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Ideal time of sonorous tongue vibration of dysphonic children

Tempo ideal de vibração sonorizada de língua em crianças disfônicas

Tiempo ideal de la vibración sonora del lengua en niños disfónicas

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Abstract

Purpose: verify the ideal time of the sonorous tongue vibration exercise (STVE) in the voice of dysphonic children. **Method**: twenty-seven children, participated from four to 11 years, diagnosed with nodules or cysts of vocal folds. Eleven children were part of the experimental group (GE) and 16 were part of the control group (GC). A sustained vowel /ɛ/ and count one to 10 were recorded before (m0) and after the first (m1), third (m3), fifth (m5) and the seventh (m7) minute of execution of the STVE. The recordings have been presented to three speech therapists that judged whether there was change in voice quality. The acoustic parameters evaluated in sustained vowel were fundamental frequency, jitter, shimmer, glottal to noise excitation (GNE) and noise. **Results**: there were no significant changes in the auditory perception evaluation between the moments of STVE execution. In the acoustic analysis, it was observed that the noise parameter decreased and the GNE parameter increased after three minutes of performing the exercise in GE, compared to the GC. **Conclusion**: there was no improvement in any of the times in the auditory perceptual analysis in the voice of dysphonic children with the STVE. The acoustic analysis indicated improvement in vocal quality in the third minute of exercise performance.

Keywords: Dysphonia; Child; Speech Therapy; Voice Quality; Exercise Therapy.

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Authors' contributions:
FCS, LAR, BOS: realized the data collection, the writing of the manuscript and the approval of the final version.
AMM, ACCG: participated in the design of the study, data analysis, guided all stages of the work and writing the manuscript and approval of the final version.

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Resumo

Objetivo: verificar o tempo ideal do exercício de vibração sonorizada de língua (EVSL) na voz de crianças disfônicas. **Método:** participaram vinte e sete crianças, entre 04 e 11 anos, com diagnóstico de nódulo ou cisto de pregas vocais. Dessas crianças, onze fizeram parte do grupo experimental (GE) e 16 do grupo controle (GC). A vogal sustentada /ɛ/ e a contagem de 1 a 10 foram registradas antes (m0) e após o primeiro (m1), terceiro (m3), quinto (m5) e o sétimo (m7) minuto de execução do EVSL. As gravações foram apresentadas a três fonoaudiólogas, que julgaram se houve modificação da qualidade vocal. Os parâmetros acústicos avaliados na vogal sustentada foram frequência fundamental, *jitter*, *shimmer*, *glotal to noise excitation (GNE)* e ruído. **Resultados:** na avaliação perceptivo-auditiva, não houve modificações significativas entre os momentos de execução do EVSL. Na análise acústica, observou-se que o parâmetro ruído diminuiu e o parâmetro GNE aumentou após três minutos de realização do exercício no GE, em comparação com o GC. **Conclusão:** não houve melhora em nenhum dos tempos na avaliação perceptivo-auditiva da voz de crianças disfônicas com o EVSL. A análise acústica indicou melhora da qualidade vocal aos três minutos de execução do exercício.

Palavras-chave: Disfonia; Criança; Fonoterapia; Qualidade da Voz; Terapia por Exercício.

Resumen

Objetivo: comprobar el momento ideal del ejercicio de vibración sonora del lengua (EVSL) en la voz de niños disfónicas. **Método:** participado veinte y siete niños, de 04 a 11 años, con diagnóstico de nódulos o quistes de los pliegues vocales. De estos niños, once eran parte del grupo experimental (GE) y 16 parte del grupo de control (GE). El sostenido vocal /ɛ/ y el recuento de 1 a 10 se registraron antes (m0) y después de la primero (m1), tercero (m3), quinto (m5) y séptimo (m7) minuto del ejecución de EVSL. Las grabaciones se presentaron a tres logopedas, que juzgaron si había modificación de la calidad vocal. Los parámetros acústicos evaluado en vocal sostenida fueron frecuencia fundamental, *jitter*, *shimmer*, *glotal to noise excitation* (GNE) y ruido. **Resultado:** en la evaluación perceptual, no hubo modificaciones significativos entre los momentos de ejecución de EVSL. En el análisis acústico, se observó que el parámetro de ruido disminuye y parámetro GNE aumentó después de tres minutos de ejecución del ejercicio en GE, en comparación con el GC. **Conclusión:** no hubo mejoría en cualquier de las tiempos en la evaluación perceptual de la voz de los niños disfónicas con EVSL. El análisis acústico indica mejoría en la calidad de la voz después de tres minutos de ejecución del ejercicio.

Palabras clave: Disfonia; Niño; Logoterapia; Calidad de La Voz; Terapia por Ejercicio.

Introduction

Childhood dysphonia is characterized by the modification of vocal parameters, which results in changes in vocal quality, *pitch*, timbre, or voice intensity. Research has shown that vocal problems persist for four years or more after their identification in 38% of children with dysphonia[1,2] , that the behavioral characteristics of dysphonic children do not establish a profile, and that the cause and effect relationship of behavioral factors under dysphonia has not yet been confirmed[3] .

There are modifications in the anatomy of the vocal tract during the phases of life, and there are differences between the structures of children and adults in relation to the glottal proportion, which explains the frequent posterior triangular cleft image found in childhood[4]. Literature indicates that vocal symptoms are present in six to 37% of children aged between four and 12 years old[5,6,7]. In this population, vocal nodules are diagnosed in approximately 40 to 60% of the cases, followed by epidermoid cyst and polyp[5,8,9].

Vocal exercises are used in speech therapy practice with the aim of rehabilitating dysphonic

voices by stabilizing the motor adjustments necessary to restructure vocal quality with minimal muscular effort, restoring the biomechanical function of the tissue, ressonantal balance and respiratory function[4,10] .

There is a paucity of studies on optimal prescription of physical exercises and muscle training, whether for conditioning or rehabilitation. In the elaboration of muscular resistance training programs, it is necessary to specify the quantitative and qualitative aspects of physical exercise, considering the components: type of exercise, intensity, regularity, progression and personalization[11] .By associating vocal training with physical exercise physiology, training for vocal performance should incorporate these principles and be based on four parameters (frequency, duration/time, intensity and progression of the exercises) to produce a training effect on the muscular systems and energy used in vocal production[12] .

Among the vocal techniques mentioned for vocal training, we can highlight the sonorous tongue vibration technique (STVT). A literature review has shown that the sonorous lip or tongue vibration technique is classified as semi-occluded vocal tract exercise, softens the contact between the vocal folds, increases vocal resistance, optimizes the mucosal wave movement, and balances the sub and supra glottal pressures[13].

Studies have verified that the ideal time for the execution of the sonorous tongue vibration technique in women without complaints and without vocal alterations is three to five minutes[14,15,16] . In men without vocal changes, the ideal time was three minutes[16]. In women with a diagnosis of vocal nodule, research has observed vocal improvements after five minutes performing the technique[10]. In the pediatric population, a single study analyzed the ideal time for performing the semi-occluded vocal tract exercise in children with nodules and vocal cysts, and found that acoustic parameters improved in the third and fifth minutes after performing the exercise[17].

Literature does not present any study on the execution of the sonorous tongue vibration in the children population. In this way, the objective of this study was to verify the ideal time of the vocal sonorous tongue vibration technique in the voice of dysphonic children.

Method

This is an experimental analytical study with a consecutive and convenience sampling, approved by the Research Ethics Committee of the institution, under the number COEP ETIC 334.400 / 2013. All subjects signed an Informed Consent Form (ICF).

Twenty-seven children of both genders, participated in the study from August 2013 to September 2014. Eleven children, aged five to 10 years old (mean = 8.13 years), two females and nine males, were part of the experimental group (EG), and 16 children, aged four to 11 years old (mean = 7.85 years), being four girls and 12 boys, were part of the control group (CG). There was no statistical significance in the analysis of association between the ages in the groups ($p = 0.730$). All participants were recruited at a private Otorhinolaryngology clinic.

The inclusion criteria for the present study were: children of both genders, aged between seven and 10 years old; otorhinolaryngological diagnosis showing presence of vocal cyst, vocal nodules and/or glottal gap; children with vocal complaints and persistent dysphonia of mild or moderate degree, according to the speech-language evaluation; and ability to perform the sonorous tongue vibration technique properly. Exclusion criteria were: presence of neurological, auditory or congenital disease that may interfere with the phonation process; undergone previous speech therapy; taking daily controlled medication.

The children who participated in the CG remained in absolute vocal rest, using games ("Bubble Shoot" and "Subway Surf") in a tablet of the brand HP 7.1 1201, that did not demand vocal activity. The vocal emissions were recorded before the beginning of the electronic games and after the first (m1), the third (m3), the fifth (m5) and the seventh minute (m7) of vocal rest. The EG children were recorded after the first (m1), third (m3), fifth (m5) and the seventh minute (m7) of sonorous tongue vibration technique. Before the recordings, all the participants were instructed on the correct execution of the vocal technique.

For the perceptive-auditory evaluations of the voice, samples of the threaded speech were recorded (numerical count from 1 to 10) and for the acoustic measurements analysis, sustained vowel emission /ɛ/ was collected at the usual frequency and intensity.

The perceptual-auditory evaluations were performed by three speech therapists with experience in the voice area. In order to determine intra-evaluation reliability, 20% of the sample was randomly repeated. The perceptual-auditory analysis was performed by comparison task, and for each pair of voices the judges were instructed to answer if they were the same or which one of them improved or worsened. The evaluators had no previous knowledge whether the voice analyzed was pre or post exercise, or whether it belonged to the EG or CG. The evaluation of the judge who presented the highest intra-evaluator agreement was considered for analysis of the results.

The vocal registers were recorded directly on a computer of the brand Acer Aspire 4739-6886, through the software VoxMetria (CTS.4.0, CTS, Paraná, Brazil). Children's voices were recorded in an acoustic booth using a Shure SM-58 unidirectional microphone and capacitor, positioned 10 cm from the corner of the mouth, in a diagonal position, with a 45° directional pickup angle. During the recording of the voices, the beginning and the end of the emission were eliminated, due to the irregularities contained in these sections. The acoustic parameters selected for analysis of the results were the fundamental frequency average(F0), jitter, shimmer, glottal to noise excitation (GNE) and noise, analyzed by the VoxMetria software.

Kappa correlation coefficient was used to analyze the intra-evaluator concordance .The analysis of association between variables was performed using the ANOVA, T-Test or Mann-Whitney Test. All data was analyzed considering 5% level of significance. The analyzes were performed in the Statistical Package for the Social Sciences (SPSS) Statistics Base, version 19.

Results

The results of the auditory-perceptual analysis did not show differences between the moments of exercise execution in both groups (Table 1).

Table 2 shows the results of the perceptual-auditory analysis, in comparison between the groups, with no differences between them.

Regarding the acoustic parameters of the voices, there was also no difference between the moments of STVT execution in the EG groups and the CG (Table 3).

Table 4 shows that, in the comparison between the groups EG and CG, the noise decreased and the GNE increased after three minutes of execution of the exercise, identifying the improvement of these acoustic parameters in the EG.

Table 1. Results of the perceptual-auditory evaluation of voice in threaded speech in the different moments of the control and experimental groups

Vocal situation	Control Group													
	m0-m1		m0-m3		m0-m5		m0-m7		m1-m3		m3-m5		m5-m7	
	n	%	n	%	N	%	n	%	n	%	n	%	n	%
Improved	4	8.33	2	4.17	6	12.50	7	14.58	1	2.13	2	4.17	0	0.00
Worsened	2	4.17	6	12.50	5	10.42	5	10.42	4	8.51	1	2.08	2	4.17
Did not modify	42	87.50	40	83.33	37	77.08	36	75.00	42	89.36	45	93.75	46	95.83
Total	48	100.00	48	100.00	48	100.00	48	100.00	47	100.00	48	100.00	48	100.00
Significance (p)	p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	
Vocal situation	Experimental Group													
	m0-m1		m0-m3		m0-m5		m0-m7		m1-m3		m3-m5		m5-m7	
	n	%	n	%	N	%	n	%	n	%	n	%	n	%
Improved	1	3.03	3	9.38	4	12.12	3	9.09	1	3.03	2	6.06	1	3.03
Worsened	6	18.18	2	6.25	2	6.06	2	6.06	3	9.09	5	15.15	0	0.00
Did not modify	26	78.79	27	84.38	27	81.82	28	84.85	29	87.88	26	78.79	32	96.97
Total	33	100.00	32	100.00	33	100.00	33	100.00	33	100.00	33	100.00	33	100.00
Significance (p)	p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001		p<0.001	

Legend: m = moment; n = number of voices; = the p-value could not be calculated; * p significant.

Table 2. Comparison of perceptual-auditory evaluation results between control and experimental groups

Time	Vocal Situation	Control Group		Experimental Group		P value
			%	n	%	
m0-m1	Improved	4	8.33	1	3.03	0.084
	Worsened	2	4.17	6	18.18	
	Did not modify	42	87.5	26	78.79	
	Total	48	100	33	100	
m0-m3	Improved	0	0	3	9.38	0.468
	Worsened	0	0	2	6.25	
	Did not modify	16	33.33	27	84.38	
	Total	16	33.33	32	100	
m0-m5	Improved	6	12.5	4	12.12	0.45
	Worsened	5	10.42	2	6.06	
	Did not modify	37	77.08	27	81.82	
	Total	48	100	33	100	
m0-m7	Improved	7	14.58	3	9.09	0.563
	Worsened	5	10.42	2	6.06	
	Did not modify	36	75	28	84.85	
	Total	48	100	33	100	
m1-m3	Improved	1	2.13	1	3.03	0.558
	Worsened	4	8.51	3	9.09	
	Did not modify	42	89.36	29	87.88	
	Total	47	100	33	100	
m3-m5	Improved	2	4.17	2	6.06	0.108
	Worsened	1	2.08	5	15.15	
	Did not modify	45	93.75	26	78.79	
	Total	48	100	33	100	
m5-m7	Improved	0	0	1	3.03	0.243
	Worsened	2	4.17	0	0	
	Did not modify	46	95.83	32	96.97	
	Total	48	100	33	100	

Legend: m = minute. ANOVA Statistical Test

Table 3. Results of the acoustic analysis of the experimental and control groups

Experimental group						
Parameter	**m0**	**m1**	**m3**	**m5**	**m7**	**P value**
SHIMER						0.471
Mean	9.30	8.37	8.64	8.92	8.28	
Standard deviation	4.50	4.33	3.81	4.77	4.28	
JITTER						0.488
Mean	1.74	1.61	1.71	1.80	1.97	
Standard deviation	1.91	1.62	1.60	2.10	2.13	
GNE						0.616
Mean	0.77	0.78	0.84	0.80	0.84	
Standard deviation	0.18	0.13	0.08	0.12	0.13	
NOISE						0.611
Mean	1.21	1.17	0.88	1.07	0.89	
Standard deviation	0.74	0.55	0.34	0.50	0.56	
FUNDAMENTAL FREQUENCY						0.820
Mean	278.87	289.65	275.81	276.83	285.21	
Standard deviation	50.63	63.50	55.53	44.20	66.82	
Control group						
Parameter	**m0**	**m1**	**m3**	**m5**	**m7**	**P value**
SHIMER						0.981
Mean	9.95	13.31	10.02	9.90	9.80	
Standard deviation	4.43	10.58	5.03	4.90	5.08	
JITTER						0.994
Mean	1.23	3.00	2.00	1.96	2.41	
Standard deviation	1.51	4.54	2.26	1.73	2.81	
GNE						0.500
Mean	0.73	0.72	0.70	0.80	0.76	
Standard deviation	0.19	0.16	0.20	0.16	0.18	
NOISE						0.504
Mean	1.36	1.42	1.47	1.09	1.25	
Standard deviation	0.79	0.67	0.82	0.67	0.74	
FUNDAMENTAL FREQUENCY						0.975
Mean	247.31	245.87	261.88	254.66	253.07	
Standard deviation	40.22	32.89	45.96	44.42	42.09	

Legend: m = minute. ANOVA Statistical Test

Table 4. Comparison of acoustic parameters between experimental and control groups

	m0		m1		m3		m5		m7	
Parameter	**GE**	**GC**	**GE**	**GC**	**GE**	**GC**	**GE**	**GC**	**GE**	**GC**
SHIMER										
Mean	9.30	9.95	8.37	13.31	8.64	10.02	8.92	9.90	8.28	9.80
Standard deviation	4.50	4.43	4.33	10.58	3.81	5.03	4.77	4.90	4.28	5.08
P value	0.713		0.156		0.448		0.607		0.422	
JITTER										
Mean	1.74	1.23	1.61	3.00	1.71	2.00	1.80	1.96	1.97	2.41
Standard deviation	1.91	1.51	1.62	4.54	1.60	2.26	2.10	1.73	2.13	2.81
P value	0.443		0.342		0.710		0.830		0.667	
GNE										
Mean	0.77	0.73	0.78	0.72	0.84	0.70	0.80	0.80	0.84	0.76
Standard deviation	0.18	0.19	0.13	0.16	0.08	0.20	0.12	0.16	0.13	0.18
P value	0.610		0.369		0.033*		0.961		0.187	
NOISE										
Mean	1.21	1.36	1.17	1.42	0.88	1.47	1.07	1.09	0.89	1.25
Standard deviation	0.74	0.79	0.55	0.67	0.34	0.82	0.50	0.67	0.56	0.74
P value	0.612		0.309		0.032*		0.940		0.188	
FUNDAMENTAL FREQUENCY										
Mean	278.87	247.31	289.65	245.87	275.81	261.88	276.83	254.66	285.21	253.07
Standard deviation	50.63	40.22	63.50	32.89	55.53	45.96	44.20	44.42	66.82	42.09
P value	0.083		0.027		0.484		0.213		0.137	

Legend: m = minute; GC = Control group; GE = Experimental group. T-test or Mann-Whitney

Discussion

The sonorous tongue vibration technique promotes filter-source interaction and retroflex resonance, which provides a greater functional balance of vocal emission, facilitates a normotensive and balanced emission in the resonance, favors glottic closure, generates greater flexibility and mobilization of the mucosa , and promotes vocal quality improvement in "relation to roughness" and soprosity[10,14] .

The execution time of the technique is one of the parameters to be considered in the prescription of vocal exercises. In order to obtain positive vocal effects, studies show that the best execution time of the sonorous tongue vibration technique varies from three to five minutes[14,15,16]. Research involving the pediatric population is scarce, with mainly studies with dysphonic women without vocal deviation, and with men without vocal deviation[10,14,15,16].

When assessing the ideal time to perform the sonorous tongue vibration technique in women with no laryngeal lesion or vocal alteration, one study found an increase in F0 and a decrease in noise from three minutes and an increase in intensity from one minute after starting the technique [15]. In another study, also with women without vocal alterations, besides the increase of F0, there was improvement in the measure of stability, jitter and harmonic-to-noise ratio, as well as positive perceptions and positive correlation between reported sensations and spectrographic analyzes[14]. In women with a diagnosis of vocal nodules, the authors verified that in the first minute there was a decrease in noise, at minute three there was an increase in F0 and in GNE measure, at minute five there was improvement in the general degree of dysphonia, decrease in roughness and soprosity and increase in pitch, and at minute seven there was worsening of vocal parameters, suggesting the presence of vocal fatigue[10]. In addition, another study verified, through acoustic parameters and high-speed kymography, positive immediate effects after sonorous vibrations of the tongue, mainly in vocal quality and vocal folds of women[18].

In women with a diagnosis of vocal nodules, the study found that the ideal time for the prescription of vocal breath and acute sound exercise was three minutes, and that the same group, after seven minutes, had worsened voice quality and

self-reported discomfort[19]. The only study of ideal vocal performance time in children was performed with the sounded blowing with straw technique in 27 children diagnosed with vocal fold nodules or cysts and aged between five and 10 years old [17]. The results showed in the EG reduction of roughness, soprosity and noise, and increase of GNE after three minutes of execution of the exercise; reduction of the general degree of dysphonia and soprosity after five minutes; and worsening of the general degree of dysphonia and roughness after seven minutes of performing the technique[17]. These results are different from the findings of this study, which identified improvement of GNE and noise in the EG. The differences can be justified by the fact that the studies evaluate different vocal techniques, whose anatomic-functional effects after execution are different. For the sounded blowing with a straw exercise, a damping of possible collisions between the vocal folds occurs due to the increase of the supraglottal pressure and decrease of the glottal pressure[4], whereas for the sonorous vibration of the tongue there is a favoring of the glottal closure, generating greater flexibility and mobilization of the mucosa[10]. Therefore, the literature findings and the results of this research cannot be compared directly.

In all the studies developed[10,14,15,16] with the same technique studied in this research, the sonorous tongue vibration technique was performed with the adult population with and without vocal alteration. It is known that there are significant differences in the anatomy of the vocal tract of children and adults regarding the glottal proportion[4]. Children have a higher larynx position in the neck, shortened vocal tract, shorter and thicker vocal folds, with poorly differentiated mucosa layers and thinner vocal ligament fibers[4].

In this study, no statistical differences were observed in the perceptual-auditory evaluation after STVT execution (Tables 2). When comparing the acoustic measurements between CG and EG, we observed reduction of the noise measurement and increase of the GNE measurement at minute three of the execution of the exercise (Table 3). The reduction of noise and the increase of GNE values correlate with the improvement of vocal quality, since they indicate a better regularity of vocal fold vibration [20,21] .

Sample size is one of the factors that influence the level of significance of an experimental study [22]. When the sample size of the study is very restricted, the subgroup analysis is made more difficult and the performance of the statistical tests can be compromised [22]. Studies with larger samples tend to obtain more accurate estimates of effect and tend to have greater power [22]. The sample of the present study was small because of the difficulty in finding children who knew how to perform the tongue vibration technique properly, in addition to the low prevalence of infantile dysphonia in the population [23,24] .

Studies with larger samples are necessary to analyze the real effect of the sonorous tongue vibration exercise in children, since the literature presents only one study in the pediatric population with the sounded blow technique with straw, showing positive effects on acoustic parameters in the third and fifth minutes after the exercise.

Conclusion

The results of the present study show that there was no improvement at any time in the perceptual-auditory evaluation of the voice of dysphonic children with the sonorous tongue vibration technique. In the acoustic analysis, it was observed a decrease in the noise measurement and increase of the GNE measurement at the third minute of the exercise, suggesting an improvement in vocal quality, since it indicates better regularity of vocal fold vibration.

It is suggested that future studies with larger samples be carried out in order to analyze the real effect of the sonorous tongue vibration exercise in the voice of child population.

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