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# Immediate effects of the high-pitched blowing vocal exercise

## *Efeitos imediatos do exercício vocal sopro e som agudo*

**ABSTRACT**

**Purpose:** To investigate the immediate effects of the high-pitched blowing vocal exercise. **Methods:** This is a comparative observational study. Participants were 46 women with ages between 25 and 45 years, who were divided into two groups: 23 individuals with vocal complaint (VCG), and 23 without vocal complaint (WVCG). The procedures included vocal auditory-perceptual analysis, acoustic analysis, videostroboscopy, and vocal self-assessment before and after ten repetitions of the high-pitched blowing vocal exercise. The auditory-perceptual analysis and the assessment of the laryngeal configuration images were carried out by three speech-language pathologists, who performed the blind analysis of two vocal samples of each subject, marking the best sample. The acoustic parameters measured were fundamental frequency, jitter and shimmer in sustained vowel, and fundamental frequency in speech. For the vocal self-assessment, participants were asked the question: "How do you think your voice is after the exercise?". **Results:** Both groups presented better voice quality in the auditory-perceptual analysis after the exercise. In the acoustic analysis, shimmer values reduced for both groups, and jitter values reduced only for the WVCG post-exercise. It was observed increase of the fundamental frequency in the VCG in the sustained vowel. The videostroboscopy showed better glottal closure and less vestibule involvement for both groups after the exercise. Vocal self-assessment indicated better voice emission post-exercise in the VCG. **Conclusion:** The high-pitched blowing vocal exercise produces positive immediate effects observed in auditory-perceptual, acoustic, and laryngeal analyses and in vocal self-assessment.

**RESUMO**

**Objetivo:** Investigar os efeitos imediatos do exercício vocal sopro e som agudo. **Métodos:** Trata-se de estudo tipo observacional comparativo. Participaram 46 mulheres com idades entre 25 a 45 anos que foram divididas em dois grupos: 23 com queixa vocal (GQ) e 23 sem queixa vocal (GSQ). Foram realizadas a avaliação perceptivo-auditiva da qualidade vocal, análise acústica, videolaringoscopia e autoavaliação da voz antes e após a execução do exercício sopro e som agudo em dez repetições. A avaliação perceptivo-auditiva e das imagens da configuração laríngea foram realizadas por três fonoaudiólogas especialistas em voz, que deveriam analisar dois trechos de cada sujeito, sem a identificação do momento do registro, assinando o melhor trecho. Os parâmetros acústicos avaliados foram frequência fundamental, *jitter* e *shimmer* na vogal sustentada e frequência fundamental na fala encadeada. Na autoavaliação vocal, todos os participantes deveriam responder à pergunta: "Como você avalia a sua voz após a realização do exercício?". **Resultados:** Na avaliação perceptivo-auditiva, ambos os grupos apresentaram melhor qualidade vocal no pós-exercício. Quanto à avaliação acústica, após o exercício houve diminuição dos valores *shimmer*, em ambos os grupos e nas medidas de *jitter* no GSQ. Observou-se aumento da frequência fundamental no GQ na vogal sustentada. A avaliação videolaringoscópica mostrou melhor coaptação glótica e menor envolvimento do vestibulo em ambos os grupos pós-exercício. A autoavaliação vocal indicou melhora na emissão da voz no GQ. **Conclusão:** O exercício vocal sopro e som agudo produz efeitos imediatos positivos nas avaliações perceptivo-auditiva, acústica, laríngea e na autoavaliação vocal.

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## INTRODUCTION

Semi-occluded vocal tract exercises (SOVTE) have been used in clinical practice with the purpose to favor voice economy and efficiency. With the semi-occluded vocal tract it occurs the phenomenon of retroflex resonance, with whole area expansion from mouth to larynx, and the glottic production, that remain activated, tends to stabilize<sup>(2)</sup>. Lips/tongue trill, bilabial fricatives, nasal sounds, straw phonation, firm glottal, labial constriction, and prolonged “b” are considered SOVTE and favor a clearer, easier to be produced voice, increasing source-filter interaction<sup>(1-3)</sup>.

Vocal exercises are used in speech therapy to enhance voice quality or to produce more appropriated muscle adjustments, acting under the intrinsic and extrinsic larynx muscles. They intend to reduce strain, to improve muscle balance and wave motion of vocal fold mucosa. The final focus is to obtain a improvement in coordination between myoelastic and aerodynamic larynx forces<sup>(4)</sup>.

Some researches were made with the purpose to understand the vocal exercises effects, as to obtain evaluation data as for therapy. It is possible to quote researches involving reverse phonation technique<sup>(5)</sup> or inhaling phonation<sup>(6)</sup>, the resonant method<sup>(7)</sup>, the vocal fry usage<sup>(8)</sup>, and the sonorous tongue trill<sup>(9-11)</sup>.

Specifically regarding SOVTE there is theoretical research about the consequence of stretching the vocal tract to improve economy in voice production. Besides, clinical analyses of some exercises strategies have been pointed out to the possibility of verifying immediate effects on voice of this exercise, however these effects are not always similar among subjects<sup>(13)</sup>.

An isolated exercise must not be used as treatment method, because it is not expected that it promotes definitive changes in dysphonic cases. However, it is important to understand the possible immediate effects of this exercise on voice, as in patient perception as in muscle adjustments, since several vocal techniques propose vocal patters modifications and higher balance of anatomical and physiological conditions of speaker<sup>(14)</sup>.

Semi-occluded vocal tract exercises are included in phonatory competence method, searching to promote a primary muscle adjustment<sup>(2)</sup>, by a right position of vocal folds, stretching corresponding to voice frequency, and glottic resistance enough to oppose pulmonary air column force<sup>(15)</sup>. Among the techniques of this method, the pitched blowing vocal exercise stands out from theoretical point of view, since would favor glottic closure without supra glottic involvement, and it may deactivate median compression of vestibular folds<sup>(2)</sup>. So, the purpose of this research was to investigate the immediate effects of pitched blowing vocal exercise in female subjects, with and without vocal complaints.

## METHODS

This is a comparative observational study with convenience sample, approved by the Ethics Committee of the Centro de Estudos da Voz (CEV), under the protocol number 2714/06. All the participants signed the informed consent, according to 196/96 CNS resolution.

Participants were 46 women with ages between 25 and 45 years (because this is the most stable voice period). So, it was eliminated any deviations related to vocal change or aging<sup>(16)</sup>.

The participants were divided into two groups: Vocal complaint group (VCG) – 23 women, aging from 25 to 45 years (mean 36.2 years), and control group, called Without vocal complaint group (WVCG) – 23 women, aging from 26 to 45 years (mean 32.5 years). The inclusion criteria in VCG were presence of diagnosed larynx lesion by otolaryngology evaluation; disturbance in voice quality evaluated by perceptual analysis by a speech pathologist, and presence of vocal complaint reported by the participant. The inclusion criteria to WVCG were absence of larynx lesion in otolaryngology evaluation; neutral voice quality evaluated by perceptual analysis by a speech pathologist, and absence of vocal complaint reported by the participant.

In VCG it was observed in otolaryngology evaluation the following larynx disturbances: vocal nodules (nine participants – 39.13%); vocal cyst (seven participants – 30.43%); *sulcus vocalis* (four participants – 17.39%), and polyps (three participants – 13.04%). All had glottic slit in larynx evaluation.

It was excluded from both groups, women having systemic diseases with voice impact, psychiatric diseases and/or neurologic diseases. The participants of the research were recruited in otolaryngology and speech and language pathology clinic from Belo Horizonte. All the participants in VCG were searching for treatment due to vocal complaint. WVCG was built by the companion of the patient that searched for medical or speech pathologist treatment in the referred clinic. All the participants passed through perceptual, acoustic, videostroboscopy evaluations and self-evaluation of voice.

To perceptual and acoustic evaluation it were collected samples of sustained vowel / / and connected speech (counting numbers from one to ten), in habitual emission, with frequency and intensity self-selected. The participants remained seated during recordings. The collect occurred immediately before and after doing the pitched blowing exercise, using a radio-shack headset (unidirectional, with condenser, placed at 6 cm and 45° from mouth of the participant). The data were collected in a single section in a silent environment. The samples were recorded direct in the computer using Voxmetria software (CTS 2.6). It was discarded the beginning and the end of the sustained vowel in order that the less stable parts would not interfere in the analysis<sup>(1)</sup>. The acoustic parameters selected were fundamental frequency ( $F_0$ ), jitter, and shimmer in sustained vowel and  $F_0$  in connected speech.

After the vowel and speech recording it was performed the larynx image examination with a Videostroboscopy Scott-LC-960, rigid optic of 9 mm, all by the same otolaryngologist physician. There was xylocaine-10% sprinkling to all the participants and they were requested to breathe trough mouth, and to produce the vowel / / effortless, sustaining the emission in frequency and intensity the closest to the habitual.

All performed the pitched blowing exercise in ten repetitions, which is equivalent to one minute, evaluated time and approved by literature<sup>(14)</sup> as capable of verifying the effect of a voice exercise. The repetition was selected because it referred

to a simpler kind of command and easier to be understood by the participants. After demonstration and little training, the participants initiated the exercise blowing air in a continuous flow to palm. After, a pitched emission was added, preferentially high pitched, maintaining the air flow and the lips in the blowing gesture, at the maximum phonation time. After ten repetitions, it was made new collect of speech sample and larynx image. Each participant answered to the following question: "How do you evaluate your voice after doing the exercise?" and each participant should choose between five of the answers possibilities: easier voice/to phonate, better voice, easier and better voice, worse voice or none change on voice.

The speech samples and larynx configuration images were analyzed by three speech and language pathologists, voice specialists, with minimum clinical expertise of three years. To verify the reliability intra-evaluator, it was repeated 10% of the samples.

To perceptual analysis, the sustained vowel and connected speech were edited in pairs, in a random recording order (pre/post exercise). The evaluators must indicate the best fragment of the pair, regarding voice quality. They could still identify if the samples showed to be unchanged in cases of absence of modifications between fragments.

To larynx configuration evaluation it was selected three parameters: glottic closure, presence of slit, and larynx vestibule involvement during voice production. It was compared the two fragments of the subject, without the identification at the moment of register. The evaluators must sign if the parameters remained unchanged, improved or worsened comparing both images.

The results were tabulated according to moment of collect: pre/post-exercise. It was performed statistical treatment of perceptual, videostroboscopy analysis and voice self-evaluation using Pearson Chi-Squared Test (comparison of answers proportion in pre and post-exercise conditions). In acoustic evaluation, it was used the Wilcoxon test to compare the means of pre and post-exercise moments. It was adopted the significance level of 0.05 (5%).

## RESULTS

At perceptual analysis the presence of best emission was frequent at post vocal exercise moment to both groups. In acoustic analysis it is possible to verify that the vocal exercise promoted decrease in shimmer value to both studied groups. It was observed an increase in  $F_0$  in VCG to sustained vowel and connected speech tasks, and a decrease in jitter values in WVCG (Table 1).

Videostroboscopy evaluation revealed improvement in glottic closure and lower larynx vestibule activation in post exercise moment to both groups. There were no changes regarding presence of glottic slit (Table 2).

Vocal self-evaluation data analysis showed positive effects of the exercise in VCG with a higher frequency of "easier and better voice" answer, standing out that the exercise improved voice quality and reduced the effort at emission (Table 3).

## DISCUSSION

Semi-occluded vocal tract exercises (SOVTE) have been suggested by clinicians, singing teachers, voice coaches as a resource of vocal training and rehabilitation. Based on the assumption that vocal tract constriction alters intern pressure, modify glottic and vocal tract configuration, and produce different acoustic patterns<sup>(1)</sup>. Many descriptions show changes in vocal folds vibratory patterns with a high interaction between source and filter<sup>(1-3,17)</sup>, reducing phonotrauma possibility.

It was opted in this research to perform several analyses (perceptual, acoustic, videostroboscopy, and self-evaluation) in order to verify which of them the possible effects would be more evident. Usually the amount and frequency of doing a determined exercise prescribed in voice therapy is an option based on empirical rules<sup>(18)</sup>. A research evaluating the time of making the sonorous tongue trill exercise in 15 men and 15 women without vocal complaint observed that in women group there was an improvement in perceptual analysis after three

**Table 1.** Perceptual and acoustic analysis pre and post high-pitched blowing vocal exercise

Perceptual	Vowel						Speech					
	VCG			WVCG			VCG			WVCG		
	Pre Better	Post Better	Unchanged	Pre Better	Post Better	Unchanged	Pre Better	Post Better	Unchanged	Pre Better	Post Better	Unchanged
n	3	16	4	3	17	3	4	16	3	4	18	1
%	13.04	69.57	17.39	13.04	73.91	13.04	17.39	69.6	13.04	17.39	78.26	4.35
Chi-squared	<0.001*			<0.001*			<0.001*			<0.001*		
Acoustic	Pre	Post		Pre	Post		Pre	Post		Pre	Post	
$F_0$	216.71	232.91	—	224.49	236.03	—	204.62	209.75	—	204	204.35	—
Wilcoxon	0*			0.05			0.03*			0.58		
Jitter	0.66	0.54	—	0.58	0.36	—	—	—	—	—	—	—
Wilcoxon	0.45			0.02*								
Shimmer	4.67	4.22	—	4.73	3.72	—	—	—	—	—	—	—
Wilcoxon	0.03*			0.01*								

\* Significant values ( $p < 0.05$ )

**Note:** VCG = vocal complaint group; WVCG = without vocal complaint group

**Table 2.** Videostroboscopy analysis pre and post high-pitched blowing vocal exercise

Parameter		Pre Best		Post Best		Unchanged		p-value
		n	%	n	%	n	%	
Glottic closure	VCG	1	4.35	17	73.9	5	21.74	<0.001*
	WVCG	3	13.04	18	78.3	2	8.7	<0.001*
Slit	VCG	0	0	1	4.35	22	95.65	<0.001*
	WVCG	4	17.39	1	14.4	18	78.26	0.04*
Vestibule involvement	VCG	2	8.7	16	69.6	5	21.74	<0.001*
	WVCG	3	13.04	16	69.6	4	17.39	<0.001*

\* Significant values ( $p < 0.05$ ) – Chi-square test after adjustment

**Note:** VCG = vocal complaint group; WVCG = without vocal complaint group

**Table 3.** High-pitched blowing vocal exercise effect self-evaluation

Self-evaluation	VCG		WVCG	
	n	%	n	%
Easier voice	6	26.09	8	34.8
Better voice	4	17.39	2	8.7
Better and easier voice	9	39.13	0	0
No difference	4	17.39	13	56.52
p-value	<0.001*		0.087	

\* Significant values ( $p < 0.05$ ) – Chi-square test after adjustment

**Note:** VCG = vocal complaint group; WVCG = without vocal complaint group

minutes of exercise, while in men group these modifications were observed after five minutes. To both groups it was observed the sensation of discomfort with the increase of exercise time. Another research<sup>(20)</sup> of the same researcher group evaluating the tongue trill result in 27 women with vocal nodules, of these ten women were also in placebo group, it was observed improvement of the perceptual voice quality parameters after five minutes of exercise and in acoustic measures after seven minutes of exercise in vocal nodules group. The placebo group however did not have any perceptual or acoustic modifications. Time analysis of exercises in dysphonic and no dysphonic subjects needed to generate a voice quality and larynx function modification is still incipient in literature and, future studies with control of voice quality types, larynx disturbances, gender, and age are important to a better comprehension of voice clinical conduction.

Several researches use perceptual or acoustic analysis as a criteria to verify the effect of an exercise<sup>(5-11,13)</sup>. However more recently the focus of patient opinion has been considered central<sup>(19,21)</sup>, since hardly a person adheres to a maneuver that causes discomfort. Besides these analyses, to verify the larynx condition must be done by visual analysis, since it is not possible to identify exactly by perceptual evaluation the muscles adjustments used. So, multiple analyses considering diverse perspectives seem to be more complete solutions.

The results of perceptual analysis in sustained vowel and connected speech tasks showed improvement after doing the exercise to both groups, which suggests not having influence of vocal complaint in such modifications. Therefore, the exercise provided improvement in voice pattern in general way,

probably due to contribution to a better source-filter interaction. This interaction was elucidated by a research that simulated in a computer the vocal fold vibration and vocal tract model, favored by the increase in intra glottic pressure and median supra glottic<sup>(1)</sup>.

The impedance combination by vocal fold adduction and epilarynx narrowing tube may provide a more efficient and economic voice<sup>(1)</sup>. A research analyzing the vocal pattern modification after SOVTE as straw phonation in women without vocal complaint concludes that there was improvement in voice emission in perceptual analysis after doing the exercise<sup>(13)</sup>. Using straw the larynx sound may be easily monitored since it is not masked by lips trill<sup>(17)</sup>.

In acoustic analysis,  $F_0$  values in sustained vowel and connected speech tasks increase after doing the exercise in VCG, suggesting that this favor  $F_0$  displacement to high pitch. The activated muscle in the exercise is cricothyroid, responsible to longitudinal tension in vocal fold, important factor in fundamental frequency control. Its contraction promotes  $F_0$  lifting, that is, the production of higher pitched sounds<sup>(2)</sup>.

Normal voice is classified as a periodic signal with low aperiodicity represented by the perturbation of sound signal indexes of fundamental frequency (jitter) and amplitude (shimmer)<sup>(22)</sup>. Jitter values did not reduce after exercise in VCG. Probably dysphonia generated deviated jitter values and doing the exercise was not enough to reduce those values. The exercise did not reduce aperiodicity of frequency cycle by cycle. This was not observed in WVCG in which aperiodicity of frequency was not that high at initial moment and the exercise reduced the jitter value, therefore, decreasing aperiodicity. In shimmer evaluation the comparison between pre and post emissions showed differences to both groups. So, shimmer may receive positive influences, more evident than jitter. It may say that vocal exercise reduced the shimmer value presented by the participants, independent of vocal complaint<sup>(2)</sup>.

In larynx evaluation there was improvement in glottic closure and decreasing of larynx vestibule involvement post exercise to both groups. These data confirm the purposes of pitched blowing exercise<sup>(2)</sup>. The adjustments occurred probably due to vestibular folds distance from median line, favoring the larynx muscle balance and deactivating median constriction of vestibule<sup>(2)</sup>. There is a parallelism between vocal fold mucosa vibration and voice quality perceived and



as better is the vibration of vocal fold coverage as better voice quality is<sup>(23)</sup>.

It was not observed difference in any of the groups regarding the presence of glottic slit. Not having changes in glottic closure might indicate that may be needed a higher number of exercises series and a higher execution time (days or weeks). Besides, VCG was pretty heterogeneous, with different kinds of larynx lesions, which may have diluted the exercise impact. New studies with specific groups of patients and controlling the number of repetitions of the exercise, or making a longitudinal analysis, following through some training sections may help to clear this question.

In voice self-evaluation, it was observed in VCG the benefits of the pitched blowing exercise with a comfortable emission after doing it. This confirms that the exercise brought benefit to vocal emission fluidity in this group, possible because it provided more comfort to phonate, stabilizing the emission (due to the whole area expansion of vocal tract, favoring glottic closure, deactivating vestibule median constriction, and balancing larynx muscles)<sup>(1,2)</sup>. It is important to highlight that the option "worse voice" was not signed by any of the participants of the studied groups.

Positive voice self-evaluation with an exercise is an important factor to adherence to treatment that many times will require a long commitment, with behavioral changes and continuous execution of the technique at home. These factors depend mainly on an alliance between speech therapist and patient. A qualitative research<sup>(24)</sup> had the purpose to document the patients perspective about barriers and facilitators in voice therapy. The authors concluded that the patients perceived vocal rehabilitation as an effective therapeutic procedure, but recognize that this is a process that requires effort to a new motor learning, besides the active self-regulation, and a good contact with the clinician. The patients reported that voice technique learning is useful, and the clinician had a fundamental influence in the process, as source of support and encouragement<sup>(24)</sup>.

A research evaluated the immediate effects of finger kazoo exercise (with a warning finger on the mouth, in central region, reducing sonorous air flow) and straw phonation in women without vocal complaint<sup>(13)</sup>. The results pointed out higher comfort at phonation with a clear, strong and easier voice. The prescription of these exercises has been done in several situations: negative supra glottic involvement, post-surgery of larynx lesions, reduction of impact between vocal folds, vocal improvement<sup>(2,17)</sup>, and vocal warming up<sup>(2,17,25)</sup>.

The pitched blowing exercise promoted positive changes in hearing, acoustic, larynx, and self-evaluation parameters. Future studies controlling different times in exercise execution and larynx disturbances are important to a higher comprehension of the benefits of this vocal technique.

## CONCLUSION

High-pitched blowing vocal exercise produces: improvement in voice quality in perceptual evaluation as for people without voice complaint as for dysphonics; modifications to different parameters for both groups in acoustic analysis;

improvement in glottic closure and less larynx vestibule involvement to both groups in larynx evaluation; and report of a better and comfortable sound emission in dysphonic subjects in voice self-evaluation.

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