI	0.733	46	-2.117	12	0.077
DVB	0	46	-0.086	12	0.050
DSH	-0.353	46	-0.285	12	0.345
DUV	0.115	46	-0.467	12	0.342
NVB	0	46	-0.083	12	0.050
NSH	-0.456	46	-0.333	12	0.308
NUV	0.152	46	-0.583	12	0.356

Mann-Whitney's U test ($p<0.05$)

*Significant values with higher scores in the FK group

** Significant values with higher scores in the FTVIA group

Subtitle: FK = finger kazoo; FTVIA = phonation into glass tube immersed in water; f0 = fundamental frequency; Fhi = high f0; flo = low f0; STD = f0 standard deviation; Jita = absolute Jitter; Jitt = percentual or relative Jitter; RAP = relative average perturbation of the frequency; PPQ = pitch perturbation quotient; sPPQ = smoothed pitch perturbation quotient; vf0 = fundamental frequency variation; ShdB = absolute Shimmer or in dB; Shim = percentual or relative Shimmer; APQ = amplitude perturbation quotient; sAPQ = smoothed amplitude perturbation quotient; vAm = amplitude variation coefficient; NHR = noise-to-harmonics ratio; SPI = soft phonation index; VTI = voice turbulation index; DVB = degree of voice breaks; NUV = number of unvoiced segments; DUV = degree of unvoiced segments; NVB = number of vocal breaks; NSH = number of subharmonic segments; DSH = degree of subharmonics segments

subjects, of both groups, did not present alterations. Generally speaking, the GFTVIA evidenced more parameters with improvements than the GFK (Table 2). A study[16] with FTVIA performed with teachers demonstrated reduction of instability, in subharmonics and noise of high frequencies, after the performance of three series of 10 repetitions of the technique.

The presence of subharmonics in the spectrogram, whose frequencies were among the harmonics, indicate irregularity to phonation or presence of other sound sources during vocal emissions[26]. The improvement in this aspect, observed in this study, agrees with literature, showing that both used ESOVTs favor the vibration of the vocal folds, providing more periodicity, justifying the findings[1,2,9,10,19,20].

However, using EBE, a research[20] with FK did not present difference in relation to the parameter subharmonic, after the technique. The same was observed in another study[10] with FTVIA, in which it was not evidenced significant differences regarding subharmonic presence, after the technique performance. Such fact highlights the importance of performing more studies using these techniques and with different populations, because the investigations findings presented discrepancies and, thus, it is still not possible to claim which are the exact changes caused by the techniques.

In relation to the vocal perceptive-auditory aspects, the FTVIA research evidenced significant soprosity improvement[10], while another recent study[15], performed with elderly people evidenced improvement in most parameters of the GRBASI scale, except soprosity. The global degree of alteration presented significant improvements. Another finding of this research, using the same technique, performed in three series of 10 repetitions in teachers with behavioral dysphonia, was the significant improvement of the general degree of disphonia, in 60% of the subjects[14].

A study[20] with FK presented decrease of vocal instability, immediately after the performance of the technique, maintaining the result after five minutes of rest. It suggests that FK generates higher stability. In this study, one group did not demonstrate higher perceptive-auditory changes than the other one (Table 3), possibly because both techniques are ESOVTs, which improve the vocal folds vibration, providing higher periodicity and stability, with decrease of aperiodic energy[1,2,9,10,20].

The results of both researches[9,10], which emphasized perceptive-auditory improvements after FK and FTVIA, individually, confirm the fact that both techniques, which are ESOVTs, generate perceptive-auditory vocal improvements and, for this reason, there was no significant difference between them, in the present study. On the other hand, a study showed differences in the perceptive-auditory evaluation between FK and phonation into tubes with lower diameter, in women without vocal complaints. It evidences improvement only after the performance of phonation into tubes. The techniques were performed for only one minute, twice in each participant, with interval of five minutes between them, always in the following order: FK, phonation into straw, phonation into straw and FK[2]. Possibly, the absence of improvement after FK is related to the time of technique performance.

In the present study, there was significant difference in the f0 standard deviation (STD), between the GFK and the GFTVIA (Table 4), with higher reduction of this measure after the FK technique, demonstrating higher stability. It agrees with the perceptive-auditory improvement found for FK, in another investigation[9].

Other measures analyzed by the Multi Dimension Voice Program Advanced (MDVPA), such as smoothed pitch perturbation quotient (sPPQ), f0 variation (vf0) and voice turbulence index (VTI) presented significant reduction in the GFTVIA, when compared with the GFK (Table 4). These results agree with the only similar study which compared FK and phonation into tube, but the tube was not immersed into water and it had lower diameter. It found similar acoustic results[2].

In an investigation[5] which compared phonation into tubes with different sizes and bilabial fricative production, the results showed that the relationship between the activities of the thyroarythenoid and crico-arytenoid muscles, using a 30 cm tube, was significantly higher during and after the exercise. It suggests that the activity of the thyroarythenoid increases, as the intraoral pressure raises, a result of the vocal tract semi--occlusion. It may explain the fact that most the improvements of this research happened with the GFTVIA, reinforcing the results of another study[11], in which it was performed electroglottography – high speed images of the vocal folds – with a rigid endoscope (high speed) and air pressure average during the performance of the technique phonation into plastic tubes (2 cm of diameter and 30, 60 and 100 cm of length), with three subjects who performed the technique in the three tubes.

With the longest tube, there was higher f0 reduction, the time of glottic cycle closed phase was lower, the subglottic pressure was higher and the amplitude of the electroglottographic (EGG) signal was lower, when compared with the shorter tube. It suggests that longer tubes require more effort and more activities of the expiratory muscles.

In the present study, the FTVIA presented improvements in more aspects than the FK technique. However, there is the necessity of more studies, because some results from literature still differ between the studied groups.

CONCLUSION

In the comparison of both techniques, the FTVIA provided more intense improvements of vocal aspects related to resonance, presence of noise and stability, than the FK technique. The FTVIA evidenced significant improvement in the definition of the first formant, in the presence of subharmonics, in the smoothed pitch perturbation quotient, in the variation of the fundamental frequency and in the voice turbulence index. The FK technique demonstrated significant reduction in the standard deviation of the fundamental frequency.

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