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Artigo Original

Immediate effect of surface laryngeal hydration associated with tongue trill technique in amateur singers

Efeito imediato da hidratação laríngea de superfície associada à técnica de vibração sonorizada de língua em cantores amadores

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Keywords

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ABSTRACT

Purpose: To analyze the immediate effect of laryngeal surface hydration associated with the performance of Tongue Trills (TT) on singers. **Methods**: Thirty singers without vocal complaints or laryngeal alterations divided into control (CG) and experimental (EG) groups. The CG performed the TT for five minutes. The EG was submitted a nebulization with 3 ml of saline solution followed by TT for five minutes. Voice self-assessment, acoustic analysis and perceptual assessment were performed at Pre (Pre TT) and post (PTT) moments in CG and pre (Pre TT), post hydration (PH) and post hydration + TT (PHTT) in GE. In the self-assessment were evaluated quality, stability, vocal intensity and hoarseness. There were extract the values of the Fundamental frequency; Jitter%; Shimmer%, Noise-to-harmonic Ratio e Cepstral Peak Prominence-Smoothed (CPPs) in the acoustic analyze. The perceptual evaluation was performed by an experienced speech therapist. **Results**: Comparing the results of self-assessment between groups showed improvement in the perception of stability and vocal intensity in the PTT (CG) in relation to PH (EG). Comparison between the EG moments showed a statistical difference in the vocal intensity perception, indicating a better results for PHTT. There was no statistical difference between the groups investigated in the perceptual assessments and acoustic analysis. **Conclusion**: Surface laryngeal hydration does not potentiate the effect of TT on naturally hydrated singers with 3ml nebulization. For voice professionals with high vocal demand, surface hydration can be introduced during voice use to maintain vocal quality.

Descritores

Voz
Qualidade da Voz
Treinamento da Voz
Adultos
Hidratação

RESUMO

Objetivo: Analisar o efeito imediato da hidratação de superfície laríngea associado à técnica de vibração sonorizada de língua (TVSL) em cantores. **Método**: Participaram 30 cantores, sem queixas vocais ou alterações laríngeas, divididos em grupo controle (GC) e experimental (GE). O GC realizou a TVSL por cinco minutos. O GE foi submetido à nebulização de 3 ml de solução salina seguido da TVSL por cinco minutos. Foram realizadas autoavaliação vocal, análise acústica e avaliação perceptivoauditiva nos momentos pré (PréTVSL) e pós (PTVSL) no GC e no momento pré (PréHTVSL), pós hidratação (PH) e pós hidratação+TVSL (PHTVSL) no GE. Na autoavaliação foram avaliados: qualidade, estabilidade, rouquidão e intensidade vocal. Os parâmetros acústicos analisados foram Frequência Fundamental; *Jitter%*; *Shimmer%*, *Noise-to-harmonic Ratio* e *Cepstral Peak Prominence-Smoothed* (CPPs). A avaliação perceptivoauditiva foi realizada por uma fonoaudióloga experiente. **Resultados**: Na comparação dos resultados da autoavaliação, entre os grupos, observou-se melhora da percepção de estabilidade e intensidade vocal no PTVSL (GC) em relação ao PH (GE). Na comparação entre os momentos do GE houve diferença estatística na sensação de intensidade vocal, apontando melhor resultado para PHTVSL. Não houve diferença estatística entre os grupos investigados na avaliação perceptivoauditiva e na análise acústica. **Conclusão**: A hidratação laríngea de superfície não potencializa o efeito da TVSL em cantores em condição natural de hidratação com uso de 3ml de nebulização. Para os profissionais da voz com grande demanda vocal, a hidratação de superfície pode ser introduzida durante a utilização da voz, para manutenção da qualidade vocal, sem perda de sua qualidade.

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INTRODUCTION

Laryngeal hydration has been described as an important resource for voice care as it promotes improvement in the biomechanical characteristics of the vocal fold mucosa, and consequently, in the quality of vocal emission[1,2]. Hydration can be performed systemically[3] and/or directly in the vocal tract, called surface hydration of the vocal folds[4-9]. Laryngeal hydration has been studied in different populations, such as voice professionals, including singers[3-5,10], teachers[7,9], individuals at risk for laryngeal pathologies or vocal complaints[11], and even those with no vocal disorders[6].

For voice professionals, the maintenance of laryngeal hydration is extremely important for the prevention of lesions arising from mucosal dehydration, which can bring greater phonatory effort during vocal emission[5] and it is a consensus that hydration must be part of vocal warm-up orientation programs for such professionals, mainly in singers[10].

Studies involving vocal fold hydration cover variables such as the type of solution that best hydrates the vocal folds[4,5], the humidity of the environment in which the subjects were exposed (normal or modified by humidifiers)[8] and the effects of dehydration and rehydration on the vocal folds[4,7,10]. For the outcome of the studies, several forms of assessment were used, such as self-perception[4,5,8,9], phonation threshold pressure[4,5] linear[5-7,9,10] and non-linear acoustic measures[8] and auditory-perceptual analysis[7-10].

The use of laryngeal surface hydration with isotonic saline solution showed better results in the auditory-perceptual assessment of vocal quality and vocal fatigue index in singing students[10], as well as, reduced vocal effort observed from self-perception measures in singers[4], reduction of acoustic parameters of speech intensity and the mean fundamental frequency (F0)[7] and improvement of vocal symptoms in teachers[9]. Based on this information, it appears that this form of hydration can be considered efficient for the population that uses the voice repeatedly.

The use of isotonic saline solution (0.9% NaCl) in nebulization after dehydration of the laryngeal mucosa is capable of reducing the phonatory pressure index[4,11], decreasing the perception of effort and the symptom of dryness in the vocal tract[10] and also improving voice quality[6,7,9]. On the other hand, not all studies have observed changes in the acoustic measurements analyzed after vocal fold surface hydration[5,8].

Based on the literature[1,2], the immediate effect of vocal fold surface hydration was not associated with traditional vocal therapy techniques, therefore, research that involved some vocal fold muscle activity associated with laryngeal hydration proposed activities of reading aloud with exposure to different levels of air humidity in individuals with and without vocal complaints[8]. In addition, In addition, research was carried out to investigat the daily use of the voice of teachers who were subjected to hydration before and during classes in the period of four consecutive weeks[7,9] and the performance of vocal load tasks at different levels of air humidity in individuals without vocal alterations[8]. The forms of applying surface hydration in vocal activities varied from study to study. There is no report of research results on its impact when used in association with the tongue vibration technique - Tongue Trills (TT).

TT is used as an important therapeutic resource in vocal therapy and improvement[12], capable of promoting changes in the vocal fold vibration pattern[13] and in acoustic parameters such as: increased F0, increased vocal intensity, reduced noise emission[14], decreased Jitter and Shimmer and vocal effort[15]. It was evidenced that the time taken to perform TT to improve vocal quality is between one and five minutes[12,14,16]. This resource can be used both for vocal improvement and warm-up[14,16] as well as for therapy in cases of laryngeal pathologies and dysphonia[14], and also, associated with other strategies, such as electrostimulation[17].

In singers, Tongue Trills have shown benefits in vocal quality[13,16], but little is known about the effect of laryngeal hydration associated with TT.

Amateur singers are professionals who are vulnerable to dehydration of the vocal folds, as the vast majority work in environments without humidification control, with competing noises and in periods of time that can reach up to six hours of work. Knowing the benefits of surface hydration of the vocal folds through nebulization is very important, as it will provide security in its application, since it has been used by this population in vocal hygiene programs. In clinical practice, studies of this nature offer greater security in the application of techniques that have shown their results scientifically.

The hypotheses of this study are: surface hydration associated with TT will improve the measures of self-assessment, acoustic analysis and auditory-perceptual assessment of the voices of amateur singers, and will also enhance the effect of the TT exercise.

Therefore, due to the scarcity of studies that associate the two resources and the need for conclusions about the effects of superficial hydration on the voice of individuals who use their voice professionally, this study aimed to investigate the effect of laryngeal surface hydration when associated with TT on the population of singers.

METHODS

Interventional, cross-sectional and prospective study. It was approved by the Ethics Committee under number CAE 64920617.9.0000.5406 (Opinion nº 2.017.690). All participants signed the Informed Consent Form (ICF).

Sample

The research was disseminated through telephone invitations to amateur singers in the city, thus constituting a convenience sample. Thirty amateur singers of both sexes, from the central-west region of the São Paulo state participated in this study. Participants were randomly divided into two groups drawn at the time of collection. In the experimental group (EG), 15 individuals participated, six females and nine males, with an average age of 27.6 years (SD = 6.16). In the control group (CG), 15 individuals participated, eight females and seven males, with an average age of 26.3 years (SD = 8.01).

The inclusion criteria were: between 18 and 40 years old, an amateur singer, no vocal complaints (vocal fatigue, voice failures, hoarseness or burning), as well as no laryngeal alterations in the otorhinolaryngological diagnosis. All participants underwent video laryngoscopy at the institution where the research was conducted, just to define inclusion. The singers who presented some alteration in the medical diagnosis were referred to speech therapy. The exclusion criteria of the participants in this research were: not being able to perform TT, being a smoker, consuming alcohol daily, presenting neurological diseases or cognitive deficits.

Procedures

In order to verify the effect of performing TT associated with vocal fold surface hydration with isotonic solution on the vocal quality of the participants, the following voice assessments were performed: vocal self-assessment, analysis of acoustic parameters and auditory-perceptual assessment.

Intervention

The NS Respiramax Automatic Ultrasonic Inhaler was used to perform nebulization. The masks used were previously disinfected. In addition, vials of 0.9% saline solution were used at room temperature.

The EG subjects were submitted to laryngeal surface hydration with three ml of saline (0.9%)[4,5], for five minutes in vocal rest. The mask was placed over the mouth and nose of the participant who performed oronasal breathing. Subsequently, they were asked to perform the TT in ascending and descending order for 5 minutes. The CG participants performed only the TT in ascending and descending order for 5 minutes[14,17].

The TT exercise was previously explained to each individual, who performed it continuously during the proposed time, breathing whenever necessary, with the usual loudness, maintaining the comfort of the emission

Assessment

Self-evaluation

A self-assessment protocol was elaborated using a five-level Likert Scale to analyze the sensation of each participant in relation to their vocal quality with the parameters of vocal quality, hoarseness, stability and vocal intensity. The answers were given according to the following criteria: 5, much improved; 4, improved; 3, has not changed; 2, worsened and; 1, much worse. The Likert scale was used due to the fact that it's easy for the participant to understand and interpret, as well as making it easier for the researcher to record responses.

Participants responded to the vocal self-assessment protocol immediately after each group's procedure. The CG participants answered after the TT was performed and those from the EG responded after being submitted to nebulization and again after the TT was performed.

Analysis of acoustic parameters

Recordings

The recordings were made in a sound proof room. A Seinheiser microphone (model E855) and a digital recorder from MARANTZ (model PMD660) were used, configured for single-channel recording, with a sampling rate of 44 kHz and 16 bits of resolution. The microphone was positioned 10 cm in front of the participant's mouth. The participant was asked to produce the vowel / a / three times in a sustained manner using the usual pitch and loudness.

In the CG, the participants' voices were recorded before the exercise (PreTT) and after its execution (PTT). Regarding the EG, an initial recording (PreTT) was made, which served as a basis for comparison with the next recordings. Thus, the voices were recorded again after hydration (PH), and after TT (PHTT).

Editing of recordings

The recordings of the vowel "a" were edited in the PRAAT Program[18], maintaining approximately three seconds of emission. The first second of the recording was removed as well as the end of the emission, so that the vocal attack and instability would not interfere in the data analysis. The recording with the best vowel / a / emission was chosen based on the signal strength and the quality of the spectrographic signal.

After editing, the analysis of the acoustic parameters was performed using the Multi-Dimensional Voice Program (MDVP) program from Computerized Speech Lab, Model 4400, Kay-Pentax, with the following measurements being extracted: Fundamental Frequency (F0); Jitter% (Jitt); Shimmer% (Shim) and Noise-to-harmonic Ratio (NHR)[6,8].

The Cepstral Peak Prominence-Smoothed (CPPS) measurement was carried out by means of the PRAAT software[18] using the recordings of the "a" vowel sustained with the configuration recommended by Maryn and Weenink[19].

Auditory Perceptual Assessment

The edited recordings were organized randomly, ensuring that the speech therapist judge did not know the time of the recording and which intervention group the voice belonged to. Pairs were organized with the following comparisons: In the CG, Pre vs PTT; and in the EG, Pre vs PH, Pre vs PTT, PH vs PHTT, of each of the participants. All pairs were randomized.

Thus, the recordings were placed on a USB stick and delivered to the specialist for the assessment along with guidelines on how to proceed with the evaluation. A speech therapist with more than five years of experience in auditory-perceptual assessment evaluated the voices using a protocol in which the perception of change in the general deviation in vocal quality (better, worse or no change) was noted. The speech therapist would listen to two recordings and then write down the judgment about the second recording in relation to the first. The evaluator could listen to the voices as many times as necessary for judgment.

In organizing the data, 20% of the recordings were repeated to perform intra-rater reliability. For the calculation of intra-rater agreement, the Interclass Correlation Coefficient (ICC) with a 0.769 result was applied, which indicates excellent agreement.

Data analysis

The data was analyzed in a descriptive and inferential manner using the SPSS 25.0 software. A significance level of 5% was considered for inferential analyses.

In the descriptive analysis of continuous quantitative and ordinal qualitative variables, measures of central tendency (mean) and variability (standard deviation) were calculated. In the descriptive analysis of nominal qualitative variables, the absolute frequency and the relative frequency percentage were calculated.

In the inferential analysis, the normality of the quantitative variables was tested with the Shapiro-Wilk Test, and all obtained non-normal distribution. Thus, the Mann-Whitney test was applied to compare the effect of the proposed intervention in both groups.

To analyze whether there were changes in vocal self-assessment, the Wilcoxon test for the EG was used, analyzing the Pre, PH and PHTT moments. As for the CG, only the characterization of the sample was performed, since the results are only from the moment after this evaluation.

The possible changes in the results of the acoustic analysis between the groups studied were verified by the Wilcoxon test for the CG, while for the EG the Friedmann test was applied. In the auditory-perceptual evaluation, Fisher's exact test was used to analyze the association between the groups.

RESULTS

Table 1 shows the values of mean, standard deviation and p-values of intergroup and intragroup comparisons of vocal self-assessment. The comparison refers to the data of the post moments between the two groups studied (PTT vs PHTT), between the PTT (CG) and PH (EG) moments, and also the comparison between the PH and PHTT moments of the EG.

The results show that the average of the values found was high, considering the following criteria: 5, much improved; 4, improved; 3, has not changed; 2, worsened and; 1, much worse. The lowest values were indicated after performing surface hydration, without performing vocal exercise. When comparing the results of the final procedures of the two groups (PTT vs PHTT), there were no differences in any of the parameters analyzed (vocal quality, hoarseness, vocal stability and intensity). Statistical differences were found in the comparisons with the post-hydration moment (EG), because the Intensity parameter had better measurements in PHTT when compared to PH and in PTT when compared to PH (CG vs EG). Similarly, a better result of the stability parameter in the PHTT group was indicated when compared with PH.

Table 2 presents the values of mean and standard deviation of the parameters of the acoustic analysis of the EG and CG and the inter and intragroup comparisons. The intergroup comparison of the CG refers to the results of the PTT vs Pre moment and of the PHTT vs PH vs Pre moments of the EG. Intergroup comparisons refer to the PTT (CG) vs PH (EG) and PTT (CG) vs PHTT (EG) moments.

The results of the acoustic analysis measures indicate normal values for the studied population and it was not sensitive to demonstrate differences between the procedures of the two groups studied.

Table 3 presents the descriptive data of the perceptual and auditory assessment of the CG and EG groups. It should be emphasized that these data come from the final result of the evaluation carried out in pairs of recordings referring to the general degree of vocal deviation. In this group the pairs of recordings are from the PTT vs Pre moments (CG); PH vs Pre, PHTT vs Pre and PHTT vs PH moments (EG).

The comparison of the pairs of recordings of the participants' voices in the auditory-perceptual assessment indicates that the "improved" response appears in the vast majority of times, even above 50% of them. The evaluation of the PHTT moment in relation to the pre-hydration draws attention with a response of 86.7% improvement in vocal quality.

In order to verify which was the best result between the two groups, an association was made between the values found in the post-procedure moment in relation to the Pre-moment. Table 4 shows the results of the association between two comparisons, that is, TT vs Pre (CG) and PHTT vs Pre (EG).

Table 4 shows that there is no statistical difference between the results of the auditory-perceptual assessment, since the "improved" response was high at the end of the two procedures, that is, both after surface hydration associated with the vocal technique as well as after the performance of TT.

Table 1. Mean values, standard deviation and p-values of intra- and intergroup comparisons at the post-procedure moment in self-assessment.

	CG		EG		EG		p-value	p-value	
	PTT		PH		PHTT		EG	CG vs EG	
	Mean	SD	Mean	SD	Mean	SD	PH vs PHTT	PTT vs PH	PTT vs PHTT
Vocal Quality	4.07	0.70	3.80	0.56	4.20	0.86	0.145	0.115	0.460
Hoarseness	4.13	0.74	3.93	0.59	4.13	0.92	0.257	0.403	0.841
Stability	4.13	0.74	3.67	0.72	4.07	0.80	0.058	**0.047***	0.808
Intensity	4.20	0.56	3.67	0.62	4.13	0.74	**0.020***	**0.021***	0.852

Legend: CG = control group; EG = experimental group; PTT = Post-TT; PH = Post-Hydration; PHTT = Post-Hydration + TT; SD = standard deviation. Wilcoxon (EG Intragroup comparison), Mann-Whitney (CG vs EG comparison). * = p>0,05

Table 2. Mean values, standard deviation and intragroup and intergroup comparisons of the evaluated moments of acoustic analysis.

Var	Group	Moment	Mean	SD	P-value			
					CG	EG	CG vs EG	CG vs EG
					PTT vs Pre	PHTT vs PH vs Pre	PTT vs PH	PTT vs PHTT
F0	**EG**	Pre	163.084	52.43	0.427	0.888	0.310	0.254
		PH	166.917	56.69				
		PHTT	166.894	50.23				
	CG	Pre	178.143	57.24				
		PTT	180.767	59.24				
Jitt	**EG**	Pre	1.144	0.78	0.609	0.701	0.663	0.395
		PH	1.013	0.54				
		PHTT	1.223	0.77				
	CG	Pre	0.862	0.58				
		PTT	0.968	0.57				
Shim	**EG**	Pre	3.523	0.89	0.910	0.112	0.983	0.206
		PH	3.682	1.32				
		PHTT	3.109	0.72				
	CG	Pre	3.699	1.52				
		PTT	3.490	0.90				
NHR	**EG**	Pre	0.131	0.026	1.000	0.635	0.884	0.983
		PH	0.129	0.027				
		PHTT	0.131	0.010				
	CG	Pre	0.135	0.022				
		PTT	0.137	0.035				
CPPS	**EG**	Pre	15.93	13.41	0.281	0.074	0.272	0.787
		PH	16.43	11.50				
		PHTT	17.35	13.67				
	CG	Pre	17.00	13.19				
		PTT	17.43	12.84				

Legend: CG= Control Group; EG= experimental group; PTT = Post TT; PH= Post Hydration; PHTT = Post Hydration + TT; SDP= standard deviation; CPPS = *cepstral peak prominence smoothed;* Jitt= Jitter; Shim= Shimmer; f0= Fundamental Frequency; NHR= Noise-to-Harmonic Ratio. Wilcoxon Test (CG intragroup comparison); Friedman Test (EG intragroup comparison); Mann-Whitney Test (CG vs EG intergroup comparison).

Table 3. Descriptive data of the Auditory Perceptual Assessment of the CG and the EG.

Variables and categories		
CG - PTT vs Pre TT	n	%
Improved	9	60.0
Has not changed	6	40.0
EG - PH vs Pre hydration		
Improved	11	73.3
Has not changed	4	26.7
EG -PHTT vs Pre hydration		
Improved	13	86.7
Has not changed	2	13.3
EG - PHTT vs PH		
Improved	8	53.3
Worsened	1	6.7
Has not changed	6	40

Legend: CG= control group; EG – experimental group; PTT = Post Tongue Trill; Pre TT = Pre Tongue Trill; PH = Post hydration; PHTT = Post hydration + Tongue Trill; n= absolute frequency; %= relative frequency percentage frequência relativa percentual. Descriptive Analysis.

Regarding the associations, there was no statistically significant result between the results of the judgment of the pairs of recordings of the PH vs Pre moments in relation to those of the PTT vs PH moments (p = 0.476).

DISCUSSION

This study analyzed the effect of laryngeal surface hydration when associated with TT on the population of amateur singers. However, evaluations after surface hydration, before the performance of TT are also included in the research. The self-assessment, acoustic analysis and auditory-perceptual assessment outcomes were used.

When comparing the final results of the two groups studied (PTT vs PHTT) in self-assessment, it was observed that the singers similarly reported their sensations related to the parameters of vocal quality, hoarseness, stability and vocal intensity. The values reported by the Likert scale were high, indicating that the participants had the sensation of a better vocal emission with the performance of these procedures. The fact that the participants are singers and have no vocal complaints may have hindered the perception of small differences in the voice and thus induced such result[20].

When the comparison was made between the PTT moment of the CG and the PH of the EG, it was possible to verify better values after the performance of the TT in relation to the parameters of vocal stability and intensity. Hydration alone was not able to cause a better sensation in relation to the analyzed parameters. Despite the methodological differences of the

Table 4. Association between the results of the auditory perceptual evaluation of the groups, from the judgment of the pairs of recordings confronting the moments before and after the procedure.

			EG (PHTT vs Pre)	CG (PTT vs Pre)	Total	p-value
Post vs Pre	Improved	n	13	9	22	0.215
		%	86.7%	60.0%	73.3%	
	Has not changed	n	2	6	8	
		%	13.3%	40.0%	26.7%	

Legend: CG= control group; EG – experimental group; PTT = Post Tongue Trill; Pre TT = Pre-Tongue Trill; PH = Post hydration; PHTT = Post hydration + Tongue Trill; n= absolute frequency; %= relative frequency percentage. Fischer's Exact Test.

studies carried out, the literature points to the feeling of less effort during the emission after the hydration of the vocal fold surface[4,5,11] and decrease in the perception of vocal symptoms[9], however such measures were extracted after the laryngeal dehydration procedure, which was not of interest in the study now presented. In a previous study, it was verified by the Voice Fatigue Index protocol that the best results were observed when surface hydration was performed in combination with systemic hydration[10]. The nebulization performed in isolation, under the conditions proposed in this study, did not change the self-assessment of the determined parameters, as its association with the TT showed superior results.

In the comparison data of the intra-group moments of the EG, in the self-assessment, there was a statistical difference in the intensity parameter, indicating a better result for the PHTT moment. These data lead us to think that the application of hydration and TT performance favors the sensation of greater vocal volume and that the proposed technique drives this perception. It is known that TT is considered a semi-occluded vocal tract exercise, so the increase in intensity and improvement in vocal stability can be explained, physiologically, by the increase in mean supraglottal and intraglotal pressures and by the improvement of glottic coaptation, which becomes more efficient[21]. The improvement in vocal quality and greater ease of vocal emission according to the participants' self-perception was also a result found in a study with women without vocal alterations[22]. However, there is still no research that can be compared with this result in relation to the effect of surface hydration on the exercise.

In the acoustic analysis, the results of the F0, Jitter, Shimmer and NHR parameters of the intra and intergroup comparison of this study did not show significant changes after the procedures performed. In the literature, these results are inconsistent. Some studies have pointed out significant improvement after the performance of TT, for example, in individuals without vocal alterations in the Jitter and Shimmer parameters[15], as well as in the F0 and noise parameters[14]. Other authors did not observe changes, such as in the vocal extension of singers after three minutes of TT[16].

Regarding hydration, the methodologies applied in the studies are different, making any form of comparison difficult. Positive changes in the results of acoustic analysis were observed in the application of surface hydration in teachers[7] and women who did not use the voice professionally[9], however, these participants were submitted to laryngeal dehydration before the hydration procedure, in order to bring the participants to the same hydration level. The lack of sensitivity of the acoustic analysis to evidence the results of surface hydration has also been reported in other studies[8,10]. In a recent study, the acoustic analysis measures were mixed, with positive data after surface hydration when compared to the hypohydrate condition, such as the increase in maximum F0 and also with the worsening of the shimmer value[10].

The results of the CPPS measure showed slightly better values in the EG in the pre and post test comparison, but with no statistically significant difference ($p = 0.07$). This measure points to the harmonic structure of the sound wave without delimiting the glottal cycles and has been recommended for the standardization of the objective evaluation of the voice for describing the vocal quality in both sustained vowel and chained speech tasks[23] and has been shown to be more reliable in relation to traditional acoustic measures[23,24] in addition to being more sensitive to small differences in the glottic wave[25]. In this study, the CPPS measure did not identify differences between the groups, which can be explained by the sample size and/or duration of the intervention.

The acoustic measures of F0, jitter, shimmer and NHR observed in this study are within the normal range and are similar to other studies with the Brazilian and international population[26,27]. The reported CPPS measure is also similar to other studies that used similar methodology for the Brazilian[24] and Finnish[28] population. However, authors who used different software from this study found higher CPPS values than those found in the present investigation[29], which points to the difficulty of comparing the studies due to the methodological differences between them. The CPPS measure is still poorly explored and further studies involving healthy and dysphonic populations are necessary in order to compare and better understand the voice of Brazilian speakers.

The results of acoustic analysis found in this study were similar for the pre and post procedure groups, possibly because at the moment before the intervention the singers had good vocal quality and did not undergo the process of laryngeal dehydration. The two research conditions carried out, with and without laryngeal dehydration, point to the importance of using surface hydration as a therapy in cases of laryngeal dehydration[6] to return to the condition of natural hydration, a condition in which the participants in this study were already at the pre-intervention moment.

The auditory-perceptual evaluation is considered the gold standard in the evaluation of the voice considering several variables such as inter and intra-reliability, validation of the instrument

used, quality of the recording of the samples and the level of experience of the evaluators[30]. In this study, the evaluator had experience in vocal assessments and more than five years of training, in addition to confirming internal standards through the performance of the intra-judge reliability test, ensuring the quality of the assessment.

In the auditory-perceptual evaluation, the numerical data shows a higher percentage of the "improved" response, especially at the PHTT moment of the EG (86.7%). This numerical data points to the tendency that the auditory-perceptual assessment is more sensitive to perceive subtle changes of the immediate effect on the vocal fold surface hydration when associated with TT. This data corroborates some studies in the literature that also did not present significant results in relation to vocal exercise[20] and surface hydration[7,8]. A decrease in breathiness was observed in the participants studied who associated surface and systemic hydration[10]. In the analysis to verify which result was the best, from the analysis of association of the values found, there was no statistical difference. Despite the high value of the "improved" response at the PHTT moment (EG), an "improved" response above 50% was also found at the PTT moment of the CG. Both results are excellent and point out that TT causes a change in vocal quality that can be seen in the auditory-perceptual assessment. Still, there are no studies that associate the two procedures which can be related to this research.

The exercise applied in this research shows results in the literature such as normotension in the action of the vocal folds, better quality of vibration of the mucosa wave, favoring vocal stability[22] and increased vocal resistance[12]. In the present study, it was observed that TT promoted an improvement in the stability and intensity of self-assessment, pointing out the beneficial action of this exercise in the voice of singers.

Considering that in the current research the technique was performed for five minutes, in just one session, we can infer that it was not enough to cause changes in vocal quality in singers with healthy voices. Even so, it was possible to observe a change in the self-assessment outcome, pointing to greater sensitivity for this type of assessment and the results of the vocal exercise action.

Despite the fact that laryngeal dehydration is commonly used in the methodologies of studies involving surface hydration, the present study did not perform this procedure so that the singers were close to the same situation of a work context, in which they would not perform laryngeal dehydration before using the voice. Scientific data suggests that surface hydration can bring benefits to voice professionals[7,10], and also its use with isotonic saline can promote less vocal effort during singing[4]. Further studies should be conducted with the population of singers using a greater amount of laryngeal surface hydration in order to better understand the clinical efficacy of this therapeutic method.

Limitations and recommendations

This study presents several limitations that can be discussed. One of them refers to the small sample size in each group, as surveys with a large number of participants may present better results from the proposed methodology. Another limitation is the lack of assessment of the quality in the singing. Although the participants were amateur singers, the initial proposal of the research project was to evaluate the immediate effect of surface hydration associated with a short time of a technique widely used among voice professionals and not its effect after a vocal warm-up program. It is necessary to carry out research with methodologies that include the hydration of the vocal fold surface associated with the warm-up program and vocal cool-down. In addition, the same methodological proposal could be tested with the application of surface hydration before or concurrently with vocal exercises.

CONCLUSION

The group of amateur singers who underwent vocal fold surface hydration did not present superior results in relation to the control group in the three forms of assessment carried out in this research: self-assessment, acoustic analysis and auditory-perceptual assessment.

In the auditory-perceptual evaluation, positive results were observed in both groups of participants.

The results of the self-assessment and the acoustic analysis showed that there was no statistically significant difference in the intra and intergroup comparison to verify the influence of hydration on TT. In general, the laryngeal surface hydration does not enhance the effect of TT in singers in a natural condition of hydration with the use of 3ml of nebulization.

Although no significant differences were observed between the groups after surface hydration, there were also no negative changes in the vocal quality of the singers, pointing to the maintenance of previous vocal quality after performing the exercise associated with hydration.

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REFERÊNCIAS

1. Alves M, Krüger E, Pillay B, van Lierde K, van der Linde J. The effect of hydration on voice quality in adults: a systematic review. J Voice. 2019;33(1):125.e13-28. http://dx.doi.org/10.1016/j.jvoice.2017.10.001. PMid:29122414.
2. Leydon C, Wroblewski M, Eichorn N, Sivasankar M. A meta-analysis of outcomes of hydration intervention on phonation threshold pressure. J Voice. 2010;24(6):637-43. http://dx.doi.org/10.1016/j.jvoice.2009.06.001. PMid:20359862.
3. van Wyk L, Cloete M, Hattingh D, van der Linde J, Geertsema S. The effect of hydration on the voice quality of future professional vocal performers. J Voice. 2017;31(1):111.e29-36. http://dx.doi.org/10.1016/j.jvoice.2016.01.002. PMid:26873423.
4. Tanner K, Roy N, Merrill RM, Muntz F, Houtz DR, Sauder C, et al. Nebulized isotonic saline versus water following a laryngeal desiccation challenge in classically trained sopranos. J Speech Lang Hear Res. 2010;53(6):1555-66. http://dx.doi.org/10.1044/1092-4388(2010/09-0249). PMid:20699338.
5. Tanner K, Fujiki RB, Dromey C, Merrill RM, Robb W, Kendall KA, et al. Laryngeal desiccation challenge and nebulized isotonic saline in healthy

male singers and nonsingers: effects on acoustic, aerodynamic, and self-perceived effort and dryness measures. J Voice. 2016;30(6):670-6. http://dx.doi.org/10.1016/j.jvoice.2015.08.016. PMid:26412295.

6. Mahalingam S, Boominathan P. Effects of steam inhalation on voice quality-related acoustic measures. Laryngoscope. 2016;126(10):2305-9. http://dx.doi.org/10.1002/lary.25933. PMid:26972609.
7. Santana ÉR, Masson MLV, Araújo TM. The effect of surface hydration on teachers' voice quality: an intervention study. J Voice. 2017;31(3):383.e5-11. http://dx.doi.org/10.1016/j.jvoice.2016.08.019. PMid:27765431.
8. Fujiki RB, Chapleau A, Sundarrajan A, McKenna V, Sivasankar MP. The interaction of surface hydration and vocal loading on voice measures. J Voice. 2017;31(2):211-7. http://dx.doi.org/10.1016/j.jvoice.2016.07.005. PMid:27522343.
9. Masson MLV, de Araújo TM. Protective strategies against dysphonia in teachers: preliminary results comparing voice amplification and 0.9% NaCl nebulization. J Voice. 2018;32(2):257.e1-10. http://dx.doi.org/10.1016/j.jvoice.2017.04.013. PMid:28579158.
10. Vermeulen R, van der Linde J, Abdoola S, van Lierde K, Graham MA. The Effect of superficial hydration, with or without systemic hydration, on voice quality in future female professional singers. J Voice. 2020; In press. http://dx.doi.org/10.1016/j.jvoice.2020.01.008. PMid:32046884.
11. Tanner K, Roy N, Merrill RM, Kendall K, Miller KL, Clegg DO, et al. Comparing nebulized water versus saline after laryngeal desiccation challenge in Sjögren's Syndrome. Laryngoscope. 2013;123(11):2787-92. http://dx.doi.org/10.1002/lary.24148. PMid:23674107.
12. de Vasconcelos D, Gomes A OC, de Araújo CMT. Voiced lip and tongue trill technique: literature review. Distúrb Comun. 2016;28(3):581-93.
13. Cordeiro GF, Montagnoli AN, Ubrig MT, Menezes MHM, Tsuji DH. Comparison of tongue and lip trills with phonation of the sustained vowel /e/ regarding the periodicity of the electroglottographic waveform and the amplitude of the electroglottographic signal. Open J Acoust. 2015;30(4):226-38. http://dx.doi.org/10.4236/oja.2015.54018.
14. Azevedo LL, Passaglio KT, Rosseti MB, da Silva CB, de Oliveira BFV, Costa RC. Avaliação da performance vocal antes e após a vibração sonorizada de língua. Rev Soc Bras Fonoaudiol. 2010;15(3):343-8. http://dx.doi.org/10.1590/S1516-80342010000300006.
15. Pimenta RA, Dájer ME, Hachiya A, Tsuji DH, Montagnoli AN. Parameters Acoustic and High-speed kymography identified effects of voiced vibration and vocal fry exercises. CoDAS. 2013;25(6):577-83. http://dx.doi.org/10.1590/S2317-17822014000100010. PMid:24626983.
16. Lima AT, Lucena JA, de Araújo ANB, de Lira ZS, Gomes AOC. Vocal range profile of chorists after the tongue-trill technique associated with scales. Rev CEFAC. 2016;18(3):626-34. http://dx.doi.org/10.1590/1982-0216201618315415.
17. Fabron EMG, Petrini AS, Cardoso VM, Batista JCT, Motonaga SM, Marino VCC. Immediate effects of tongue trills associated with Transcutaneous Electrical Nerve Stimulation (TENS). CoDAS. 2017;29(3):e20150311. http://dx.doi.org/10.1590/2317-1782/20172015311. PMid:28614457.
18. Boersma P, Weenink D. Praat: doing Phonetics by Computer. Version 5.3.56. [Internet]. Amsterdam: University of Amsterdam; 2005 [cited 2020 Apr 4]. Available from: http://www.praat.org
19. Maryn Y, Weenink D. Objective dysphonia measures in the program praat: smoothed cepstral peak prominence and acoustic voice quality index. J Voice. 2015;29(1):35-43. http://dx.doi.org/10.1016/j.jvoice.2014.06.015. PMid:25499526.
20. Fadel CBX, Dassie-Leite AP, Santos RS, Santos CG Jr, Dias CAS, Sartori DJ. Immediate effects of the semi-occluded vocal tract exercise with LaxVox® tube in singers. CoDAS. 2016;28(5):618-24. http://dx.doi.org/10.1590/2317-1782/20162015168. PMid:27849247.
21. Titze IR. Voice training and therapy with a semi-occluded vocal tract: rationale and scientific underpinnings. J Speech Lang Hear Res. 2006;49(2):448-59. http://dx.doi.org/10.1044/1092-4388(2006/035). PMid:16671856.
22. Schwarz K, Cielo CA. Modificações laríngeas e vocais produzidas pela técnica de vibração sonorizada de língua. Pro Fono. 2009;21(2):161-6. http://dx.doi.org/10.1590/S0104-56872009000200013. PMid:19629328.
23. Patel RR, Awan SN, Barkmeier-Kraemer J, Courey M, Deliyski D, Eadie T, et al. Recommended protocols for instrumental assessment of voice: american speech-language-hearing association expert panel to develop a protocol for instrumental assessment of vocal function. Am J Speech Lang Pathol. 2018;27(3):887-905. http://dx.doi.org/10.1044/2018_AJSLP-17-0009. PMid:29955816.
24. Lopes LW, Sousa ESS, Silva ACF, Silva IM, Paiva MAA, Vieira VJD, et al. Cepstral measures in the assessment of severity of voice disorders. CoDAS. 2019;31(4):e20180175. http://dx.doi.org/10.1590/2317-1782/20182018175. PMid:31433040.
25. Maryn Y, Roy N, De Bodt M, Van Cauwenberge P, Corthals P. Acoustic measurement of overall voice quality: A meta-analysis. J Acoust Soc Am. 2009;126(5):2619-34. http://dx.doi.org/10.1121/1.3224706. PMid:19894840.
26. Spazzapan EA, Cardoso VM, Fabron EMG, Berti LC, Brasolotto AG, Marino VCC. Acoustic characteristics of healthy voices of adults: from young to middle age. CoDAS. 2018;30(5):e20170225. http://dx.doi.org/10.1590/2317-1782/20182017225. PMid:30365649.
27. Spazzapan EA, Marino VCC, Cardoso VM, Berti LC, Fabron EMG. Acoustic characteristics of voice in different cycles of life: an integrative literature review. Rev CEFAC. 2019;21(3):e15018. http://dx.doi.org/10.1590/1982-0216/201921315018.
28. Phadke KV, Laukkanen AM, Ilomäki I, Kankare E, Geneid A, Švec JG. Cepstral and perceptual investigations in female teachers with functionally healthy voice. J Voice. 2020;349(3):485.e33-43. http://dx.doi.org/10.1016/j.jvoice.2018.09.010. PMid:30342798.
29. Watts CR, Awan SN, Maryn Y. A comparison of cepstral peak prominence measures from two acoustic analysis programs. J Voice. 2017;31(3):387.e1-10. http://dx.doi.org/10.1016/j.jvoice.2016.09.012. PMid:27751661.
30. Oates J. Auditory-perceptual evaluation of disordered voice quality. Folia Phoniatr Logop. 2009;61(1):49-56. http://dx.doi.org/10.1159/000200768. PMid:19204393.

Authors' contribution

MCBR participated in data collection, data analysis and interpretation and writing of the article. SMMO - participated in the idealization of the study, collection, analysis, interpretation of the data and review of the article; JSC participated in the idealization of the study, data collection and interpretation of the results; EAS, LAS participated in data collection, data interpretation and writing of the article; EMGF participated, as advisor, in the idealization of the study, analysis, interpretation of the data and writing of the article.