Case Report

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Intensive short-term therapy with phonation into a glass tube immersed in water: male case studies

Terapia breve intensiva com fonação em tubo de vidro imerso em água: estudo de casos masculinos

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ABSTRACT

This is a case study of three men aged 25, 39, and 40 years old, evaluated before and after ten consecutive phonation sessions into a glass tube immersed in water. The objective of this study was to describe the vocal results of intensive short-term therapy with phonation into a glass tube immerse in water in three men without laryngeal disorders and vocal complaints. In two subjects, most glottic source measurements improved, but without becoming normal. In all three subjects, most sound pressure measurements increased above normal; most of the maximum phonation times have increased, but without becoming normal; the difference between vowel average and number count remained outside the normal range; the results of s/z and ė/e ratios remained or entered the normal range. The results of the self-assessment questionnaires (Voice Activity and Participation Profile, Vocal Tract Discomfort Scale, and Talkativeness and Vocal Loudness Self-Assessment Scale) showed that the scores remained or little changed after therapy. All subjects showed pre-contemplation, first stage, on the URICA-Voice Scale. In the three men, after intensive short-term therapy with phonation into a glass tube immerse in water, there was a slight improvement in most vocal measures, but they still remained altered and, on the URICA-Voice scale, the group was classified as Pre-Contemplation.

Keywords: Acoustics; Phonation; Speech therapy; Voice quality; Voice

RESUMO

Trata-se de um estudo de casos de três homens com 25, 39 e 40 anos de idade, avaliados antes e após dez sessões consecutivas de fonação em tubo de vidro imerso em água. O objetivo foi descrever os resultados vocais da terapia breve intensiva com fonação em tubo de vidro imerso em água, em três homens sem afecções laríngeas e com queixas vocais. Em dois sujeitos, a maioria das medidas de fonte glótica melhorou, mas sem entrar na normalidade. Nos três sujeitos, a maioria das medidas de pressão sonora aumentou acima da normalidade; a maioria dos tempos máximos de fonação aumentou, mas sem entrar na normalidade; a diferença entre a média das vogais e a contagem de números permaneceu fora da normalidade; os resultados das relações s/z e ė/e permaneceram ou entraram na normalidade. Os resultados dos questionários de autoavaliação (Perfil de Participação em Atividades Vocais, Escala de Desconforto do Trato Vocal e Autoavaliação do Grau de Quantidade de Fala e Volume de Voz) mostraram que os escores se mantiveram ou pouco mudaram após a terapia. Todos os sujeitos mostraram Pré-contemplação, primeiro estágio, na Escala URICA-Voz. Nos três homens, após terapia breve intensiva com fonação em tubo de vidro imerso em água, houve discreta melhora na maioria das medidas vocais, mas ainda permaneceram alteradas e, na escala URICA-Voz, o grupo se classificou em Pré-Contemplação.

Palavras-chave: Acústica; Fonação; Fonoterapia; Qualidade da voz; Voz

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INTRODUCTION

Intensive Short-Term voice Therapy (IVT) is a short-term treatment that involves sessions with simultaneous therapeutic approaches, rigorous practice, overload, learning of new vocal behaviors, and greater transfer of learned skills. Daily IVT sessions may vary from three to seven hours per day, usually using more than one vocal technique, often one to four times a week, and the total treatment time may last three to four weeks[1-4].

Among the therapeutic options, there are the Semi-occluded Vocal Tract Exercises (SOVTE), which are performed with some occlusion in the vocal tract. These exercises are responsible for modifying the acoustic impedance of the vocal filter, increasing the interaction between source and filter. Partial occlusion of the vocal tract generates retroflex sound energy, which promotes the distortion of the vocal folds during vibration, reducing the risk of trauma and balancing the subglottic and supraglottic pressures, providing economy and vocal efficiency[2-4].

SOVTE are those such as phonation into a glass tube immerse in water (PGTIW), straw phonation, nasal sounds, cupped hands/glottal firmness, sound fricatives, *finger kazoo,* rounded vowels, *lessac y-buzz*, lip constriction, sounds vibrating, extended /b/, among others[2-4].

PGTIW has been used in Finland since the 1960s. It is a technique in which the tube is kept in the subject's mouth, acting as an artificial extension of the vocal tract. It can be performed with the tube immersed into different water depths, according to the vocal or laryngeal problem presented by the patient, and the greater the depth, the greater the pressure exerted and the resistance to emission[1,2,4,5].

PGTIW can be considered a consistent technique that has many benefits to the voice. There is an improvement in vocal self-perception and intrinsic laryngeal muscle mobility, decreasing the hyperfunctional phonatory pattern, improving the respiratory level, promoting the increase of the number of harmonics and the sound pressure level (SPL)[1-4].

Men present peculiar acoustic vocal aspects resulting from anatomical and physiological characteristics, such as the position and size of the larynx and vocal tract, as well as the length and width of the vocal folds[2]. However, only two studies on speech therapy with PGTIW were found in men[2,5].

For this reason, this study of male cases aimed to describe the vocal outcomes of IVT with PGTIW in three men without laryngeal disorders (LD) and with vocal complaints, with the purpose of contributing to the literature and the clinical practice of speech therapy in further treatments that will use these resources with this and other populations.

CLINICAL CASE PRESENTATION

Case study based on a larger research database, previously approved by the Ethics Committee on Research with Human Beings of the Federal University of Santa Maria - UFSM (number 35265814.8.0000.5346)[4]. Social networks contact with schools, universities, and commercial establishments were used for the dissemination of the study and recruitment of participants. The subjects received clarifications about their participation in the research and signed the Free and Informed Consent Form (FICF), as recommended by Resolution 466 of the National Research Ethics Commission - CONEP/2012.

To select the subjects at the time of the assessments and treatment, the following inclusion criteria were adopted: signature of the free and informed consent form; gender/male gender; presence in 75% or more of therapeutic sessions; adult age group (19-44 years old - DeCS- Health Sciences Descriptors), in order to exclude hormonal dysfunctions and structural changes arising from puberty and presbilarynx; presence of vocal complaints and otorhinolaryngologic diagnosis of normal larynx[2-4,6,7].

The exclusion criteria adopted were: records with incomplete data; history of diagnosed neurological, psychiatric, endocrinological, gastric or respiratory diseases; respiratory infections and allergies on the day of the assessments; have performed head and neck surgery and/or laryngeal surgery; present any disease that could make it impossible to perform the technique; have performed speech therapy prior to PGTIW; be a singer; present hearing loss; report of habits of alcoholism and smoking, which are aggressive agents to the larynx and may generate LD; being or have been under speech-related speech therapy and/or otorhinolaryngologic treatment and having a diagnosis of LD[2,3,6,7].

At the time of the assessment, participants answered a questionnaire about identification data, vocal habits, health history, information about previous treatments and singing practice, and they performed pure tone audiometry screening at frequencies ranging from 500 to 4000 Hz at 25 dB, by airway, with a *Fonix*® audiometer (*FA* 12 *Digital*, *Frye Electronics*, United States), considering thresholds greater than 25 dB as suggestive of hearing loss. They also performed an otorhinolaryngological medical assessment[2,4,7].

Thus, out of a total of six, three men who met the inclusion and exclusion criteria were selected. Three subjects were excluded due to presenting incomplete data.

The subjects' data regarding age, profession, and vocal complaints were respectively: S1 (subject 1), 39 years old, photographer, vocal fatigue complaint; S2 (subject 2), 25 years old, college student, hoarseness complaint, and S3 (subject 3), 40 years old, agricultural technology coordinator, hoarseness and vocal fatigue complaint.

Measurements of maximum phonation times (MPT), sound pressure levels (SPL), dynamic extension, as well as data related to acoustic vocal analysis and self-assessment protocols were collected. All assessments were performed on the day before the first day of therapy and reassessments on the same day after the tenth and last IVT session with PGTIW, and participants were advised not to perform any other vocal exercises during this period.

The MPT /a/, /i/, /u/, /s/, /z/, /e/ and number counting were collected in a quiet room, with environmental noise below 50 dB SPL (measured with SPL *Icel meter*, DL-4200), under the guidance that subjects took deep inspiration and then sustained each phoneme at normal *pitch* and loudness, without using expiratory reserve[4], to prevent a possible increase in muscle tension. The sustained emission of MPT /ė/ (voiceless /e/)[8] was also collected. Each MPT was collected three times with a *Vollo*® stopwatch (*Stopwatch* model VL512), and the highest value of each was considered.

For MPTs, the male normality pattern was used between 25 and 35 seconds for the vowels /a/, /i/ and /u/, 15 to 25 seconds for /z/ and /s/[9] and the interval between 16 to 18 seconds for /e/ and /ė/[8]. In the counting of numbers, the normality pattern considered was 1 to 3 seconds higher than the average of the

vowels /a, i, u/, considering a difference greater than 4 seconds indicative of phonation hyperfunction[9].

For voiced phonemes, values below the normal range were considered as probable air escape during phonation and, above, as a possible presence of glottic hyperfunction[8,9]. For the non-voiced ones, the reduced values were considered as suggestive of lack of expiratory control and the increased values as such as airflow control better than expected[8].

Modal SPL was obtained through the emission of the vowel /a:/, with SPL meter (*Icel*®, DL-4200, Brazil), positioned 90º in front of the subject's mouth and 30 cm away[2,4,9]. As normality pattern for modal SPL, the value of 64 dB[9] was used. Still, with the SPL meter, the weakest and strongest possible emission of /a:/ was requested, composing the dynamic extension of the subject. Normality for men is low emission at 54 dB and strong at 76 dB[9].

A professional digital recorder (*Zoom*®, H4n, United States), set at 96 kHz, 16 bits, 50% of the input signal pickup level was used. A *Behringer*® microphone (ECM 8000, Germany) has been coupled, with an ultra-linear frequency response between 15 and 20 kHz and a sensitivity of 70 dB. The microphone was positioned at an angle of 90º in front of the subject's mouth, 4 cm away from the mouth for emission of the sustained vowel /a/[2,3,7,9].

Acoustic analysis of the vowel /a:/, edited without the vocal attack and the end of the emission, was performed to avoid more unstable parts of the signal through *Kay Pentax*® *Multi-Dimensional Voice Program Advanced* (MDVPA) (United States), with 44 kHz pickup rate and *16-bit* analog-to-digital conversion. The default time for the analysis window was 4 seconds[2,4].

Several measures were interpreted together, according to the acoustic phenomenon to which they were related. Frequency measurements were taken: fundamental frequency (f0), maximum f0 (fhi), minimum f0 (flo), standard deviation of f0 (STD); frequency disturbance measures: absolute *jitter* (*Jita*), percentage or relative *jitter* (*Jitt*), f0 perturbation mean (RAP), f0 perturbation quotient (PPQ), smoothed f0 perturbation quotient (sPPQ), f0 variation (vf0); amplitude perturbation measures: absolute or dB *shimmer* (ShdB), percentage or relative *shimmer* (*Shim)*, amplitude perturbation quotient (APQ), smoothed amplitude perturbation quotient (sAPQ), amplitude variation (vAm); noise measurements: noise-harmonic ratio (NHR), vocal turbulence index (VTI), smooth phonation index (SPI); voice break measures: degree of vocal breaks (DVB), number of vocal breaks (NVB); measures of unvoiced segments: number of unvoiced segments (NUV), degree of unvoiced segments (DUV); subharmonic segment measurements: degree of subharmonic components (DSH), number of subharmonic segments (NSH). Thus, it was possible to analyze the aperiodicity/noise levels, harmonic energy, frequency, and stability of the vocal signal. The f0 was considered as the reference pattern of 80 to 150 Hz for males and, for the other measures, the normal range proposed by the MDVPA[2,4,8,9] was considered.

Four self-assessment protocols were also applied, as follows:

- Vocal Activity and Participation Profile (VAPP), which analyzes how much a voice problem restricts and limits social and professional vocal activities and vocal treatment outcomes. It consists of 28 questions (total score of 280 points), divided into five aspects: self-perception of vocal problem intensity (10 points), effects at work (40 points), effects on daily communication (120 points), effects on social communication. (40 points), effects on emotion (70 points). The VAPP has two additional scores (100 points each): activity limitation score (ALS), obtained by summing the total of even-numbered questions of work, daily communication, and social communication, and participation restriction score (PRS) that one obtains by summing the total of odd-numbered questions of these same aspects. In this assessment, it was considered as a normality criterion that the higher the total score of the subject, the greater the limitation in vocal activities and the greater his restriction of participating in activities involving the voice use[4,10]. As there are no reference values for normality, the subjects were compared before and after therapy. Decreasing the score values indicates good results;
- Vocal Tract Discomfort Scale (VTDS), which aims to assess the frequency and intensity of sensation and/or symptoms on a scale of 0 (never/none) to 6 (always/extreme), total common of eight symptoms of vocal tract discomfort. The normality for this protocol is that there is no discomfort. The results of the subjects were compared before and after therapy;
- URICA Scale - Voice, which aims to map the self-perceived adherence stages by patients, demonstrating readiness for treatment. The scale is composed of 32 items, divided into four stages of adherence, and the questions and scores for each of these stages, respectively: Pre-contemplation (PC)-questions1, 5, 1, 13, 23, 26, 29, and 31 (up to 8 points); Contemplation (C) - questions 2, 4, 8, 12, 15, 19, 21, and 24(8 to 11 points); Action (A) - Questions 3, 7, 10, 14, 17, 20, 25, and 30 (11 to 14 points) and Maintenance (M) - Questions 6, 9, 16, 18, 22, 27, 28, and 32(from 15 points). Possibilities for answers are presented in 5-point Likert Scale, where the subject can choose one of the following answers: "I strongly disagree," "I disagree," "I do not know," "I agree," and "I strongly agree." After applying this questionnaire, the simple average of each stage is performed, and the formula (average C + average A + average M) - average CP to obtain the readiness for change score[11]. The adherence stages obtained through the above-mentioned calculation are interpreted as follows: PC and C are the stages in which the subjects have not yet assumed a coping attitude towards the vocal problem. In stage A, the subject is considered to act towards doing something to change voice-related behaviors. Stage M is characterized by the existence of all efforts of the subject to prevent the return to previous patterns and consolidate gains, usually maintaining behaviors favorable to vocal health[11];
- Talkativeness and Vocal Loudness Self-Assessment Scale (TVLSAS), divided by the degree of talkativeness and containing three levels: 1 to 3 (quiet, non-talkative person), 4 to 6 (moderately talkative person), and 7 (extremely talkative person). Regarding the loudness, the levels are: 1 to 3 (very low-pitched person), 4 to 6 (medium-low-pitched person), and 7 (very high-pitched person). When interpreting the results, it is considered appropriate, as stated in the protocol itself, if the response obtained is 4 for talkativeness

and loudness (no vocal efforts). For answers below 4, introspection and lower risk of developing vocal problems are suggested. Grades 6 and 7 suggest that communication is a very present aspect in the subject's life and that there is a potential risk of developing voice problems.

Participants held a total of ten consecutive IVT sessions for two weeks, except Saturdays and Sundays. Each session took place once a day, with an average duration of 50 minutes, exclusively using the PGTIW technique (the duration of each session varied between each subject since the technique was performed in each one's MPT), at previously agreed times, according to the availability of each patient. During this period, the subject performed six sets of 15 PGTIW repetitions with a 1-minute passive rest interval (absolute silence) between each series, in a IVT format[2,4,6,12].

Different therapists performed the therapy and each one of them attended the same subject, at most, five times, in order to minimize the possible influence on the research results. The training was conducted with all therapists, in which they received necessary information regarding the therapy and all assessment and reassessment procedures performed. They received these printed guidelines, and they were asked to practice the procedures before, with each other[4].

For PGTIW, we used a 27 cm long, 1 mm thick, and 9 mm diameter glass tube was used and a 12 cm wide, 12 cm deep, 15 cm long container with water up to 9 cm. A holder was attached to the container to fix the tube, keeping the distal end submerged at 2 cm from the surface, with a marked measure on the tube (depth used for cases of hypertension or vocal improvement, because the greater the depth, the greater the sound resistance in the tube) and 45° immersion angle of the tube into water. Thus, the 45º angle between the tube and the chin could be kept the same for the three participants, who remained seated with their feet flat on the floor and the spine erect[2,4].

For PGTIW emission, it was instructed that inspiration was performed and a sonorous breath was made inside the tube, with the phoneme /u/ in usual *pitch* and *loudness* and MPT, involving the proximal end of the tube with the lips. Each sonorous expiration in the tube was considered a repeat of PGTIW. Participants were able to drink non-sparkling water at room temperature during the passive rest period[1,2,4,5,12].

Data from the three subjects were descriptively calculated, allocated in three tables and compared with normality and between pre and post-IVT moments with PGTIW.

In the results of MDVPA acoustic vocal measurements before and after IVT with PGTIW, it was found that measurements improved slightly after therapy, but they were still above normal (Table 1).

Table 1. Results Acoustic Analysis Vocal Glottic Source

Acoustic Analysis Vocal Glottic Source (MDVPA)										
	S1			S2			S3			NI
	Pre	After	Dif.	Pre	After	Dif.	Pre	After	Dif.	
f0 (Hz)	109.633	111.784	2.151	146.445	143.820	-2.625	129.484	165.164	35.68	80-150
fhi (Hz)	111.718	126.620	14.902	180.006	162.097	-17.909	177.146	174.946	-2.2	0-150.080
flo (Hz)	107.908	107.340	-0.568	122.740	131.072	8.332	66.929	129.946	63.017	0-140.418
STD (Hz)	0.630	1.531	2.161	7.133	1.980	-5.153	43.444	2.758	-456.93	0-1.349
Jita (us)	29.895	52.377	22.482	287.323	85.707	-201.616	459.688	94.449	-365.239	0-83.200
Jitt (%)	0.328	0.585	0.257	4.198	1.232	-2.966	5.493	1.560	-3.933	0-1.040
RAP (%)	0.188	0.337	0.149	2.513	0.741	-1.894	3.357	0.974	-2.383	0-0.680
PPQ (%)	0.202	0.342	0.14	2.635	0.754	-1.881	3.273	0.838	-2.435	0-0.840
sPPQ (%)	0.415	0.644	0.229	2.743	0.783	-1.96	9.380	0.932	-8.448	0-1.020
vf0 (%)	0.575	1.370	0.795	4.871	1.377	-3.494	33.551	1.670	-31.881	0-1.100
ShdB (dB)	0.254	0.343	0.089	0.901	0.519	-0.382	0.694	0.342	-0.352	0-0.350
Shim (%)	2.893	3.882	0.989	10.334	5.928	-4.406	7.649	3.867	-3.782	0-3.810
APQ (%)	2.392	2.995	0.603	7.649	4.318	-3.331	5.087	2.608	-2.479	0-3.070
sAPQ (%)	5.403	4.551	-0.852	8.573	6.082	-2.491	7.088	3.496	-3.592	0-4.230
vAm (%)	8.800	19.485	10.685	11.363	15.710	4.347	24.818	15.573	-9.245	0-8.200
NHR (%)	0.136	0.134	-0.002	0.203	0.110	-0.093	0.209	0.173	-0.036	0-0.190
VTI	0.042	0.042	0.000	0.050	0.028	-0.022	0.054	0.031	-0.023	0-0.061
SPI	25.171	24.644	-0.527	13.211	13.518	0.307	12.500	18.641	6.141	0-14.120
DVB (%)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0-1.000
DSH (%)	0.000	0.000	0.000	2.222	0.000	-2.222	14.375	0.889	-13.486	0-1.000
DUV (%)	0.000	0.827	0.827	32.836	0.000	-32.836	19.598	0.662	-18.936	0-1.000
NVB (%)	0	0	0	0	0	0	0	0	0	0-0.900
NSH (%)	0	0	0	2	0	-2	23	4	-19	0-0.900
NUV (%)	0	7	7	44	0	-44	39	3	-36	0-0.900

Subtitle: Pre = pre-Intensive short-term therapy with phonation into a glass tube immersed in water; After = After- Intensive short-term therapy with phonation into a glass tube immersed in water; f0 =fundamental frequency (Hz); fhi = f0high(Hz); flo = f0 low(Hz); STD =standard deviation of f0 (Hz); Jita =absolute jitter(us); Jitt = jitter percent(%); RAP = relative average perturbation (%); PPQ =pith perturbation quotient f0 (%); sPPQ =smoothed pitch perturbation quotient(%); vf0 =f0 variation (%); ShdB = absolute or dB *shimmer* dB (dB); Shim = percentage or relative *shimmer* (%); APQ =amplitude perturbation quotient (%); sAPQ =smoothed amplitude perturbation quotient (%); vAm =peak-to-peak amplitude variation (%); NHR = noise to harmonic ratio(%); VTI =voice turbulence index; SPI = soft phonation index; DVB =degree of vocal breaks (%); DSH =degree of sub-harmonic components (%); DUV = degree of unvoiced segments(%); NVB =number of voice breaks (%); NSH = number of sub-harmonic segments (%); NUV =number of unvoiced segments (%); S = subject; dB = decibel; Dif. = difference; Nl= normality

The results of the MPT and SPL measurements before and after IVT with PGTIW showed that most of the MPT increased, but they still remained below normal; the difference between vowel average and number count remained out of the normal range; the results of s/z and ė/e ratios remained or entered the normal range, and most SPL measurements increased above the normal range (Table 2).

In the self-assessment questionnaires, before and after IVT with PGTIW, the results showed that most scores changed little after therapy and the URICA-Voice scale classified the three subjects in the Pre-contemplation stage (Table 3).

Table 2. Maximun phonation times and sound pressure levels

Maximun phonation times and sound pressure levels										
	S1			S2			S3			NI
	Pre	After	Dif.	Pre	After	Dif.	Pre	After	Dif.	
MPT/a/ (s)	21.2	25.3	4.1	7	7.5	0.5	10.1	15.0	4.9	25-35
MPT/i/ (s)	24.3	22.8	-1.5	7.1	8.1	1	13.7	17.4	3.7	25-35
MPT/u/ (s)	25.0	22.9	-2.1	6.7	6.9	0.2	14.0	16.6	2.6	25-35
MPT/s/ (s)	21.1	20.7	-0.4	13.2	13.0	-0.2	11.4	13.4	2.0	15-25
MPT/z/ (s)	19.4	19.7	0.3	10.0	13.5	3.5	13.1	10.2	-2.9	15-25
MPT/e/ (s)	19.4	17.4	-2.0	7.9	8.5	0.7	14.9	12.6	-2.2	16-18
MPT/ė/ (s)	20.7	20.7	-0.0	14.3	14.4	0.1	10.7	14.9	4.1	16-18
Counting of n (s)	24.9	26.8	2.0	13.6	20.1	6.5	13.5	17.9	4.4	-
Average /a.i.u/ (s)	23.5	23.6	0.2	6.9	7.5	0.6	12.6	16.3	3.7	25-35
s/z	1.1	1.0	-0.0	1.3	1.0	-0.4	0.9	1.3	0.5	0.8-1.2
ė/e	1.0	0.8	-0.1	0.5	0.6	0.1	1.4	0.9	-0.5	0.8-1.2
Difference in between average /a.i.u/ and the counting of n (s)	1.4	3.2	1.8	6.7	12.6	5.9	0.9	1.6	0.7	1-3
SPL(dB)	71	69.0	-2	60	71	11	64	76	12	64
SPL Min. (dB)	58	56	-2	53	57	4	54	62	8	54
SPL Max. (dB)	82	94	12	75	79	4	77	84	7	76

Subtitle: Pre = pre-Intensive short-term therapy with phonation into a glass tube immersed in water; After = After- Intensive short-term therapy with phonation into a glass tube immersed in water; S = subject; MPT = Maximun phonation times; s = seconds; SPL = sound pressure levels; Min. =minimum; Max. = maximum; dB = decibel. Dif. = difference; NI= normality; ė = /e/ voiceless

Table 3. Self-assessment Protocols

Self-assessment Protocols										
	S1			S2			S3			NI
	Pre	After	Dif.	Pre	After	Dif.	Pre	After	Dif.	
VAPP										
Total	7	4	-3	11	13	2	182	190	8	-
Vocal problem intensity	1	0	-1	2	1	-1	10	10	0	-
Effects at work	0	0	0	1	1	0	19	19	0	-
Effects on daily communication	0	0	0	4	7	3	64	76	12	-
Effects on social communication	0	0	0	0	0	0	23	22	-1	-
Effects on emotion	6	4	-2	4	4	0	66	63	-3	-
ALS	0	0	0	4	7	3	65	73	8	-
PRS	0	0	0	1	1	0	41	44	3	-
URICA Scale- Voice										
Pre-contemplation	2.5	2.3	-0.2	1.5	1.3	-0.2	1.2	1.3	-1.2	0-8
Contemplation	3.6	3.9	0.3	4.6	3.7	-0.9	3.7	4.3	0.3	8-11
Action	2.9	2.3	-0.6	4.1	4.1	0	3.3	4.1	0.6	11-14
Maintenance	3	2.9	-0.1	2.7	2.4	-0.3	2.3	3.9	1.7	≥15
VTDS										
Frequency	5	5	0	2	2	0	4	10	6	-
Intensity	5	5	0	2	2	0	3	5	2	-
TVLSAS										
Degree of talkativeness	5	5	0	4	3	-1	7	7	0	4
Vocal Loudness	4	5	1	4	4	0	6	6	0	4

Subtitle: Pre = pre-Intensive short-term therapy with phonation into a glass tube immersed in water; After = After- Intensive short-term therapy with phonation into a glass tube immersed in water; S = subject; VAPP = Vocal Activity and Participation Profile; VTDS = Vocal Tract Discomfort Scale; TVLSAS = Talkativeness and Vocal Loudness Self-Assessment scale; ALS =activity limitation score; PRS = participation restriction score; Dif. = difference; NI= normality

DISCUSSION

In this study, most glottic source measurements of S2 and S3 improved slightly after IVT with PGTIW, agreeing with the literature reporting improvement[1,3,4,12,13]. However, these measurements still remained altered when compared with the normal range (Table 1). In a randomized controlled trial using IVT with PGTIW in women with and without LD, an improvement in the acoustic vocal aspects of the glottic source was also found in both groups[4].

Unlike the others, S1 presented most of the acoustic measurements within the normal range before and after therapy, with worsening of those related to vocal signal stability and periodicity: STD, vf0, Shim, vAm and NUV (Table 1). This result partially agrees with those working on straw-phoned SOVTE[6].

Research[5] has verified the effects of LaxVox® tube speech therapy on acoustic parameters in men and women. There was a decrease in *jitter* and increase of f0 with the tube at 5 cm of immersion into water, similar results to those of S2 and S3 for *jitter* measurements, and from S3 to f0. When analyzing the immediate effect of seven SOVTE in men and women[14], a slight increase in f0 was observed, partially agreeing with the results of S3, whose f0 increased considerably and passed to the female range. However, other studies[1,6,12,13] have stated a decrease in f0 after the SOVTE.

The increase in f0 occurs due to the activation of the cricothyroid intrinsic laryngeal muscle, treble tensor[2,6], which helps the adduction and glottal firmness when increasing the pressure, to overcome the vocal tract semi-occlusion during the SOVTE[1,14]. It is important to note this effect in the clinical use of PGTIW in both men and women, as it may not be desired and it may compromise the end result of the treatment.

Research[6] on the immediate effect of the use of plastic straw in the air, in men and women with and without laryngeal injury, found that men with injury reduced f0 and increased *jitter* and *shimmer*; and men without injury increased f0, *jitter*, and *shimmer* after the technique. These results partially resemble those of this study, where S3 increased f0. The results of this research also converge to another investigation[1] about the immediate acoustic effects of resonance tube exercises in subjects of both genders. In the study cited, there was a reduction in *jitter* and *shimmer* values (as occurred with S2 and S3, although still outside the normal range) and increased harmonic-noise ratio, resulting in a more stable voice with less noise.

An investigation[15] conducted with subjects of both genders researched the results of SOVTE and it observed an improvement in vocal quality, with a decrease in roughness, which partially agrees with the results of the acoustic vocal measurements of this study. It is possible that PGTIW has increased the harmonic component of the signal due to changes in vocal fold mobilization, due to the massage effect[3], and the increased contact quotient between them[1], making vibration more periodic.

In this study, most MPT (vowels, fricatives, number counts, and vowel averages) increased after IVT with PGTIW, but they still remained below the normal range, as did the difference between vowel average and number counts. The results of s/z and ė/e, ratios remained or entered normality (Table 2).

A study[13] verified the effects of different types of resonance tube in men and women with and without dysphonia. PGTIW in men showed a decrease in vAm and f0 and increased MPT /s/ and /z/. These results agree with those of this study, regarding the increase of MPT, and disagree, regarding vAm, which presented increase after IVT, with PGTIW in S1 and S2, and f0, which increased in S3.

A study[4] performed with IVT with PGTIW in women with and without LD showed that women without LD showed improvement in MPT /a /, / u /, / z /, / ė /, mean of /a,i,u/, number count and s/z ratio, agreeing with the results found here.

In the same study[4], there was an increase in the difference between vowel average and number counting, although this has been an isolated improvement. This differs from the results of this work in which the difference between the vowel average and the number count remained outside the normal range.

In this case study, most SPL measurements increased above normal (Table 2). Research[7] with another SOVTE (*finger kazoo)* technique in individuals seeking vocal improvement also found an increase in SPL and MPT /a/, after performing the technique. This can be explained by the fact that the SOVTE provide an increase in the degree of adduction between the vocal folds, without increasing stress, which is reflected in the increase in SPL[1].

In this research, the URICA-Voice Scale showed results classified in the PC stage for the three subjects after IVT with PGTIW (Table 3).

A study[11] conducted with dysphonic patients found that after applying the URICA-Voice Scale, most participants were in the C stage (57.6%) and PC (30.3%), with no association of the stages with age, type of dysphonia, education, or the number of speech therapy sessions. This result partially confirms the findings of this research, since, even after IVT with PGTIW, the three subjects did not seem to assume the coping with their vocal complaints, remaining in the PC stage, which may restrict treatment results (Table 3).

The results of the self-assessment questionnaires remained, or little changed (for better or for worse), after IVT with PGTIW, showing that in the three cases evaluated vocal therapy did not promote changes in voice self-perception (Table 3).

The findings of the present study are in contrast to several studies[1-4,6,11,15] that found improvements in self-assessment after treatment with SOVTE.

The participants in this study had no LD, only some vocal complaints, a fact that may justify the low perception of changes in vocal self-assessment, contrary to the literature[1-4,6,11,15]. Another aspect that may have contributed to these results in the self-assessments is the fact that the three subjects are in the PC stage of the URICA-Voice Scale (Table 3), which shows little attitude towards vocal complaints[11] and, possibly, towards post-therapy vocal self-assessment.

The literature[1-7,12-15] showed the immediate effects or after some time of the use of SOVTE. However, it is difficult to discuss the results of PGTIW in men, as there are rare studies with this group, as well as the IVT modality, and no studies on IVT with PGTIW with men.

Analyzing the results together, it was possible to notice that the PGTIW technique, whose sound energy reflected in the water (retroflex resonance) increases the airway pressure[3,6], produced benefits in phonation support and sound pressure, noticed in increased MPT and SPL. The literature states that SOVTE balance subglottic and supraglottic pressures, improving the respiratory level and the degree of vocal fold adduction, with lower collision force between them, providing economy and vocal efficiency[1-4,7]. Still, the SOVTE increase the sound wave sensation in the oral cavity, favoring the control of voice production[6].

All of these aspects may explain the increase in support and sound pressure that occurred in the three subjects studied, as it is possible that PGTIW, like other SOVTE, caused increased glottic resistance, with increased SPL and MPT, without overload or stress to the vocal folds[7,14]. SOVTE reduce the phonation pressure threshold (minimum air pressure to initiate sounding), and they facilitate the onset of phonation and the reach of subglottic pressure, increasing the SPL with low vocal load[14].

It has been reported[7] that *finger kazoo*, a type of SOVTE, influenced pneumo-phono-articulatory coordination and vocal production proprioception, with positive results on SPL and MPT, as occurred in this study.

Also, the PGTIW in S2 and S3 caused glottal improvements in vocal production, evidencing, in the acoustic analysis, the slight reduction of measures related to noise and frequency and amplitude perturbation (although still altered after therapy), resulting in voice with greater stability and periodicity[1-4,12,13]. For PGTIW, the literature has indicated improved mobility of the intrinsic larynx muscles, producing a massage effect on the soft tissues of the larynx and oral cavity, decreasing the hyperfunctional phonation pattern, improving the respiratory level and promoting the increase of harmonic energy[1-4,7,14].

FINAL COMMENTS

In the group of three men, after IVT with PGTIW, there was a slight improvement in most vocal measurements, but they still remained altered. In the URICA-Voice Scale, all subjects were classified in the PC stage, showing lack of coping with vocal complaints, which may have been reflected in the absence of consistent modifications of the other self-assessments.

The small number of subjects may have limited the evidence of all positive effects of PGTIW in the IVT modality presented in the literature through different assessments. However, there were slight positive effects on objective vocal measurements. Thus, further studies with larger samples are suggested.

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