

Daniela Macedo dos Rios Gonçalves<sup>1</sup>   
Rosiane Kimiko Yamasaki Odagima<sup>1</sup>   
Thays Christina Garcia Vaiano<sup>1</sup>   
Elisabeth Amin<sup>1</sup>   
Mara Behlau<sup>1</sup> 

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#### Correspondence address:

Daniela Macedo dos Rios Gonçalves  
Centro de Estudos da Voz – CEV  
Rua Machado Bittencourt, 61,  
10º andar, Vila Clementino, São Paulo  
(SP), Brasil, CEP: 04044-905.  
E-mail: dannyryos@live.com

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# Immediate effect of phonation into silicone tube on gospel singers

## *Efeito imediato da fonação em tubo de silicone em cantores gospel*

### ABSTRACT

**Purpose:** To investigate the immediate effect of phonation into silicone tube on self-assessment and vocal quality of gospel singers. **Methods:** The sample was composed of 40 gospel singers without vocal complaint, males and females, from 18 to 40 years. The singers performed semi-occluded vocal tract exercise in LaxVox® silicone tube. The end of the tube was submerged in water (2cm depth), for three minutes. Before and after exercise, voice recording was performed for perceptive-auditory evaluation, and only after exercise, the voice and comfort phonation self-assessments (CSA) were performed. The descriptive and inferential statistical analysis were performed. **Results:** All participants reported improvement in voice. In addition, a significant higher proportion of them indicated phonation comfort improvement after exercise. According to the perceptive-auditory evaluation, there was no difference in the comparison of the proportions of pre- and post-exercise perceptive-auditory evaluation categories in gospel singers. **Conclusion:** The phonation exercise into a silicone tube caused an immediate positive effect on gospel singers' voice and comfort phonation self-assessments. There was no significant difference in the perceptive-auditory evaluation before and after phonation into silicone tube in gospel singers.

### RESUMO

**Objetivo:** Investigar o efeito imediato da fonação em tubo de silicone na autoavaliação e na qualidade vocal de cantores gospel. **Método:** Amostra composta por 40 cantores gospel sem queixa vocal, ambos os sexos, 18 a 40 anos. Os cantores realizaram um exercício de trato vocal semiocluído de fonação em tubo de silicone LaxVox®, com uma extremidade submersa em água a 2cm de profundidade, por 3 minutos. Antes e após o exercício, foi realizada gravação da voz para avaliação perceptivo-auditiva, e somente após o exercício foi feita autoavaliação da voz e do conforto fonatório. Os dados foram analisados por meio de estatística descritiva e inferencial. **Resultados:** Todos os participantes relataram melhora na voz, além de proporção significativamente maior de melhora do conforto fonatório pós-exercício. Na avaliação perceptivo-auditiva, não houve diferença na comparação das proporções das categorias da avaliação perceptivo-auditiva pré e pós-exercício em cantores gospel. **Conclusão:** O exercício de fonação em tubo de silicone promoveu efeito imediato positivo na autoavaliação da voz e do conforto fonatório dos cantores Gospel. Não houve diferença significativa na avaliação perceptivo-auditiva pré e pós-exercício de fonação em tubo de silicone em cantores gospel.

Study conducted at Centro de Estudos da Voz – CEV - São Paulo (SP), Brasil.

<sup>1</sup> Centro de Estudos da Voz – CEV - São Paulo (SP), Brasil.

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## INTRODUCTION

Gospel music is a musical genre of Afro-American originated on the slave farms in the south of the United States of America (USA). Originally, a solo singer accompanied by a choir and a small instrumental group used to sing gospel music. Currently, in the USA and other countries, gospel music is a category of Christian Music<sup>(1)</sup>.

In Brazil, since the 1990s, this music genre has added more diversified musical styles, involving an increasing audience. The appreciation of gospel music by the media and the public expanded the possibility of professional singers gospel to participate in singing in churches and shows<sup>(2-4)</sup>.

Speech therapist is the regulated professional to act in the prevention and treatment of vocal disorders, in addition to perfecting the voice standards. In recent years, gospel singers have been sought these professionals for guiding them in health promotion and preventing vocal alterations<sup>(5)</sup>.

The practice of speech-language therapists usually involves direct vocal interventions, with the practice of exercises, and indirect, with orientations on health and vocal hygiene<sup>(6)</sup>. Among the exercises used by speech-language therapists in direct clinical practice, semi-occluded vocal tract exercises (SOVTE) have become more important. Such exercises, such as phonation in tubes and straws, have been used in the rehabilitation of vocal disorders<sup>(7)</sup> and in training that aims to improve voices<sup>(8-14)</sup> of several populations, among them, the singers.

Sovijärvi first explained tube-phonation SOVTE with one of the extremities submerged in water, in the 1960s decade<sup>(15)</sup>. The author developed phonation exercise in resonance tube, performed with the use of glass tubes with one of the extremities submerged in water. Recent research<sup>(16)</sup> shows that one of the main characteristics of this exercise is the fact that the tube end submerged in water causes a pressure modulation produced by water bubbling.

The research conducted by Sihvo e Denizoglu<sup>(17)</sup> also indicated that the coaptation of the vocal folds occurs more smoothly and, consequently, more efficiently, with a better mobility of the vocal folds free edge. The authors attributed the fact to the increased activity of the thyroarytenoid muscle, replacing the activity of the lateral cricoarytenoid muscle. In addition, resonance SOVTE using silicone tube, also called tube phonation, promotes a vertical lowering of the larynx, expands the vocal tract and reduces the collision force between the vocal folds<sup>(18)</sup>.

With regard to vocal training, the technique of resonance in silicon tube has been used for vocal training purposes because it allows improving voice control and decreasing excessive tension during phonation. In addition, it is thought that water resistance would enhance the effects of SOVTE<sup>(7)</sup>. Tube phonation SOVTE showed positive results of the technique in different populations<sup>(19)</sup>.

Considering that the application of SOVTE with phonation in silicone tube immersed in water can improve the vocal conditioning and promote the phonatory balance, we believe that its accomplishment can bring positive benefits related to the phonatory comfort and vocal quality in gospel singers.

Thus, the aim of this study was to investigate the immediate effect of phonation in silicon tube on self-assessment and vocal quality of gospel singers.

## METHODS

This research has a prospective and analytical design. The study was approved by the Research Ethics Committee of the Specialization Center in Clinical Speech Therapy under number 360,689. All participants were informed about the study before signing a free and Informed Consent Form (ICF).

To select the participants for the present study, we established inclusion and exclusion criteria. Inclusion criteria were: age between 18 and 40 years old, absence of self-reported vocal complaint and acting as a professional gospel singer with at least five years of experience. Exclusion criteria were: self-reference of having auditory complaint, respiratory disease, neurological impairment or severe cardiopathy and current speech-language pathology. To select the participants, a questionnaire was applied to identify and collect data regarding sex, age, profession and health information. Data obtained in the questionnaire characterized the sample.

To participate in this study, we selected 40 singers of gospel musical genre without vocal complaints, 19 females and 21 males, with a mean age of 27.2 years old.

The same researcher performed the evaluation of the outcomes and the execution of the technique. The procedures were performed in the following order: 1) Vocal pre-exercise recording; 2) Implementation of phonation SOVTE in silicon tube; 3) Vocal post-exercise recording; 4) Application of the self-assessment questionnaire.

### Vocal recording and perceptual auditory assessment of voice

Before and after the execution of the vocal exercise, emission of the sustained vowel “e” and “counting numbers from one to ten” in the usual pitch and loudness were recorded. The recording of the vocal sample was standardized and followed the calibration of the program Phonoview 2.0 (CTS *Informática*, Brazil) with one-way microphone (Shure, SM58, Brazil) of flat response, positioned on pedestal with 45° angle and at 5cm from the mouth. The microphone was connected to an external sound card (M-AUDIO Interface card Fast Track Pro-M 4x4 audio, PRO Tools, USA), with recording rate of 44, 1kHz. Each recording was individually calibrated for the acoustic program requirements.

The samples (vowel and numbers) were extracted in WAV audio format of the Phonoview 2.0 program (CTS *Informática*, Brazil). The first second of sustained vowels and numbers was eliminated to remove the appearance of voice, and the next three seconds were analyzed, to avoid providing any additional information about the condition (pre- or post-exercise) that could interfere with the evaluators’ assessment.

Subsequently, three speech therapists specializing in voice, with a minimum experience of ten years in the profession received

the voice samples (vowel and numbers). The professionals obtained the pre- and post-exercise samples randomly paired.

The professionals were instructed to first listen to them in pairs and to indicate in a specific protocol which of the two emissions could be considered different from the perceptual-auditory point of view, or if they were similar. When different, the evaluators were instructed to check which was the best sample regarding vocal quality, that is, to check the voice with better interaction source-filter (sample A or sample B). To calculate the intra-rater reliability, 20% of the voices were replicated. The Kappa index of inter-evaluator concordance was calculated in pairs and obtained values between 0.1 and 0.29 for vowels and from 0.1 to 0.47 for numbers counting. The intra-evaluator reliability was between 0.1 and 1.0 for vowels, and between 0.2 and 0.6 for number counting. Thus, for the statistical analysis of the auditory-perceptual evaluation, we opted to use the results of the judge's most reliable judgement.

### Execution of the phonation SOVTE in LaxVox Silicone Tube®

All participants performed a SOVTE with LaxVox® Tube. It is a technique that belongs to the category of phonation in resonance tube immersed in water, however, uses a tube of silicone<sup>(8-10)</sup>.

The practice of the technique consisted of some steps, in which the participants were instructed and monitored during its realization: 1) The participants performed the exercise in sitting position; 2) They should relax and focus on posture and respiration. They should relax face, neck, the upper part of the back and the pectoral muscle; 3) They should put the silicone tube of 35cm in length and 9-12mm in diameter, inside a pet bottle of 500ml, with 250ml of water, with the proximal end of the tube in the mouth, between or in front of the incisor teeth and above the tongue and the distal end should be immersed in water and kept between 1 and 2cm deep; 4) They should inspire by the nose and expire by the mouth, emitting the vowel "U" focusing on diaphragmatic respiration<sup>(20)</sup>.

The phonation SOVTE in silicon tube was performed for 3 minutes, in normal frequency and intensities.

### Application of the self-assessment questionnaire

Only after the singers performed the vocal technique, they filled out a self-assessment questionnaire of voice and phonatory comfort. In the instrument, they should answer whether they observed modifications in the vocal characteristics (sustained emission of the vowel and numbers counting) before and after performing the exercise. The analysis parameters were: phonatory comfort and vocal quality. The singer performed self-assessment through a questionnaire based on their perception before and immediately after the exercise, consisting of two closed questions: "Please, in relation to phonatory comfort, indicate if you feel the same, better or worse than before the exercise", and, "Please, observing your voice, do you believe that vocal quality is the same, better or worse than

before performing the exercise?". They had to check one of the options: "the same", "better" or "worst". The participants performed self-assessment without hearing the recorded samples (pre-and post-technical).

### Data analysis

The statistical analysis of the data was performed in a descriptive and inferential manner, using the SPSS 25.0 software. We adopted a significance level of 5% for all inferential statistical analyses. All the variables in the present study are nominal qualitative and were descriptively analyzed by frequency and percentage. We used the equality of two proportions test for the inferential statistical analysis of the proportion of each variable categorical. For the variables with multiple categories, the category of higher proportion was the reference for comparison.

## RESULTS

The sample of the present study consisted of 40 participants, 19 females and 21 males, aged between 19 and 40 years old, and an average of 27.2 years old (Table 1). There was no difference in the proportion of sex (Table 2).

The results were divided into two aspects: voice and post-exercise phonatory comfort self-assessment, and auditory-perceptual evaluation of the vowel and number counting, pre- and post-exercise.

All singers (100%) reported improvement in their post-exercise voice self-perception. It was not possible to analyze by means of inferential statistics the proportion of response categories of the variable self-assessment of voice in gospel singers, since this is constant, that is, there was no variation since all participants reported the same answer category. Regarding the perception of phonatory comfort, there was a significantly higher proportion of gospel singers who reported improvement in phonatory comfort after the execution of SOVTE, in relation to the proportion of worsening ( $p < 0.001$ ) (Table 3).

We observed a higher frequency of participants with better vocal quality after the technique in the sustained vowel (40.0%) and numbers counting (55%). However, there was no difference when comparing the proportions of the auditory-perceptual evaluation categories pre- and post-phonation SOVTE in silicon tube in gospel singers (Table 4).

**Table 1.** Description of age in gospel singers

Variable	Average	SD	Minimum	Maximum
Age	27.20	4.80	19.00	40.00

Descriptive analysis

**Captions:** SD = standard deviation

**Table 2.** Description and analysis of sex proportion in gospel singers

Sex	Frequency	Percentage	p-value
Male	21	52.5	0.377
Female	19	47.5	

$p < 0.05$  – Equality of two proportions test

**Table 3.** Analysis of voice self-assessment and phonatory Comfort post phonation SOTVE in silicone tube in gospel singers

Self-assessment	Vocal Quality		p-value	Phonatory Comfort		p-value
	Frequency	Percentage		Frequency	Percentage	
The same	-	-	-	-	-	<0.001*
Better	40	100		38	95.0	
Worst	-	-		2	5.0	

\*p<0.05 - Equality of two proportions test

**Table 4.** Analysis of auditory-perceptual evaluation pre and post phonation SOTVE in silicone tube in gospel singers

Evaluation	Vowel "e"		p-value	Numbers		p-value
	n	%		n	%	
Pre technique better voice	12	30.0	0.294	9	22.5	0.052
Post technique better voice	16	40.0	Ref.	22	55.0	Ref.
Similar	12	30.0	0.294	9	22.5	0.052

p<0.05 - Equality of two proportions test

**Caption:** Ref. = Category of higher proportion considered as reference for comparison

## DISCUSSION

Vocal techniques are important tools in the process of vocal rehabilitation and training<sup>(21,22)</sup>. Therefore, there is a need to obtain more information about the immediate effects of vocal techniques. In this research, we investigated the immediate effect of phonation SOVTE in silicone tube in gospel singers without vocal complaint, through voice and phonatory comfort self-assessment and voice auditory-perceptual analysis.

Phonation SOVTE in resonance tubes are beneficial for rehabilitation and voice training for more than one century<sup>(23)</sup>. These exercises, despite their long tradition of use in Europa<sup>(7)</sup>, have been gaining popularity worldwide only in the last two decades and, at the same time, studies have aimed at understanding their physical principles and immediate vocal effects. However, there are still few scientific contributions in this sense<sup>(24,25)</sup>.

In this study, all gospel singers reported improvement in voice self-perception, in addition to a significantly greater proportion of improvement in the perception of phonatory comfort after the execution of SOVTE. Semi-occluded vocal tract exercises improve proprioception, accentuating some vibratory sensations during and after exercise<sup>(8,10,26)</sup>. According to the literature, such vibratory sensations could originate from a process of converting energy into the glottis that, when efficient, would be distributed through the regions of the face and head, resulting in a brighter and more projected vocal quality<sup>(27)</sup>. This sound effect has been observed in studies on the phonation SOVTE in rigid and flexible resonance tubes, which describe an increase in spectral prominence in the singer's formant region (resulting from a grouping of third, fourth and fifth formants), due to changes in vocal tract adjustment after exercise<sup>(10,23,26,28)</sup>. Moreover, because the singers have vocal training, it is common to have good proprioception, which may also have favored the perception of improvement with the exercise<sup>(14)</sup>. We believe that this may have resulted in improved self-perception of voice and phonatory comfort of singers after exercise.

In the auditory-perceptual evaluation of the voice, both of sustained vowels and number counting, despite the higher

frequency of improvement in the post-technical vocal quality, there were no significant difference between the categories of presentation of vocal pre- and post-technique results. In general, the literature shows better results in the vocal quality after SOVTE performance for this type of evaluation in individuals with behavioral or organic dysphonias (OD)<sup>(24,29)</sup>. Thus, the fact that the sample of the research was composed of singers who already have an internal calibration related to vocal production, without vocal complaint, which may hinder the auditory perception of small differences in vocal quality compared with emissions pre- and post the performance of a single exercise<sup>(14)</sup>, may have contributed to the lack of auditory-perceptual difference immediately after exercise.

The results of this study corroborate a study<sup>(14)</sup> that analyzed the immediate effects of the semi-occluded vocal tract exercise with LaxVox® Tube in 23 singers without vocal complaints, students of lyrical singing. The participants performed a sequence of three exercises, one minute each, totaling three minutes, with a LaxVox Tube® immersed to 2cm of the water surface in a 500ml bottle, half of it filled with water. The authors showed that the SOVTE with LaxVox® Tube promoted positive immediate effects on self-assessment and acoustic analysis of the voice of the professional singer without complaints; however, it did not generate significant immediate modifications in the auditory-perceptual evaluation of speech and singing. The authors attributed this fact to the fixed time of exercise execution, which was three minutes, as in the present study.

A study with SOVTE, similar to the present research - glass tube with an end in water, also in the population of singers - pointed out that less experienced singers obtained the best results in post-exercise vocal quality.

Thus, daily vocal training would provide a better habitual phonation, which would not be likely to improve with short duration exercise<sup>(23)</sup>, justifying the findings of this study.

We believe that the present study differs from the others in the literature by indicating that the population of singers is different from the individuals in general, since it presents better proprioception, and perceives the self-reported improvement

in vocal comfort and quality, even though it is not clinically significant. Therefore, it is necessary to consider vocal use and the previous training for the use of voice when using and analyzing the results of SOTVE in vocal clinic.

One of the limitations of this study relates to the execution time of the exercise, which was three minutes. Another limitation may be related to the fact that the voices are eminently normal, and the fact that singers with a certain internal calibration in vocal production may have interfered in the manifestation of changes in vocal quality.

Future studies could be performed in singers without vocal complaint with different times of execution of the technique. Furthermore, longitudinal studies on the effect of phonation SOTVE in silicone tube in singers with vocal complaint can also introduce important scientific contributions to the clinical community in the voice area.

## CONCLUSION

Phonation SOTVE in silicone tube promoted an immediate positive effect on the voice and phonatory comfort self-assessment of gospel singers. There was no significant difference in the auditory-perceptual evaluation before and after SOTVE in gospel singers.

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## Authors contributions

*DMRG* - study design, data collection, data analysis, study writing; *RKYO* - study design, writing and review of the study; *TCGV* - study design, writing and review; *EA* - study design, writing and review; *MB* - study design, data analysis, writing and review of the study.