

Efficacy of Doctorvox Voice Therapy Technique for Mutational Falsetto

*I. Ilter Denizoglu, †Mustafa Sahin, *Seda Bayrak, and *M. Nur Uygun, *Izmir, and †Aydin, Turkey

Summary: Objective. This study investigated the efficiency of the DoctorVox Voice Therapy Technique using high back-pressure on mutational falsetto.

Study Design. A total of 21 men with mutational falsetto and 25 age-matched healthy men were included. All patients received DoctorVox voice therapy using the doctorVOX device with high back-pressure. Ear nose and throat examination, videolaryngostroboscopy, and acoustic (SPL, mean F0, first three formants, jitter%, shimmer%, and NHR) and electroglottographic analysis (Closed Quotient and Contact Index) were performed at pretreatment, and at 1 and 6 months after treatment. The VHI-10 and the GRBAS scales were used for perceptual voice evaluation.

Results. Compared with the pretreatment values, the first and sixth month values after treatment demonstrated a significant decrease in VHI-10, GRBAS, F0, F1, F2, F3, Jitt %, Shimm %, NHR, and contact index and a significant increase in closed quotient among MF patients. In the sixth month after treatment, VHI-10, jitt%, and NHR parameters were significantly lower than those of the first month. The first-month data for VHI-10, jitt%, and NHR values was significantly higher than that of the control group, while there was no significant difference between the sixth-month data and that of the control group.

Conclusions. The DoctorVox Voice Therapy Technique is highly effective in mutational falsetto treatment. At the first session, the patients reach a lower fundamental frequency in the chest register; by the 1 month after treatment, they have a normal pitch at speaking. The improvement in perturbation measures may continue for 6 months. Patients should be followed up regularly for at least 6 months after treatment to obtain optimum treatment outcomes.

Key Words: Mutational falsetto—Puberphonia—Voice therapy—DoctorVox voice therapy—LaxVox voice therapy.

INTRODUCTION

In the pubertal period, with the effects of growth and sex hormones, the respiratory, phonation, and resonance parts of the body start to develop, and consequently the intonation and quality of voice alter.¹ At the end of this period, the mean fundamental frequency decreases by almost 1 octave in males and three to five semitones in females, and reaches the adult levels.² As a functional voice disorder Mutational Falsetto (MF) is a vocal register shift that is seen in the pubertal period. It may be defined as an effort to phonate that is similar to phonation in the preadolescent period in adolescent males.¹ Although there is no anatomical or physiological defect, the vocal behavior pattern has not been able to adapt to the new physio-anatomy, and so patients phonate in falsetto register.^{2,3} This results in a high pitched voice which is discordant with the patient's age and gender. In addition to an abnormally high pitched voice, vocal instability, poor voice control, pitch breaks, breathiness, effortful phonation, and talking in a monotonous pitch are other common voice abnormalities resulting from MF.²⁻⁴

A detailed history, ear, nose, and throat physical examination including videolaryngostroboscopy (VLS), and perceptual and acoustic analysis of the voice are required for a diagnosis of MF. In some patients, psychological evaluations may also be required.^{4,5}

In general, patients explain that they feel more relaxed in the falsetto register but that they are aggrieved because their speech does not sound 'right' compared to other people in their age or peer group. Their main complaints include an inability to talk loudly, and being mocked.⁵

MF may also cause psychosocial problems, especially in conservative societies, where it may result in prejudice around sexual identity.⁶ MF is a voice disorder that should be treated because of the effect it has on personal and social cohesion, and integration. Over time, MF can trigger problems such as introversion, social phobia, anger and depression, and these problems can continue into adulthood.⁴⁻⁶

There are two main categories of treatment methods for MF: surgery and voice therapy (VT).^{3,4} The main surgical methods defined in the literature for MF treatment are botulinum toxin type A injection, suprahyoid release, and relaxation thyroplasty, such as modified relaxation Isshiki (type III) thyroplasty.⁷⁻⁹ Surgical methods may be the treatment of choice for recalcitrant MF patients, however some authors strongly oppose the surgical approach.^{10,11}

VT seems to be the primary treatment method for MF. Various voice therapy techniques have been defined: the chewing approach, relaxation exercises, breathing training, coughing, digital manipulation, laryngeal

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From the *Medical Park Health Center, Department of Otolaryngology, Clinical Vocology Unit, Izmir, Turkey; and the †Adnan Menderes University Medical School, Department of Otolaryngology, Aydin, Turkey.

Address correspondence and reprint requests to Mustafa Sahin, Adnan Menderes University Faculty of Medicine, Department of Otorhinolaryngology, Aydin 09100, Turkey. E-mail: iskebaha@gmail.com

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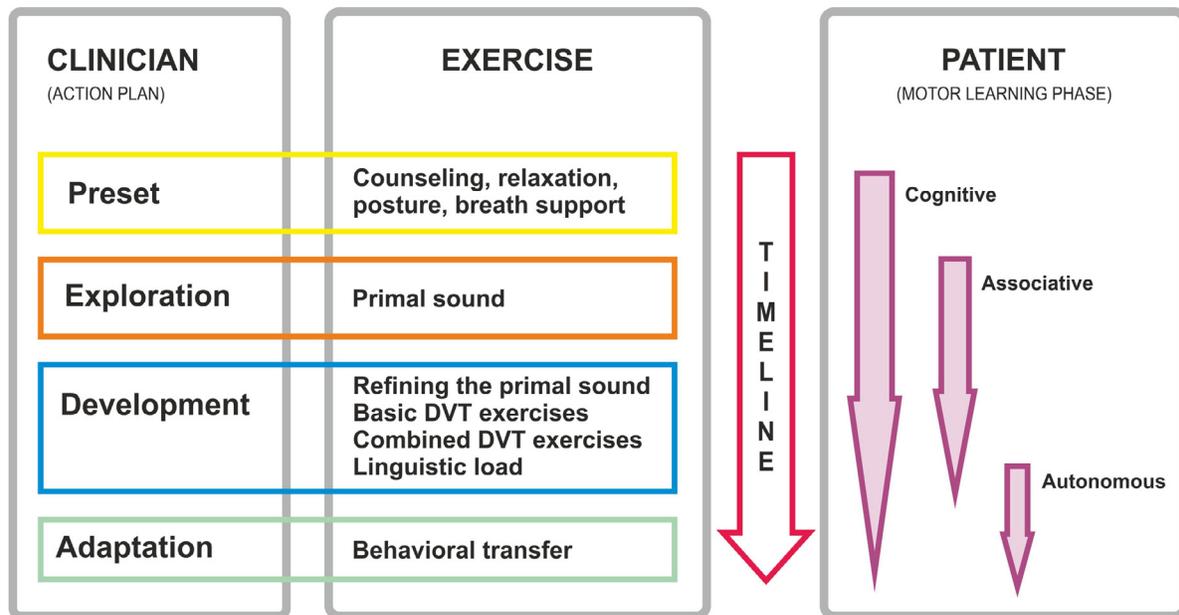


FIGURE 1. Three main factors in the clinical programming of DVT: patient, clinician, and the exercise.

manipulation, half swallow boom, and auditory and visual feedbacks.^{12–15}

One of the most popular VT technique groups for dysphonia are the semiocluded vocal tract exercises (SOVTE). SOVTE aim at improving voice quality and promoting easy phonation, and have been recommended for vocal pathologies such as vocal fatigue, recurrent laryngeal nerve palsy, and nodules.¹⁶ SOVTE were defined to increase vocal tract inertance, enhance vocal economy, and balance activation of the TA and CT muscles. The squared-up vertical edge of the vocal folds is especially important in order to achieve the optimal glottic configuration of the chest register.¹⁷ This may happen through the active contraction of the vocalis segment of the TA muscle, in order to resist the high back-pressure. The use of tubes to extend and constrict the vocal tract was proposed as early as 1899 by Spiess.¹⁸ Phonating into glass tubes with one end submerged in water is known to have started in Finland in the 1950s, by Antti Sovijarvi.¹⁹ The glass tubes were then called resonance tubes. LAX VOX exercises with a silicone tube were first demonstrated by the Finnish voice pathologist Marketta Sihvo.²⁰

These exercises were modified and expanded by Ilter Denizoglu into the DoctorVox Voice Therapy Technique (DVT). The DVT is a new framework providing the clinician with a comprehensive schedule. The DVT program combines different approaches (physical, clinical, and pedagogical), and provides a multidimensional-multilevel approach to voice therapy. The program can be utilized with pedagogical vocalogy, and a similar process can be applied to singing voice therapy. New therapy devices (doctorVOX, pocketVOX, and maskVOX) were also devised for vocal exercises.²¹

DoctorVox Voice Therapy Technique

DVT is a technique which directly changes the vocal mechanism. It is a holistic approach combining phonation,

resonance, and breathing in VT. It is a multi-dimensional, multi-level treatment strategy, and uses an integrative approach for any given voice patient. DVT provides an action plan and the tools to be used; the clinician decides on each step according to the patient's clinical condition (pathology, clinical survey, motor learning state, state of change, motivation, personal capabilities, etc) throughout the treatment process (Figure 1).

Patient monitoring during DVT

The clinician must consider the motor learning level of the patient when developing a new skill, and creating a new vocal behavior instead of the former unhealthy one. The treatment plan ought to be designed for each patient in bespoke fashion. Therapy adherence is a major factor in the treatment of voice disorders. Task orientation, motivation, and attentional focus are important factors for motor learning Schmidt RA, Lee TD. *Motor Control and Learning: A Behavioral Emphasis* (4th ed.). Champaign, IL: Human Kinetics; 2005. In order to gain a motor skill, three phases can be distinguished throughout the whole therapy process, the cognitive, associative, and autonomous phases, as explained below for the DVT process.

Cognitive phase. The first process when starting a new exercise is learning what to do and understanding the goal or purpose. Multichannel biofeedback (visual, kinaesthetic, and auditory) is helpful provided by DVT tools and tasks for processing the new information and for the verification of a given (correct) exercise pattern at home. In the cognitive phase, the duration of the sessions may be 20–40 minutes (even more), and the session rate may be as often as 2–5 times a week. Home exercises are simply given as

1 minute every 1 hour. This would take 15 minutes daily, but the impact is better than that of an exercise performed once a day for an hour.

Associative phase. Exercise is the main tool for motor learning; in the associative stage, a new vocal skill is developed. Starting from the simple (basic tonal exercises) to the complex (combined tonal exercises and linguistic load), a movement program is developed by gathering the pieces together. Less feedback is required during this phase. The duration of the sessions in this phase is between 20 and 30 minutes. The session rate may be once or twice a week. In this phase home exercise is 3–5 minutes 5–7 times a day. This can be arranged according to the patient's daily life.

Autonomous phase. The skill which was gained in the associative stage is to be converted into a behavior. The autonomous stage involves less and less attention from the patient so that they can do other tasks at the same time. Moving from the primal sound through tonal exercises, the patient is supposed to transfer the new vocal pattern to reading a text, singing a song, or holding a conversation. Unless there are serious mistakes, the voice patient has very few feedback requirements during this stage of motor learning. The time between therapy sessions may be more than a week, or a conversation may be held on the phone or through audio–visual internet communication. Homework schedules may differ among subjects.

Clinician's action plan in DVT

DVT has four sequential steps from the clinician's perspective: preset, exploration, development, and adaptation.

Preset. Preset includes counseling, relaxation, posture, and breathing issues. *Counseling* is mainly about the patient's understanding of what to do, how to do it, and why. *Relaxation* is not a slouched state, it involves balance or 'resetting to the factory settings'. Consciously, relaxing the shoulders, neck, and jaw will help greatly. *Posture* is defined in a simple way (high sternum, relaxed shoulders, balanced head, and a dynamic spine) which is known as the *noble posture* in singing pedagogy. *Breathing* instructions have a simple goal: relaxing the secondary breathing muscles and redirecting the effort from upper chest and shoulders to the abdominal–waist region. In this step, blowing into the tube without phonation requires monitoring the breath by controlling (estimation of transglottic air-flow) the bubbling.

Exploration. The gateway to target vocal behavior involves two main elements: maximum vocal economy and safety. This step is dedicated to finding a reflexive voice which is defined as primal sound in vocal pedagogy.²² The primal sound is supposed to be a neutral vowel (schwa), which has no meaning and does not relate to the linguistic brain activities. This vocal pattern can be achieved through probing therapy techniques and directly by DVT exercises.

Development. Once the primal sound is achieved, tonal exercises are started in order to develop and stabilize the target vocal pattern. The first step is to refine the primal sound by establishing a balanced glottal attack and glottal damping, lowering the larynx, and releasing the tension in the supraglottic region. The clinician then chooses among various tonal exercises (Table 1) and prepares an exercise program for each patient according to their needs

TABLE 1.
Vocal Development Exercises in DVT

Refining the Primal Sound	Balancing the Glottal Attack and the Glottal Damping	
	Comfortable vertical laryngeal position (suprahyoid relaxation)	
	Modifying the supraglottic activity	
	Focusing	
Basic exercises	<i>Pitch based exercises</i>	Sostenuto, Glissando, Portamento, Portato, Staccato, Legato
	<i>Loudness based exercises</i>	Stable (Piano, forte)
		Variable (Crescendo, decrescendo)
Combined exercises	<i>Vocal play</i>	Descending glissando
		Monotone staccato
		Descending staccato –glissando
	<i>Messa di Voce</i>	Constant loudness with variant pitch
		Constant pitch with variant loudness
	<i>The corridor exercise</i>	
	<i>Melodies with primal sound (happy birthday song, etc)</i>	
	<i>Linguistic load</i>	From primal sound to meaningful vowels (start with [u], [o] by laxvoxing)
		Melodies with a single vowel (songs which patient knows well)
		Various vowels phonated with the same tone using the <i>maskVOX</i>
		Phonating vowels out without device

and capabilities, and the pathological process. The linguistic load in the DVT process means that the vocal task becomes more complex by adding meaning to the tone. It may be performed with a specially devised oral mask (maskVOX) which provides free articulation through DVT vocal exercises.

Adaptation. The treatment process, in general, is not finished without the behavioral transfer of the new vocal skill. Adapting the new muscle technique (vocal pattern) to daily life starts with taking the tube or mask out and maintaining the same vocal pattern in the syllable-word-sentence-reading-conversation hierarchy. Psychological adaptation is the second major goal of the last phase of DVT practice. The patient may need to be motivated by the clinician, and it is advisable to discuss the new vocal image with the patient, and in the context of their social environment.

Data regarding the role of DVT, which has been used in the treatment of many voice disorders in our clinic for years, in MF treatment is limited. This study, with the main aim of investigating the effectiveness of DVT in MF treatment; is the first to report the treatment outcomes of the DVT method performed with the doctorVOX device using high back-pressure in patients diagnosed with MF.

MATERIALS AND METHODS

This prospective single-blinded clinical study was carried out in the clinical vocology unit of the otorhinolaryngology department at a research and training hospital. It was approved by the research ethics committee of Adnan Menderes University (decision number: 2016/029). The patients, whose voice symptoms had lasted at least 2 years, and were diagnosed with MF, were informed about the disease, available treatment methods and about the study protocol. Consecutive patients admitted to the clinic were enrolled. Written informed consent was obtained from the patients who agreed to be involved in the study. The study was conducted in accordance with the principles of the Declaration of Helsinki. Exclusion criteria included: metabolic, neurological, vascular, or autoimmune diseases, and any severe systemic disorder; a history of any respiratory, neurological, psychiatric, or endocrine diseases; laryngeal surgery, head and neck trauma, radiotherapy to the head and neck region, chemotherapy, voice therapy, or vocal training. Patients with any vocal fold pathologies such as vocal nodules, polyps, or sulcus vocalis, found in the laryngeal examination were excluded from the study.

Twenty-four volunteer patients, fitting the defined criteria, were included in the study. Two patients were excluded from the study since they did not regularly attend the DVT sessions, but their treatment continued. One patient was excluded from the study because his first- and sixth-month evaluations after treatment could not be performed. Consequently, the data of 21 male patients was evaluated in this study. The control group consisted of 25 age-matched, healthy males who did not have any voice problems.

Demographic information, medical and voice habituation history was obtained. Detailed ear, nose, and throat, and neurologic examinations were performed. Voice-related data from the time of diagnosis and after DVT treatment (first and sixth months) was gathered for all patients. VLS (Karl Storz Pulsar GmbH&Co. KG, Tuttlingen, Germany) was performed to evaluate vocal fold movements and mucosal waveform pattern. There were no signs of upper airway infection in any evaluation. The validated Turkish version of the Voice Handicap Index-10 (VHI-10) was used for subjective self-reporting of the severity of vocal symptoms.²³

The perceptual voice quality of patients was evaluated using the GRBAS scale by an experienced specialist who did not know the subjects. GRBAS is a reliable and valid scale consisting of five parameters (Grade, Roughness, Breathiness, Asthenia, and Strain).²⁴ Judges scored GRBAS by listening to voice recordings reading a passage in Turkish which comprises 219 words with rich and balanced phonemes, and noted the total GRBAS score for each recording.

Voice samples were recorded in a sound-insulated room with a high-quality unidirectional electret condenser microphone (Beick, BE 8800). Each patient was given a short practice period prior to the first recording to adapt to the procedure. The subject was instructed to phonate a sustained vowel [a] at a habitual pitch and comfortable loudness for at least 5 seconds. The task was repeated 3 times for each subject and each trial was captured on hard disk at a 44.100-Hz sampling rate and 16-bit resolution. Dr.Speech (Tiger Electronics Inc.) software (Vocal Assessment, Real Analysis) for Windows (Version-4.30, MA, US) was used to capture and analyze the voice samples. One second at the beginning and 1 second at the end of the analyzed voice samples were removed to avoid unintended irregularities and variability in voicing onset and offset. The mean values were then calculated for each subject. Acoustic parameters were obtained, namely, mean fundamental frequency (F0), the first three formants (F1, F2, and F3), sound pressure level (SPL), jitter percent (Jitt%), shimmer percent (Shim%), and Harmonic-to-Noise Ratio (NHR).

Dr.Speech electroglottography (EGG) was performed to synchronically analyze the EGG and acoustic parameters. Each participant phonated the vowel [a] at a comfortable pitch and loudness. The test was repeated several times before obtaining a good tracing of the graph. The middle 3 seconds of each sample was used for analysis. The EGG parameters analyzed were the Closed Quotient (CQ) and Contact Index (CI).

The sessions were all performed by the same phoniatrian for all patients, who was experienced with DVT. No other treatment methods were used to change the voice register. Psychotherapy was not used with any patient.

The DVT procedure applied in this study for MF was:

1. Counseling: the nature of the disorder was explained in detail. The patients were taught about the 'normal' timbre and pitch of the voice.

2. The doctorVOX device was used with its tip-tuner in order to increase back-pressure. In the first session, the amount of back-pressure was decided empirically and raised until the chest register was observed. The water depth and the tip-tuner were used to adjust the back-pressure.
3. Patients then performed the DVT exercises at home; and 10 sessions of therapy (each session lasting approximately 25 minutes) were given. The first five sessions were made every consequent workday.
4. Back-pressure was gradually decreased by retracting the tip-tuner. When the patient had acquired the skills for phonating in the chest register, the back-pressure was adjusted between 4 and 7 cm H₂O. The intraoral air pressure was measured by adjusting a pressure sensor (Keller PR-4) to the silicone mouthpiece of the doctorVOX device.
5. The subsequent sessions were set at twice a week, then once a week.
6. When the sessions were complete, the patients were taken to the consultation period for transfer and adaptation. The new skill, using the new muscle setup during phonation, is then transferred to behavior by sustaining the phonation without the device (counting, reading, conversation, and singing). The new vocal skill was used with different vocal tract shapes (ie vowels) in the linguistic load step of VT. The last phase was the adaptation phase of the VT; patients first counted in the tube with low backpressure and then without the device. Reading and speaking with the new motor skill was encouraged by the participation of the family or friends in the therapy.
7. Adaptation to the social environment (family, friends, etc) was then achieved through counseling.
8. Patients were called for the first- and the sixth-month examinations.

The back-pressure range was between 17 and 25 cm H₂O for register transition (falsetto to chest) in the first few sessions. Intraoral air pressure was measured by adjusting a pressure sensor (Keller PR-4) to the silicone mouthpiece of the doctorVOX device.

IBM SPSS Version 20.0 software was used for statistical analysis (IBM Corp., Armonk, NY). The changes between different time periods within patients were evaluated using paired sample *t* test. The numerical results were submitted as a mean \pm standard deviation. Statistical significance level was set as $P < 0.05$.

RESULTS

The mean age of the 21 patients with MF was 22.4 \pm 8.1 years, and the mean age of the 25 control cases was 21.8 \pm 7.3 years. There was no significant difference between groups for age ($P = 0.984$). There was no pathological finding of vocal folds in either control or MF groups in VLS evaluation.

When the pretreatment voice evaluation parameters of patients were compared with the control group (Tables 2 and 3); there was a statistically significant difference between these two groups in all values except SPL. There was no statistically significant difference in SPL regarding the pretreatment values and first- or sixth-month values after treatment.

There were statistically significant alterations in the evaluated data of MF patients for both the first and sixth month after the treatment, compared with the pretreatment data. This alteration was a decrease in VHI-10, GRBAS, F0, F1, F2, F3, Jitt%, Shimm%, NHR, and CI values, and an increase for CQ values (Tables 2 and 3).

When the first- and sixth-month data after treatment were compared; the alterations in GRBAS, F0, F1, F2, F3, Shimm%, CQ, and CI values were not statistically significant. GRBAS, Shimm%, and CI values were less in the sixth

TABLE 2.
The Control Group and Patient Vocal Analysis Parameters at Three Different Times

	Pretreatment Mean \pm SD	Post-treatment 1st mo Mean \pm SD	Post-treatment 6th mo Mean \pm SD	Control Group Mean \pm SD
VHI-10	34.3 \pm 7.4	4.02 \pm 2.24	1.48 \pm 0.66	0.38 \pm 0.41
GRBAS_t	2.32 \pm 1.48	1.37 \pm 0.51	1.12 \pm 0.58	0.94 \pm 0.43
F0 (Hz)	211.9 \pm 30.8	138.5 \pm 25.6	139.4 \pm 28.7	134.7 \pm 20.1
F1(Hz)	868.6 \pm 94.3	721.1 \pm 73.8	718 \pm 69.3	706.8 \pm 72.1
F2(Hz)	1775.2 \pm 213.6	1304 \pm 159.5	1316 \pm 171.5	1288 \pm 164.6
F3(Hz)	2773.5 \pm 286.3	2394 \pm 178.1	1426 \pm 184.1	2457 \pm 176.3
SPL	71.4 \pm 7.1	72.3 \pm 8.2	70.9 \pm 7.3	72.6 \pm 6.8
%Jitt	1.12 \pm 0.47	0.82 \pm 0.28	0.61 \pm 0.23	0.57 \pm 0.16
%Shimm	3.41 \pm 1.22	2.66 \pm 0.84	2.54 \pm 0.71	2.57 \pm 0.64
NHR	0.57 \pm 0.19	0.36 \pm 0.07	0.21 \pm 0.05	0.15 \pm 0.04
CQ	51 \pm 12.3	63.1 \pm 7.6	66.8 \pm 8.2	65.1 \pm 6.4
CI	-0.38 \pm 0.04	-0.53 \pm 0.03	-0.56 \pm 0.03	-0.58 \pm 0.0

Abbreviations: CI: contact index; CQ: contact quotient; F0: fundamental frequency; F1, 2, 3: first, second, and third formant frequency; %Jitt: jitter percent; NHR: noise-to-harmonic ratio; %Shim: shimmer percent; SPL: sound pressure level; VHI-10: voice handicap index-10. Values are expressed as mean \pm SD. $P < 0.05$ is considered statistically significant.

TABLE 3.
Statistical Significance of Differences Between Three Different Periods of Patient Results and Between Post-Treatment Patient Results and Control Group Results

	Precontrol	Pre-1st mo	Pre-6th mo	1st mo–6th mo	1st mo-Control	6th mo-Control
VHI-10	0.000	0.000	0.000	0.038	0.001	0.116
GRBAS _t	0.000	0.001	0.000	0.238	0.421	0.335
F0 (Hz)	0.000	0.000	0.000	0.673	0.749	0.602
F1(Hz)	0.000	0.000	0.000	0.826	0.562	0.313
F2(Hz)	0.000	0.000	0.000	0.459	0.632	0.506
F3(Hz)	0.000	0.000	0.000	0.357	0.334	0.216
SPL	0.128	0.229	0.656	0.685	0.866	0.718
%Jitt	0.000	0.001	0.000	0.023	0.012	0.422
%Shimm	0.000	0.000	0.000	0.254	0.438	0.238
NHR	0.000	0.000	0.000	0.022	0.010	0.127
CQ	0.000	0.000	0.000	0.317	0.223	0.440
CI	0.000	0.000	0.000	0.261	0.661	0.547

Abbreviations: CI: contact index; CQ: contact quotient; F0: fundamental frequency; F1, 2, 3: first, second, and third formant frequency; %Jitt: jitter percent; NHR: noise-to-harmonic ratio; %Shim: shimmer percent; SPL: sound pressure level; VHI-10: voice handicap index-10. $P \leq 0.05$ indicates statistical significance.

month, while CQ was higher. At the sixth month after treatment; VHI-10, jitt%, and NHR parameters were statistically significantly lower than those of first-month data (Tables 2 and 3).

When the data obtained from the patients on the first month after treatment was compared with the control group; there was no statistically significant difference for F0, F1, F2, F3, Shimm%, CQ, and CI parameters, and VHI-10, jitt%, and NHR values were significantly lower in the control group (Tables 2 and 3).

When the data obtained from the patients at the sixth month after treatment was compared with the control group; no parameters demonstrated a statistically significant difference (Tables 2 and 3).

All patients were able to speak and sing with the chest register at the end of the first month of treatment; the chest register was also successfully phonated in the first two sessions in all patients.

DISCUSSION

Despite the high incidence of MF, which cannot be underestimated among patients with dysphonia; it is a disease that is rarely diagnosed. Tatlipinar and Dursun reported the incidence of MF as 1.8% (among 1946 patients) in

dysphonic patients, and Hammarberg reported this incidence as 2%–3%.^{2,25}

The behavioral treatment of MF is short, easy, and highly effective but if MF is untreated it may lead to a chronic communication disorder, causing psychological and social problems in patients that may continue into adulthood.¹⁰

VT is the first intervention given to patients with MF.¹¹ In this study, we used DVT as the voice therapy method, and it was determined that DVT treatment performed with the doctorVOX device was highly successful in MF. This is the first study reporting the treatment outcomes of this method in MF treatment.

DoctorVOX, which uses the mechanisms of DVT, was devised by Denizoglu. The main mechanism involves artificial elongation of the vocal tract and a secondary vibrating resistance (ie water bubbles) for vocal tract impedance. The artificial vocal tract elongation is provided by an adjustable built-in tube; back-pressure is formed by a certain amount of water (forming a back-pressure due to the height of the water column), and the tip-tuner in the device (Figure 2). During vocal exercise, the user blows air/voice through the inner tube and takes the physical–physiological advantages of DVT.

The primary benefit of resonance tube exercises has been attributed to the need to modify respiratory flow and

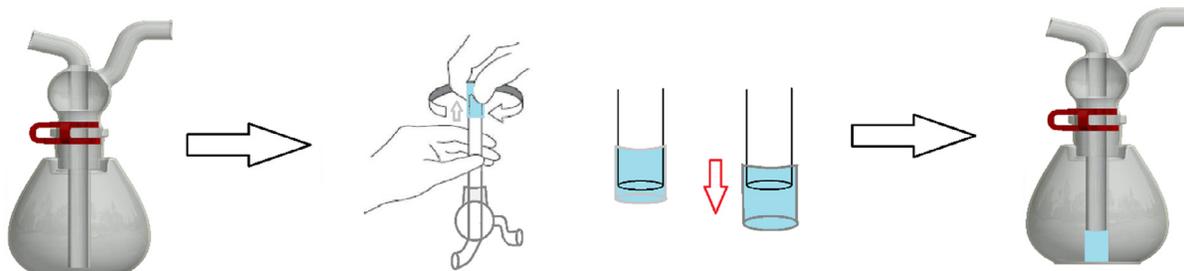


FIGURE 2. doctorVOX device mounting the tip-tuner for higher back-pressure (technical drawing).

subglottal pressure because of the change in vocal tract resonance caused by the semioclusion of the vocal tract.²⁶ In addition, two sources of vibrations reduce the load on the vocal folds and encourage a constant flow of breath with an adequate glottal configuration that is neither pressed nor breathy.²⁷ In DVT a second source of vibration at the distal part of the vocal tract creates a varying supraglottal pressure that affects the vocal fold vibration pattern.²¹ In order to use this second vibration source more effectively, some modifications may be performed in a resonance tube. In this study, as performed in our daily clinical routine practice, we determined the back-pressure level that was allowing the larynx to work most comfortably and maximizing the source-filter impedance match (comfortable phonation, comfortable low larynx position, feeling the vibration on the face, etc) for each patient. In general, a back-pressure level of 4–7 cm H₂O was appropriate for comfortable phonation in most of the patients. During therapy termination, decreasing the back-pressure by removing the tip-tuner, decreasing the water level, and performing phonation with the empty tube was used to continue the system behavior without assistive physical support.

It has been reported that, after therapy for MF, the vocal fold contact area became wider, and the respiration pattern, and voice quality were improved.² In this study, at the end of treatment, all patients reached a more appropriate basic fundamental frequency range for their age and gender. Significant improvements determined in voice-related quality of life and voice quality of patients (decrease in VHI-10 and GRBAS) were also reflected as significant alterations in the results of acoustic and EGG analyses (decrease in jitter, shimmer, and NHR; increase in CQ). According to perceptual GRBAS evaluation, all of our MF patients successfully lowered their modal speaking voice after DVT.

Although MF is known as a voice frequency problem, vocal instability is a comorbidity possibly due to an imbalance in glottal tension.³ DVT can eliminate this by supplying a second source of vibration at the distal part of the vocal tract, which creates a varying supraglottal pressure that affects the vocal fold vibration pattern. In our study, this data was also supported by the determination of an approach to the normal values in jitter, shimmer, NHR, and CQ parameters. Dagi et al evaluated the treatment outcomes of 45 patients, and there was no significant difference regarding the voice analyses results (F0, F1, F2, F3, jitter%, shimmer%) at the third and sixth months after treatment; and low voice frequency was continuing for after 6 months.⁶ Compared with the pretreatment data in our study, the continuation of the corrections in perturbation parameters determined in the first month after treatment to the sixth month (except F0) supports the idea that the new frequency was stabilized and that the adaptation of laryngeal muscles for the phonation mode (vocal plasticity) was continuing. For that reason, we suggest using such perturbation parameters in the follow-up of patients with MF. This data also suggests that alterations in frequency are not the only

criteria in treatment success, but the patients should be supported with longer treatment and consultation periods for a healthier voice adaptation period, because corrections in VHI-10, GRBAS, jitt%, NHR, and CQ parameters were continuing after the first month.

Improving the phonation skills of the patient in the modal register does not mean the termination of treatment; it is necessary that the skills should be transformed into behavior.

Although at the end of the sixth month after treatment, the voice-associated life quality and perceptual voice quality of the patients were fairly close to the normal values in the control group (without a statistically significant difference), they still did not reach those normal values. This may reflect the low number of patients/cases in this study and the continuation of voice alterations. For that reason, long-term follow-up of patients (at least 6 months, as per this study) is important. Even though MF patients had significant benefits from the initial treatment, slightly above normal voice quality and voice associated life quality scores suggest that there are still vocal issues that need to be clarified in this patient group. Similarly to our results, Liang et al reported that VT may last 1 year, especially in the patients without laryngeal hyperfunction.¹¹ More studies are therefore warranted in this subject.

The frequency of therapy visits was highly intensive in our treatment model. The rationale for this intensity involves the specific VT process for the MF. The main goals of voice therapy in puberphonia can be summarized in three issues: (1) acquiring a new motor skill (ie chest register), (2) adaptation of the skill to behavior, and (3) preparing the patient for the major personal image change. The register shift can be obtained in a few sessions and muscular adaptation is quite fast. The patient's motivation for their new image (which also arrives very quickly) and precise motor control in the first week is very important. For these reasons, the first five sessions of the DVT program for puberphonia was held on five consecutive workdays. When the patient is confident with the new motor skill and the sound of their voice is assured, the session rate was reduced.

CONCLUSIONS

DVT was shown to be highly effective in the treatment of mutational falsetto using the high back-pressure levels in the beginning of therapy obtained by the doctorVOX device. In the first month, the patients reach low speaking phonation frequency, and the corrections to perturbation irregularities continued for at least 6 months. Investigating this treatment method in larger patient groups with different auditory issues is warranted.

Conflict of Interest

The authors declare that this study has received no financial support and that there is no conflict of interest between the authors.

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SUPPLEMENTARY DATA

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