Case Report

Hands-over-mouth exercise in supracricoid horizontal partial laryngectomy: initial study

Efeito imediato da técnica de firmeza glótica nas laringectomias parciais horizontais supracricoides: estudo inicial

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ABSTRACT

Supracricoid horizontal partial laryngectomy is a surgical technique used to treat laryngeal tumors restricted to glottic and supraglottic regions, preserving at least one of the arytenoids. This surgery allows for maintenance of the sphincter and respiratory functions, as well as phonation, with rough vocal quality. Rehabilitation aims to promote sphincter contraction of the remaining structures to improve swallowing and phonation. The hands-over-mouth exercise is usually employed to improve glottic closure: one cupped hand gently covers the half-open mouth to almost completely obstruct the airway during sustained emission of a voiced fricative phoneme. To understand the effect of this technique in patients submitted to supracricoid laryngectomy, we evaluated the configuration of the laryngeal remaining structures and vocal quality during supraglottic phonation, after a hands-over-mouth exercising period of two--minutes, by comparing digitizing voice samples and nasolaryngoscopic images of six patients, before and after the task. We used the GRBASI scale to access vocal quality and analyzed the pattern of constriction, the degree of approximation and the vibratory amplitude to evaluate the images. In this pilot, we observed an increase in vibratory amplitude of the remaining structures of five patients and concluded that the hands-over-mouth exercise can be used as a complementary exercise to improve supraglottic voice quality.

Keywords: Laringectomy; Supracricoid laryngectomy; Voice; Voice quality; Voice training

INTRODUCTION

Partial laryngectomy is a surgical technique that aims at conserving the sphincter, respiratory and phonatory function of the larynx as much as possible. They can be vertical or horizontal, depending on the resection plan. Supracricoid horizontal laryngectomy (SCPL) is a type of horizontal laryngectomy, first described in 1959[1]. This treatment option for transglottic tumors, with involvement of the glottic and supraglottic regions, consists of the resection of the laryngeal structures superior to the cricoid cartilage (vocal, vestibular and aryepiglottic folds, preserving one or two arytenoids). For reconstruction, the laryngeal remains are lifted up towards the hyoid bone and the epiglottis (cricohyoidoepiglottopexy – CHEP); or, when the epiglottis is removed, the elevation goes towards the hyoid bone and the base of the tongue (cricohyoidopexy – CHP)[2,3]. SCPL is an oncologically safe surgical technique, with good results in the treatment of laryngeal cancer[4].

After SCPL, the supraglottic structures become the sound source for phonation. In CHEP reconstruction, the mucosal vibration of the arytenoid and the epiglottis produces voice (aryepiglottic phonation). In CHP, the mucosal vibration of the arytenoid against the base of the tongue is what will generate sound[5,6]. Although quasi periodic vibration of such structures may exist[7], spectrographic analysis shows noise predominance in the high frequency region of the spectrum[8].

Speech and swallowing rehabilitation aims at promoting sphincter-like movement of the remaining structures to

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Conflict of interests: None

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improve swallowing and phonation. In order to restore phonation, laryngeal adduction exercises are employed[9]. Once phonation is produced, some techniques involving lips or tongue vibration, or emission of fricative voiced phonemes are selected in order to stabilize emission; to improve communication quality overall, resonance and overarticulation exercises are applicable[10]. Initially, the vocal quality tends to be breathy, gradually becoming rough during the rehabilitation process.

In 2005 a survey was conducted with patients who have developed a satisfactory supraglottic phonation after partial vertical laryngectomy, in order to evaluate the effect of the vocal fry technique upon laryngeal configuration. To produce the vocal fry (or creaky voice or pulse register), patients are requested to sustain the vowel /a/ in pulse register, in a very low frequency, repeated times. It was possible to observe increase in the vibratory amplitude and in the approximation of the remaining supraglottic structures[11].

Exercises involving emissions with half-occluded vocal tract, as lip or tongue vibration, bilabial fricatives, humming and phonation in tubes or straws, are usually employed in the daily clinical practice to improve vocal efficiency, promoting normal loudness under less mechanical trauma to the tissues, facilitating the source-filter interaction[12-14]. Hands-over-mouth exercise is usually employed to improve glottic closure: one cupped hand gently covers the half-open mouth to almost completely obstruct the airway during sustained emission of a voiced fricative phoneme. Benefits from this technique include improvement of glottic closure and reduction in the participation of supraglottic structures during phonation, whenever they interfere in a negative way[9].

In our ambulatory practice, we have observed loudness improvement in supraglottic phonation as an immediate effect of the hands-over-mouth exercise in patients submitted to SCPL. Despite this technique is used to promote vocal folds adduction and simultaneously produce the abduction of supracricoid structures, it is possible that, in the absence of the vocal folds, there is a sphincter-like movement of the remaining structures, in patients submitted to SCPL.

This hypothesis raised the following questions: what is the effect of this exercise on the new configuration of the larynx, in which vocal folds are absent? Are there any modifications in the vocal parameters evaluated by auditory perceptive analysis? Can this exercise contribute to promote an approximation of the remaining structure as well as mucosal vibration, which is usually small after this surgery?

Therefore, the purpose of this work was to evaluate the configuration of the laryngeal remaining structures and the vocal quality, of patients submitted to SCPL and with a stable vocal quality during supraglottic phonation, after performing hands-over-mouth exercise for two-minutes.

CLINICAL CASES PRESENTATION

Six patients submitted to SCPL under rehabilitation treatment at Irmandade Santa Casa de Misericórdia de São Paulo with a stable supraglottic voice quality were enrolled in this study. Supraglottic voice was considered stable when all voiced phonemes could be audible throughout regular connected speech. Exclusion criterion was prior employment of firming glottis technique in the rehabilitation process. Chart 1 displays the subjects' characterization.

This study was fully approved by the Ethics Committee of the Hospital da Irmandade Santa Casa de Misericórdia de São Paulo, under process number 098/07. All participants previously signed a detailed free and informed consent.

A plan of sequential procedures was followed to obtain the data:

1. Computerized recording of voice samples in a silent room, using the Gram® Software Spectrogram (version 5.0.5, Freeware, Copyright 1994-1999) and a Sennheiser microphone (model Evolution 815s). Patients were required to perform the following tasks: sustained vowel /a/ in habitual pitch and loudness, count from 1 to 20, sing "Happy birthday to you", and say something about their perception about their own voices.
2. Hands-over-mouth exercise training, verifying patients' adequate performance.
3. Nasolaryngoscopic inspection (flexible optic fiber, Pentax®, FNL-10R) of the remaining laryngeal structures at rest and during three sequential sustained emissions of the vowel /a/.
4. Hands-over-mouth exercising for two minutes: one cupped hand gently placed over half-open mouth to an almost complete airway occlusion associated to a series of long sustained emissions of a voiced fricative phoneme. We considered two minutes to be enough time for this therapeutic test based on previous report of positive results obtained with the fry technique applied within this same time period in partially laryngectomized patients[11].
5. Steps 3 and 1 were repeated.

Auditory-perceptual and laryngeal configuration evalua-

Chart 1. Sample characterization of patients submitted to SCPL per gender, age, type of reconstruction, remaining arytenoids and post-operative radiotherapy

Patient ID	Gender	Age	Reconstruction type	Remaining arytenoids	Radiotherapy
1	Male	44	CHEP	Right	No
2	Male	44	CHEP	Left	No
3	Male	61	CHEP	Both	No
4	Male	65	CHEP	Left	No
5	Female	54	CHEP	Both	Yes
6	Female	37	CHEP	Right	No

Note: CHEP = Cricohyoidoepiglottopexy

tions were performed to analyze the samples collected before and after the hands-over-mouth exercise, as described below.

Auditory-perceptual evaluation of voice

Three experienced speech-language pathologists evaluated pairs of voice samples (before and after exercising), randomly selected. The GRBASI scores were attributed by consensus. The GRBASI[15] is an evaluation scale and the acronym for six parameters: grade of dysphonia (G), roughness (R), breathiness (B), asthenia (A), strain (S), and instability (I), to which the evaluators attribute a score: absent – 0, mild – 1, moderate – 2, and intense – 3.

Configuration of the laryngeal remaining structures

Three experienced health professionals – two speech-language pathologists and a head and neck surgeon – evaluated the nasolaryngoscopic DVD records, in pairs, randomly selected, following the same method we applied to grade the voice samples. The following parameters were also graded by consensus:

- Pattern of constriction of the laryngeal remaining structures during phonation: anteroposterior, median, or circular. We considered an anteroposterior constriction pattern whenever the most evident movement was the approximation of the epiglottis or the base of the tongue to the remaining(s) arytenoid(s); median constriction was defined whenever the predominant movement was the displacement of the supraglottic remaining structures towards the median sagittal plan; and circular constriction was attributed whenever a balanced displacement of the remaining structures was observed towards the center of the airway tract.
- Degree of approximation of the remaining laryngeal structures: same, higher, or lower.
- Vibratory amplitude of the mucosa and reconstruction tissues of the remaining structures: same, greater, or smaller.

With the scores attributed to the images and sounds, we sorted the pairs of data (before and after the two-minute exercising task) and analyzed the results. Descriptive statistics is presented but no significance test was used due to small number of subjects in our sample.

RESULTS

Table 1 displays the results obtained from the auditory-perceptual analysis, and Chart 2 shows the results from the laryngeal configuration study.

Figures 1, 2 and 3 show images obtained from patient 3 while inhaling, during sustained phonation before exercising, and immediately after the two-minutes exercising, during the same task. In the images obtained after the hand-over-mouth exercise we observed a greater approximation of the laryngeal remaining structures and the lateral pharyngeal walls as well. Moreover the images were blurrier, due to the greater vibratory amplitude of mucosal and reconstruction tissues.

DISCUSSION

There is a complete modification of laryngeal configuration as a result from a SCPL: in the absence of the vocal folds, the remaining structures and the mucosal cover become the new sound source for phonation[2,3,5,6]. Thus, there is contact between the remaining arytenoid with the epiglottis (after CHEP reconstruction) or with the base o the tongue (after CHP). In order to promote the approximation of the remaining structures and induce supraglottic phonation, laryngeal adduction exercises are selected to the rehabilitation treatment[10]. However, we

Table 1. GRBASI auditory-perceptual evaluation of supraglottic voices pre and post the two-minute hands-over-mouth exercise

Patients	GRBASI scale											
	G		R		B		A		S		I	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	3	3	3	3	1	0	0	0	1	0	0	0
2	2	2	2	2	0	0	0	0	1	1	0	0
3	3	3	3	3	2	1	0	0	3	1	0	0
4	2	2	2	2	2	2	0	0	0	0	0	0
5	3	2	3	2	2	1	0	0	0	0	0	0
6	2	2	2	2	0	0	0	0	0	0	0	0

Chart 2. Approximation of the laryngeal structures, vibratory amplitude and constriction of the remaining phonatory structures before and after the two-minute hands-over-mouth exercise

Patients	Approximation of structures	Vibratory amplitude	Constriction of the remaining phonatory structures	
			Before	After
1	Same	Greater	Median	Median
2	Greater	Greater	Circular	Circular
3	Greater	Greater	Anteroposterior	Circular
4	Same	Greater	Anteroposterior	Anteroposterior
5	Same	Greater	Anteroposterior	Anteroposterior
6	Same	Same	Circular	Circular

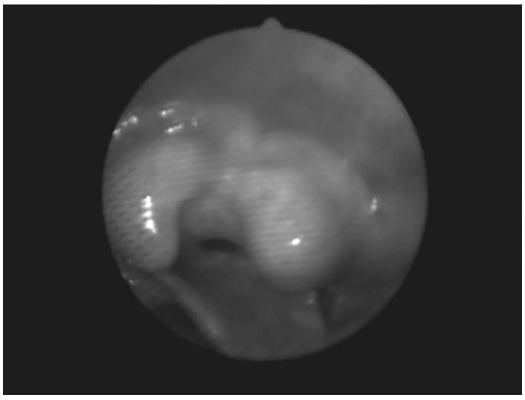

Figure 1. Laryngeal image at rest

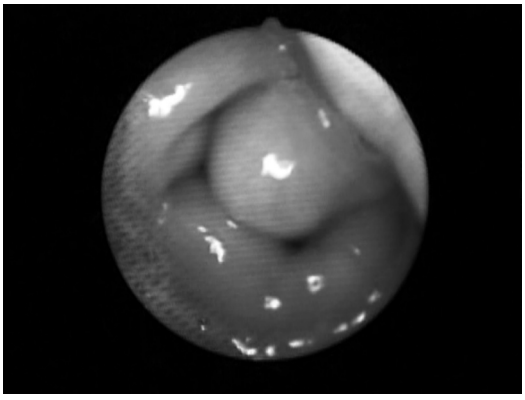

Figure 2. Laryngeal image during phonation, before exercise

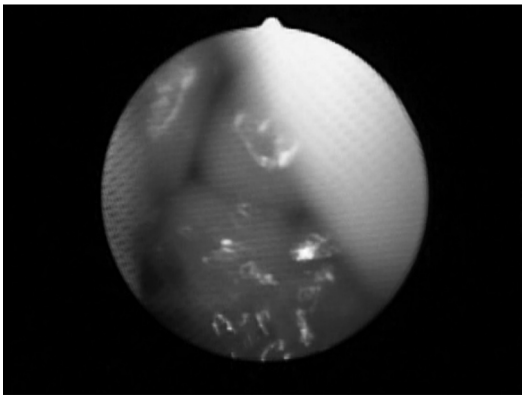

Figure 3. Laryngeal image during phonation, after exercise

have noticed that, besides the rough quality of the supraglottic voice, breathiness and strain are also present and patients usually complain of tiredness due to the effortful speak. How then, to improve the vibration of such structures and provide more vocal resistance? What effectively occurs in the larynx after performing some vocal rehabilitation exercises?

The hands-over-mouth exercise is one of the exercises performed with half-occluded vocal tract. There is a greater approximation and elongation of the vocal folds as a result of training, increasing glottic resistance to the pulmonary airway pressure and ultimately reducing the signs and symptoms of vocal fatigue[12]. Our first hypothesis in this study was that hands-over-mouth exercise would improve the supraglottic vocal quality of our patients, since, in the absence of the vocal folds, the other remaining structure along the upper airway would get close together. However, our findings show that only in two patients occurred greater approximation of the remaining laryngeal structures, and in the other four, no difference was observed. However, the vibratory amplitude increased in five of our patients (Chart 2 and Figure 3). This finding is consistent with the literature, suggesting improvement in the vibratory amplitude as a benefit from this technique[9]. To patients with a normal larynx, a partial occlusion in the front of the vocal tract increases the supraglottal and intraglottal pressures, leading to a strong interaction of the vocal folds, increasing glottic vibration[12]. Probably the same happens in the supraglottic region (which becomes the vocal sound source in this kind of laryngectomized patients) and with the pharyngeal region (immediately superior to it), thus increasing the vibration of the remaining structures.

In this study, we could observe improvement in one case, with regards to the general degree of dysphonia, also in one case, in what concerns roughness; in three cases there was improvement in breathiness and in two cases, improvement in what concerns tension (Table 1). Instability was not observed in any of our patients, probably because unstable supraglottic phonation was an exclusion criterion. It is likely that the reduction of breathiness is associated to the increasing of the vibratory amplitude of the remaining structures, causing a stronger contact, reducing the audible air escape that caused breathiness. In what concerns vocal strain, it is possible that the phonation effort was reduced due to the same reason. This was observed in three patients (Table 1)

In this study, we chose to set two minutes for the patient to perform the exercise, as to reproduce the method of a previously published article[11]. However, in another studies involving tongue vibration technique, authors report best results after three minutes exercising[13]. It is possible that more benefits could be achieved if the technique were performed during a longer period of time.

It would be interesting to go further with this study: to evaluate the time factor, and to compare it with other exercises that require a partial occlusion of the vocal tract, since effects may vary depending on the different resistance degree offered by the specific exercises. A previous study[14] compared the effects of two exercises of half-occluded vocal tract (finger kazoo and phonation with a plastic straw) in subjects without vocal complaints and reported positive results only with the latter technique. The small number of patients did not allow for a detailed statistic analysis. More concrete results could possibly be achieved with a larger sample.

Results from this pilot study shows that it is possible to perform a therapeutic test with the firming glottic technique. This exercise may contribute to increase the vibratory amplitude of the remaining structures after SCPL, thus reducing breathiness and tension during supraglottic phonation.

FINAL COMMENTS

The hands-over-mouth exercise can be used as an option to increase the vibratory amplitude of the remaining structures in patients submitted to SCPL.

RESUMO

A laringectomia parcial horizontal supracricoidea é indicada para o tratamento do câncer da laringe que não invade a subglote e preserva ao menos uma das aritenoides. Esta cirurgia possibilita a manutenção das funções respiratória e esfinctérica da laringe e permite a fonação com característica predominantemente rugosa. O trabalho fonoaudiológico visa promover a aproximação das estruturas remanescentes para reabilitar a deglutição e fonação do paciente. A técnica de firmeza glótica é um exercício indicado para melhorar a coaptação das pregas vocais, sendo realizado por meio da oclusão quase total da boca com a mão em concha, durante a emissão de fricativo sonoro sustentado. Para compreender como esta técnica atua nas estruturas supraglóticas, foi avaliada a configuração laríngea e a qualidade vocal de pacientes submetidos à laringectomia supracricoide, com voz supraglótica estável, após dois minutos de realização da técnica de firmeza glótica. Foram avaliados seis pacientes, com gravação das amostras de voz em programa computadorizado e nasolaringofibroscopia, antes e após dois minutos de realização da técnica. Para a avaliação perceptivo-auditiva das vozes foi utilizada a escala GRBASI. O tipo de constrição da laringe remanescente, grau de aproximação e amplitude de vibração das estruturas foram avaliados nos exames de nasolaringofibroscopia. Houve aumento da amplitude de vibração das estruturas remanescentes em cinco pacientes, redução da soprosidade em três e da tensão vocal em dois pacientes. Neste estudo inicial com seis indivíduos, observamos que a técnica de firmeza glótica pode ser utilizada como exercício complementar para melhorar a qualidade vocal supraglótica e ampliar a vibração das estruturas remanescentes.

Descritores: Laringectomia; Laringectomia supracricoide; Voz; Qualidade da voz; Treinamento da voz

REFERENCES

1. Mayer EH, Reider W. Technique de laringectomie permettant de conserver la permeabilité repiratoire (la crico-hyoido-pexie). Ann Otolaryngol. 1959;76:677-81.
2. Karasalihoglu AR, Yagiz R, Tas A, Uzun C, Adali MK, Koten M. Supracricoid partial laryngectomy with cricohyoidopexy and cricohyoidoepiglottopexy: functional and oncological results. J Laryngol Otol. 2004;118(9):671-5.
3. Allicandri-Ciufelli M, Piccinini A, Bergamini G, Ruberto M, Ghidini A, Marchioni D, et al. Atypical neoglottis after supracricoid laryngectomy: a morphological and functional analysis. Eur Arch Otorhinolaryngol. 2011;268(7):1029-34.
4. Gonçalves AJ, Bertelli AA, Malavasi TR, Kikuchi W, Rodrigues AN, Menezes MB. Results after supracricoid horizontal partial laryngectomy. Auris Nasus Larynx. 2010;37(1):84-8.
5. Chawla S, Carney AS. Organ preservation surgery for laryngeal cancer. Head Neck Oncol. 2009;1:12.
6. So IK, Yun YS, Baek CH, Jeong HS, Son YI. Speech outcome of supracricoid partial laryngectomy: comparison with total laryngectomy and anatomic considerations. Otolaryngol Head Neck Surg. 2009;141(6):770-5.
7. Hayashi S, Hirose H, Tayama N, Imagawa H, Nakayama M, Seino Y, et al. High-speed digital imaging laryngoscopy of the neoglottis following supracricoid laryngectomy with cricohyoidoepiglottopexy. J Laryngol Otol. 2010;124(11):1234-8.
8. Portas JG, Queija D dos S, Arine LP, Ferreira AS, Dedivitis RA, Lehn CN. Voice and swallowing disorders: functional results and quality of life following supracricoid laryngectomy with cricohyoidoepiglottopexy. Ear Nose Throat J. 2009;88(10):E23-30.
9. Behlau M, Gielow I, Gonçalves MI, Brasil O. Disfonias por câncer de cabeça e pescoço. In: Behlau M. Voz: o livro do especialista. vol. 2. Rio de Janeiro: Revinter; 2005. p. 213-85.
10. Angelis-Carrara E de, Barros AP. Reabilitação fonoaudiológica nas laringectomias parciais. In: Angelis-Carrara E de, Fúria CL, Mourão LF, Kowalski LP. A atuação da fonoaudiologia no câncer de cabeça e pescoço. São Paulo: Lovise; 2000. p. 221-5.
11. Serrano DM, Suehara AB, Fouquet ML, Gonçalves AJ. Uso do som crepitante grave (modelo *vocal fry*) na laringectomias parciais verticais. Rev Disturb Comun. 2005;17(1):19-25.
12. 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.
13. Menezes MH, Duprat AC, Costa HO. Vocal and laryngeal effects of voiced tongue vibration technique according to performance time. J Voice. 2005;19(1):61-70.
14. Sampaio M; Oliveira G; Behlau M. Investigation of the immediate effects of two semi-occluded vocal tract exercises. Pró-Fono. 2008;20(4):261-6.
15. Hirano M, Bless DM. Exame videoestroboscópico da laringe. Porto Alegre: Artes Médicas; 1993.