Voice Improvement in Patients with Functional Dysphonia Treated with the Proprioceptive-Elastic (PROEL) Method

E. Lucchini, A. Ricci Maccarini, E. Bissoni, M. Borragan, M. Agudo, M.J. González, V. Romizi, A. Schindler, M. Behlau, T. Murry, and A. Borragan, *Loma Linda, California*

Summary: The objective of the study was to analyze the outcome of the proprioceptive-elastic (PROEL) voice therapy method in patients with functional dysphonia (FD). Fifty-two patients with FD were involved in the study; they were composed of three subgroups of patients with (1) FD without glottal insufficiency (n = 28), (2) FD and glottal insufficiency (n = 9), and (3) FD, glottal insufficiency, and vocal nodules (n = 15). A multidimensional assessment protocol including videolaryngostroboscopy; maximum phonation time; perceptual evaluation of dysphonia with the Grade, Instability, Roughness, Breathiness, Asthenia, and Strain (GIRBAS) scale; and 10-item version of the Voice Handicap Index was conducted before and after 15 sessions of voice therapy. All voice therapy sessions were conducted by the same speech-language pathologist. The comparison between voice assessment before and after voice therapy with the PROEL method in patients with FD, in all the three subgroups, revealed a statistically significant improvement in periodicity and the mucosal wave in the laryngostroboscopy, maximum phonation time, GIRBAS scale scores, and VHI-10.

Voice of patients with FD improved after treatment with the PROEL method. Further studies are needed to analyze the efficacy of the PROEL method with randomized double-blind clinical trials using different methods for voice therapy. At present, the PROEL method represents an alternative tool for the speech pathologist to improve voice in patients with FD.

Key Words: Functional dysphonia–Voice therapy–Multidimensional voice assessment–Proprioceptive-elastic method–Hoarseness.

INTRODUCTION

Functional dysphonia (FD) is a group of voice disorders that occur in the absence of structural or neurological laryngeal diseases. FD is related to vocal behavior, leading to negative habits and inadequate voice use.[1] Minor tissue changes, such as vocal fold nodules, that are direct results of vocal misuse or trauma to vocal folds by phonatory behavior can also be considered in the FD group.[2]

FD represents a significant health problem if we consider that more than 50% of voice disorders are considered functional.[1–3] The literature on FD has shown the efficacy of voice therapy for this voice behavior.[2,4,5] In particular, a systematic review with a meta-analysis of three randomized clinical trials has shown evidence of voice therapy effectiveness.[2] Nonetheless, it is common clinical experience that some patients with FD are resistant to existing common voice therapy approaches. The need for novel approaches continues. A new voice therapy method based on a multidimensional rationale was developed by Alfonso Borragán and published in Spain in 1999[6] and later in Italy in 2008.[7] The purpose of the current study is to prospectively analyze vocal improvement using this method in a prospective trial.

The specific aim of the study is to analyze, through a multidimensional diagnostic protocol, the impact of the proprioceptive-elastic (PROEL) method for treating patients with FD. The importance of the study lies in the fact that there is no evidence of the efficacy of the PROEL method. Unlike previously developed voice therapy methods for FD, the PROEL method combines a multidimensional approach. The method uses communication with the receptors of the phonatory organ in a language that is precise and includes pressure, vibration, temperature, and stretching. Another example of a multidimensional approach in the treatment of vocal disorder is found in Pedrosa.[8]

Clinical evidence of the PROEL method's efficacy supports its use in everyday clinical practice. Thus, the PROEL method could be an additional method for FD voice therapy. Furthermore, it could also be used with patients whose voice disorders have not improved with other methods.

The PROEL method

Figure 1 is a diagram of the input parameters to the PROEL method. The fundamental goals of the PROEL method are to rebalance the phonatory system by eliminating muscle tension in an attempt to seek greater elasticity in the body. Freeing the body of muscle tension in turn produces greater elasticity of the phonatory system. Greater elasticity leads to the generation of more agile movements with less exertion of energy and effort.[9] The voice is conceptually the product of an elastic system and, hence, seeking elasticity is equivalent to taking the system to its maximum ecological state (better adjustment, finer tuning). In addition, it is necessary to generate energy to obtain a voice

Accepted for publication May 23, 2017.
Conflict of interest: None.
Disclosure: No funding nor financial relationship to disclose.
Authorship: T. Murry, A. Ricci Maccarini, A. Schindler, A. Borragan, E. Lucchini: Conception, design, analysis, and interpretation of data; drafting the article and revising it critically for important intellectual content; final approval of the version to be published.
A. Ricci Maccarini, E. Lucchini, E. Bissoni, M. Borragan, M. Agudo, M.J. González, V. Romizi: Acquisition and analysis of data; drafting the article and revising it critically for important intellectual content; final approval of the version to be published.
From the Department of Otolaryngology-Head and Neck Surgery, Loma Linda University Health, Loma Linda, California.
Address correspondence and reprint requests to Thomas Murry, Department of Otolaryngology-Head and Neck Surgery, Loma Linda University Health, 1895 Orange Tree Lane Redlands, Loma Linda, CA 92354. E-mail: tmurry@llu.edu
Journal of Voice, Vol. 32, No. 2, pp. 209–215
0892-1997

https://doi.org/10.1016/j.jvoice.2017.05.018

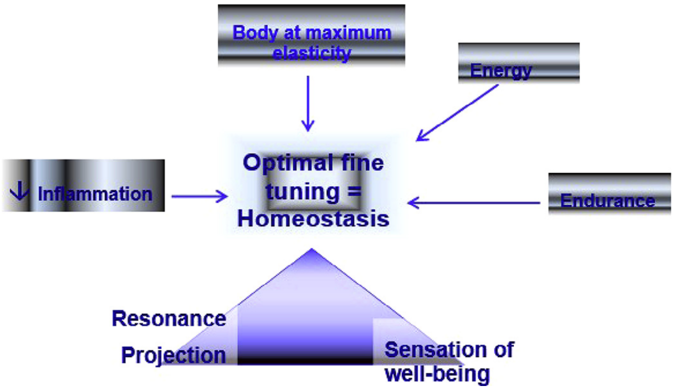

FIGURE 1. Diagram of the input parameters to the PROEL method.

that is heard well (with resonance) even from a distance (good vocal projection) and one that responds to individual daily overloads, in a system with a bare level of inflammation. Vocal production should always convey to others the sensation of well-being.

It is not a method that is specific to the treatment of only one pathology, but rather, a method that uses a holistic approach to help improve a patient's dysphonia.

Through stimulation of the receptors of the phonatory system, vocal positions, body postures, and movements, patients with dysphonia rapidly and unexpectedly change their voice and produce a voice with less vocal effort and acoustically closer to normality.[7] For example, if we place our body in a state of imbalance, a flexion of 10°, taking the body to a position similar to the Leaning Tower of Pisa (Figure 2),[10] produces a change in the voice that is emitted with much less effort. Changes in the voice achieved through practical activities (as opposed to trying to explain unnecessary theoretical explanations to the patient) are the keystone of the therapeutic procedure.

To be effective, the technique must be repeatable and reproducible as many times as required. Therefore, to permit the imprint of a correct speech signal model to be stored at the brain level, the maneuvers we carry out are few and are repeated in the same patient during the therapy sessions.[11]

The PROEL method seeks to achieve healthy vocal production through the discovery of spontaneous and concrete proprioceptive sensations, postures, and movements. This technique generates immediate changes in the voice that improve vocal quality and reduce effort and phonatory fatigue.

The PROEL method was formalized by Borragán[7] and has been divided into five phases that progress as follows:

1. Control of vocal risk factors
2. Vocal proprioceptive awareness
3. Elimination of the mechanisms of stress, tension, and muscular stiffness
4. Projection and resonance of the voice
5. Research into the feeling of freedom and well-being.

The results obtained with this method offer supportive evidence of a valid treatment technique not only from the viewpoint of the therapist but also from that of the patient. Nevertheless, there are no data available on the efficacy of the PROEL method in patients with FD. This lack of data is therefore the reason for this research study.

FIGURE 2. Distension by means of instable balance: Leaning Tower of Pisa posture.

MATERIALS AND METHODS

Study design and approval

This prospective single group pretest/posttest study compared the voice quality of patients before and after the use of the PROEL method voice therapy through a multidimensional protocol in a group of 52 patients with voice disorders. Written informed consent was obtained for each enrolled patient. Patients who were recruited understood the information that the researchers gave them, and agreed to participate without any compensation. The study was carried out according to the Declaration of Helsinki and approved by the Institutional Review Board.

Patients

The study followed patients receiving treatment at the Centro de Foniatría y Logopedia de Santander, Spain, and at the Voice Center of the Bufalini Hospital, Cesena, Italy, between 2011 and 2012. The criteria for inclusion were having had 15 complete therapeutic sessions; exhibiting dysphonia and vocal fatigue that interfered with their professional, social, and personal life and that lasted for more than 3 months; having been diagnosed, through a laryngeal stroboscopic study, with FD; and having had an acoustic and perceptive study of their voice. Patients who had a different pathology such as laryngeal polyp and congenital lesions of the vocal folds (VF), or previous vocal therapy or surgery were excluded from the study.

Each patient was assessed jointly by a phoniatrician and a speech-language pathologist at the beginning and at the end of the voice therapy program. Voice therapy started between 20 and 30 days after the multidimensional voice assessment.

Physical examination

Each subject underwent a videolaryngostroboscopy, with a rigid endoscope (Atmos (Atmos Medizin Technik GmbH KG, Lenzkirch, Germany) 4450.47 70° rigid telescope, 8706CA or Karl Storz (Karl Stortz, Segundo, California, USA) 70°, pulsar endoscope). Based on physical examination, patients were divided into groups consisting of FD, FD with glottic insufficiency, and FD with nodules and glottic insufficiency.

The following stroboscopic parameters were considered: glottic closure (complete, slightly incomplete, incomplete); periodicity of glottic vibration (regular, irregular, incoherent); and mucosal wave of the vocal fold (normal, little, big, absent), according to Hirano.[12–14] Assessments of stroboscopic parameters were performed on randomly presented video recordings without audio. The assessors (two experienced laryngologists) did not know if they were assessing pre- or post-therapy recordings.

Patients were asked to produce an /a/ for as long as possible. The maximum phonation time (MPT) was determined by measuring the sustained /a/ in three productions using a stopwatch. The longest sustained phonation among three tests was used for further analysis.

Perceptual evaluation of dysphonia

All voices were recorded with a microphone positioned approximately 15 cm from the mouth and slightly below the chin to reduce airflow effects. The Grade, Instability, Roughness, Breathiness, Asthenia, and Strain (GIRBAS) scale[15–17] was used for the perceptual evaluation of dysphonia. An experienced phoniatrician and an experienced speech pathologist rated each patient on standard sentences. Specifically, patients were asked to read the five standard sentences of the Consensus Auditory-Perceptual Evaluation of Voice in the Italian version.[18] The perceptual assessors did not know if they were assessing pre- or post-therapy voices.

Patient's self-assessment of dysphonia

To have self-assessment data on the perceived quality of life related to the voice handicap, each subject completed the 10-item version of the Voice Handicap Index (VHI-10)[19] in the Italian version[20] and in the Spanish version.[21] The cut-off score was 11.[22]

Statistical analysis

Results are given in terms of median and range for all parameters we have considered in the stroboscopic, perceptual, and acoustical findings. Stroboscopic scores before and after voice therapy were compared through a McNemar test or a Fisher exact test as appropriate. MPT, perceptual and perturbation analysis, and VHI data of patients before and after voice therapy were compared using Wilcoxon signed-ranks test, as scores proved to be not normally distributed with the Kolmogorov-Smirnov test. The differences were considered statistically significant at $P < 0.05$. Statistical analyses were done using the *SPSS* 11.5 package (SPSS Science, Chicago, IL).

Procedure of voice therapy with the PROEL method[7]

Each subject had 15 voice therapy sessions with an experienced speech-language pathologist. The frequency of therapy sessions was twice a week for 45–60 minutes. Each session was carried out individually and by the same professional.

The first session of voice therapy was devoted to two areas. First, an analysis verified the existence of risk factors, ie, those that may generate overload, affect the patient's emotional state, produce stiffness, inflammation, and loss of lubrication, and influence the patient's physical or mental condition.

Second, we implemented the most efficient anti-inflammatory measures adapted to each patient: in case of laryngopharyngeal reflux, counseling on diet and medication was provided; in case of smoking, patients were asked to quit or at least reduce the number of smoked cigarettes; in case of allergy, medical treatment was revised. Here, patients were taught how to humidify (nasal hydrotherapy) and lubricate the phonatory system. Patients were also counseled on the impact of hydration on voice production and voice disorders.[23,24] Each session included an assessment of the effectiveness of vocal therapy.

The second to fourth sessions were geared toward increasing vocal proprioceptive awareness by means of discovering the sensations that breathing produces, the awareness of pressure and effort, the awareness of body posture, the proprioception of the tongue, and the awareness of vibratory sensations along the anterior alveolar ridge.[25]

From the fifth to the eighth sessions, the aim was to eliminate the mechanisms of stress, tension, and muscular stiffness, bringing the system to maximum distension by means of fast and agile movements, stretching of the tongue, and other articulators and movements of counter-resistance. Moreover, maximum distension was achieved by inducing the body into a state of imbalance through facilitating postures,[7] such as "hands-knees", "hand-knees falling," and "Leaning Tower of Pisa." In the hands-knees position the patient stands with the torso horizontal and the hands placed on the knees for support. In the hand-knees falling posture, the patient stands in the hands-knees position but ranging forward by raising the heels from the floor. In the Leaning Tower of Pisa (Figure 2) position, an extreme or forced, unnatural posture is held and the patient looks up at the ceiling with his or her head placed well back and chin pointing upward.

FIGURE 3. Ventilation mask used during phonation to improve overall vocal volume.

The objective was to obtain a dysphonia-free voice, produced with minimum effort as described by Diaz Gómez et al.[6]

The ninth to eleventh sessions promoted resonance and vocal projection through vocal impedance activities and laryngeal manipulation. The objective was to produce a larger space in the vocal tract and a wider oral and pharyngeal cavity. This was achieved in a number of ways. The first is by talking with an object inside the mouth, thus preventing any escape of sound pressure with a correct closure of the soft palate. The second is by feeling vibratory sensations along the anterior alveolar ridge, thereby modifying the impedances of the system. This increases the intraoral pressure and opens the pharyngeal spaces. The third is by using systems that partially occlude the cavity[7,26–28] such as an "Ambu Res-Cue Mask" (Figure 3) and "Ambu Res-Cue Mask" with tube inserted into a bottle of water. (Figure 4). Then, by performing semioccluded vocal tract exercises, the impedance of the vocal tract changes.[29] The fourth is by using other systems that increase the resonance sensation, such as emitting sound within a bucket.

From the twelfth to fifteenth sessions, the euphonious voice was extended to everyday life, seeking vocal play, which produces a major sensation of freedom and well-being.

In addition, controlled vocal overloads were applied including talking at a loud volume, talking with background noise, talking increasingly longer for periods of time, and increasing the duration and frequency of such periods. These techniques were applied to the vocal tract to increase vocal resistance.

Each patient received concrete instructions from the speech therapist to carry out a series of exercises for 5 minutes at two different moments of the day.

RESULTS

A total of 52 patients, 48 females and 4 males, with FD participated in the study (Table 1). The mean age was 43.2 ± 11.8 years (range, 21–66 years). Patients were categorized as follows: 28 with FD, 9 with FD with glottic insufficiency, and 15 with FD, glottic insufficiency, and vocal nodules.

FIGURE 4. Ventilation mask with tube inserted into a bottle of water. Carrying out semioccluded vocal tract exercises changes the impedance of vocal tract.

Physical examination

The improvement of glottic closure, periodicity, and mucosal wave of male and female patients after voice therapy and as observed on videolaryngostroboscopic images is shown in Table 2. Although glottic closure improved after voice therapy with the PROEL method, improvement did not reach statistical significance in the whole group ($P = 0.33$). It also did not reach statistical significance in the subgroups of patients with nodules ($P = 0.51$), FD ($P = 0.44$), and FD with glottic insufficiency ($P = 0.42$).

TABLE 1.
Demographic and Clinical Characteristics of Patients Included in the Study*

FD	Males : Females	Median Age (Range)
FD with GI and VN	0:28	42.5 (25–66)
FD without GI and VN	2:7	43 (33–58)
FD with GI without VN	2:13	39 (21–66)
Total	4:48	42 (21–66)

* Patients with functional dysphonia (FD) with or without glottic insufficiency (GI) and with or without vocal nodules (VN), living in Santander and surroundings and in Cesena and surroundings, teachers in most of the cases, no professional singers.

TABLE 2.
Laryngostroboscopic Findings in the Population Before and After Voice Therapy

Laryngostroboscopic Parameters		FD with VN (n = 28)	FD (n = 9)	FD GI (n = 15)	Total (n = 52)
Glottic closure before therapy	Complete	1	0	1	2
	Partially incomplete	21	7	10	38
	Largely incomplete	6	2	4	12
Glottic closure after therapy	Complete	23	4	11	38
	Partially incomplete	5	5	4	14
	Largely incomplete	0	0	0	0
Regularity before therapy	Regular	21	5	13	39
	Irregular	7	4	2	13
Regularity after therapy	Regular	25	7	15	47
	Irregular	3	2	0	5
Right mucosal wave before therapy	Normal	5	5	1	11
	Small	22	3	12	37
	Absent	1	1	2	4
Right mucosal wave after therapy	Normal	5	9	13	27
	Small	22	0	2	24
	Absent	1	0	0	1
Left mucosal wave before therapy	Normal	6	5	0	11
	Small	22	3	14	39
	Absent	0	1	1	2
Left mucosal wave after therapy	Normal	28	9	12	49
	Small	0	0	3	3
	Absent	0	0	0	0

Note: For each parameter, the number of patients with a particular finding before and after voice therapy is reported for functional dysphonia (FD) with or without glottic insufficiency (GI) and with or without vocal nodules (VN).

Regularity significantly improved in the whole group ($P = 0.01$), but no statistical significance was reached in the nodules ($P = 1$), FD ($P = 0.5$), and FD with glottic insufficiency ($P = 1$) subgroups of patients. As for the mucosal wave, a significant improvement was found in the whole group of patients ($P = 0.01$).

The MPT significantly improved in the whole group as well as in the three subgroups of FD patients after voice therapy with the PROEL method (Table 3).

Perceptual and self-assessment of dysphonia

The GIRBAS scale values before and after voice therapy are shown in Table 4. The voices were judged to be more breathy than rough, with a moderate to severe degree of dysphonia before therapy. On average, the mean values of the A parameter were higher than the S values in the pretherapy assessment, probably because the glottic insufficiency often gives the impression of asthenicity even if a strain is present. A general reduction of severity was found for all the parameters after voice therapy. The difference on the Wilcoxon signed-ranks test was statistically significant, the only exception being the S parameter.

VHI-10 values before and after voice therapy significantly improved in the whole group as well as in the three subgroups of FD patients after voice therapy with the PROEL methods (Table 5).

DISCUSSION

Voice therapy is the main treatment for FD,[1,2,4,5,7,28,29] and many methods of voice therapy for FD have been proposed. The PROEL method is based on a “reconstruction” of the patient’s phonatory pattern, breaking the wrong pattern by means of unstable balance and other proprioceptive-elastic exercises. When the body is in a “teeter point” in which there is substantially less rigidity, the patient’s whole body is compelled to restore its equilibrium.[9] All muscles loosen and adopt a state of oscillation

TABLE 3.
Median and Range MPT Scores in the Population Before and After Voice Therapy

MPT	FD with VN (n = 28)	FD (n = 9)	FD GI (n = 15)	Total (n = 52)
MPT pre	14.5 (9–19)	14 (11–23)	15 (10–19)	14.5 (9–23)
MPT post	19 (12–25)	15.5 (12–30)	19 (12–25)	19.0 (12–30)
P value	0.0001*	0.027*	0.001*	0.0001*

Note: P values of the Wilcoxon test are also reported for FD with or without GI and with or without VN.
* Statistically significant.
Abbreviations: FD, functional dysphonia; GI, glottic insufficiency; MPT, maximum phonation time; VN, vocal nodules.

TABLE 4.
Median and Range GIRBAS Scores in the Population Before and After Voice Therapy for FD With or Without GI and With or Without VN

GIRBAS parameter	FD with VN (n = 28)	FD (n = 9)	FD with GI (n = 15)	Total (n = 52)
G pre	2 (1–3)	1 (1–3)	1 (1–3)	1 (1–3)
G post	0 (0–1)	0.5 (0–1)	0 (0–2)	0 (0–2)
P value	0.0001*	0.034*	0.001*	0.0001*
I pre	0 (0–2)	0 (0–1)	0 (0-0)	0 (0–2)
I post	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
P value	0.008*	0.083	1.000	0.001*
R pre	1 (0–3)	1 (0–2)	1 (0–2)	1 (0–3)
R post	0 (0–1)	0 (0–1)	0 (0–1)	0 (0–1)
P value	0.0001*	0.034*	0.004*	0.0001*
B pre	1 (0–3)	1 (0–3)	1 (1–3)	1 (0–3)
B post	0 (0–1)	0 (0–1)	0 (0–2)	0 (0–2)
P value	0.0001*	0.10	0.0001*	0.0001*
A pre	1 (0–2)	0.5 (0–1)	0 (0–2)	0 (0–2)
A post	0 (0-0)	0 (0-0)	0 (0–1)	0 (0–1)
P value	0.0001*	0.046*	0.046*	0.0001*
S pre	1 (0–3)	1 (0–3)	1 (0–3)	1 (0–3)
S post	0 (0–1)	0 (0–1)	0 (0–1)	0 (0–1)
P value	0.0001*	0.034	0.002	0.0001*

Note: P values of the Wilcoxon test are also reported.
* Statistically significant.
Abbreviations: FD, functional dysphonia; GIRBAS, Grade, Instability, Roughness, Breathiness, Asthenia, and Strain; GI, glottic insufficiency; VN, vocal nodules.

to combat the sensation of falling. This is the optimum scenario to achieve maximum muscular elasticity. It has been shown that the utility efficiency of the organism in relation to the force and muscular power exerted on the surroundings decreases to 80% and 60%, respectively, if a driven object requires stabilization.[30]

The results of this study demonstrated a statistically significant improvement of perceptual evaluation of dysphonia, patient's self-assessment of dysphonia, MPT, and improvement of the parameters of periodicity and mucosal wave found on laryngostroboscopy. We may speculate that laryngostroboscopy results are due to a better-balanced muscle tone among intrinsic and extrinsic laryngeal muscles. We have reached this conclusion because each time the body is placed at a tipping point (like a teeter totter), voice changes have been recorded in both a dysphonic and normal voice. However, no other findings support this hypothesis, as this was not specifically investigated in the study.

In addition, the improvement of MPT might be related to a more balanced laryngeal muscle functioning, although an improvement in the respiratory mechanism and in pneumophonatory coordination, per se could also explain this finding.

Because the human ear offers the best device for evaluating the human voice[13] even though it is not an objective evaluation, it is important to note the finding of improvement in the perceptual evaluation of dysphonia in the group. Regarding the improvement of the patients' self-assessments of their dysphonia, although VHI-10 is one of the most important outcome measurements, the placebo effect at the end of the treatment should also be considered.

Voice improvement was obtained in the three groups chosen for the study. These groups were composed of patients with FD without glottic insufficiency, patients with FD and glottic insufficiency, and patients with FD, glottic insufficiency, and vocal nodules. The resultant improvement demonstrates the efficacy of the PROEL method in each case of FD.

The efficacy of the PROEL method has yet to be compared with other methods of voice therapy for FD. This remains the focus of future studies.

TABLE 5.
Median and Range VHI-10 Scores in the Population Before and After Voice Therapy for FD With or Without GI and With or VN

VHI-10 (n.v. >11)	FD with VN (n = 28)	FD (n = 9)	FD with GI (n = 15)	Total (n = 52)
VHI-10 pre	10.5 (5–21)	7 (3–18)	8 (5–22)	9 (3–22)
VHI-10 post	3.5 (1–12)	4 (0–6)	3 (2–10)	4 (0–12)
P value	0.0001*	0.012*	0.001*	0.0001*

Note: P values of the Wilcoxon test are also reported.
* Statistically significant.
Abbreviations: FD, functional dysphonia; GI, glottic insufficiency; n.v., normal value; VN, vocal nodules.

CONCLUSIONS

The PROEL method improved the voice of patients with FD. Further studies are needed to analyze its efficacy with randomized double blind clinical trials using different methods for voice therapy. At present, the PROEL method can be considered an effective method of voice therapy to improve voice in patients with FD.

REFERENCES

1. Roy N. Functional dysphonia. *Curr Opin Otolaryngol Head Neck Surg*. 2003;11:144–148.
2. Ruotsalainen JH, Sellman J, Lehto L, et al. Interventions for treating functional dysphonia in adults. *Cochrane Database Syst Rev*. 2007;(3):CD006373.
3. Herrington-Hall BL, Lee L, Stemple JC, et al. Description of laryngeal pathologies by age, sex, and occupation in a treatment-seeking sample. *J Speech Hear Disord*. 1988;53:57–64.
4. Wilson JA, Deary IJ, Scott S, et al. Functional dysphonia. *BMJ*. 1995;311:1039–1040.
5. Behlau M, Madazio G, Oliveira G. Functional dysphonia: strategies to improve patient outcomes. *Patient Relat Outcome Meas*. 2015;6:243–253. doi:10.2147/PROM.S68631. eCollection 2015.
6. Díaz Gómez M, Gonzalez Riancho Colongues A, Borragán Torre A. Asociación CELF, ed. *CELF: Cirugía Endolaríngea Fibroscópica y Rehabilitación Vocal*. 1999.
7. Borragán A, Lucchini E, Agudo M, et al. Il Metodo Propriocettivo Elastico (PROEL) nella terapia vocale. *Acta Phon Lat*. 2008;30(1):18–50.
8. Pedrosa V, Pontes A, Pontes P, et al. The effectiveness of the comprehensive voice rehabilitation program compared with the vocal function exercises method in behavioral dysphonia: a randomized clinical trial. *J Voice*. 2015;30:377, e11-9. doi:10.1016/j.jvoice.2015.03.013. pii: S0892-1997(15)00055-7, Epub ahead of print.
9. Blickhan R, Andrada E, Müller R, et al. Positioning the hip with respect to the COM: consequences for leg operation. *J Theor Biol*. 2015;382:187–197.
10. Rode C, Sutedja Y, Kilbourne BM, et al. Minimizing the cost of locomotion with inclined trunk predicts crouched leg kinematics of small birds at realistic levels of elastic recoil. *J Exp Biol*. 2016;219:485–490.
11. (a) Nacci A, Fattori B, Mancini V, et al. Posturographic analysis in patients with dysfunctional dysphonia before and after speech therapy/rehabilitation treatment. *Acta Otorhinolaryngol Ital*. 2012;32:115–121.(b) Hirano M. Objective evaluation of the human voice: clinical aspects. *Folia Phoniatr*. 1989; 41:89–144.
12. Hirano M, Bless DM. *Videostroboscopic Examination of the Larynx*. San Diego, CA: Singular Publishing Group Inc.; 1993.
13. Ricci Maccarini A, Lucchini E. La valutazione soggettiva ed oggettiva della disfonia. Il protocollo SIFEL, in Official Lecture at the XXXVI National Congress of the Italian Society of Phoniatrics and Logopedics. *Acta Phon Lat*. 2002;24:13–42.
14. Hirano M. *Clinical Examination of Voice*. Wien—New York, NY: Springer Verlag; 1981.
15. Dejonckere PH. Perceptual and laboratory assessment of dysphonia. In: Rosen CA, Murry T, eds. *The Otolaryngologic Clinics of North America*. Supplement on "Voice Disorders and Phonosurgery". 2000:731–750.
16. Dejonckere PH, Bradley P, Clemente P, et al. A basic protocol for functional assessment of voice pathology, especially for investigating the efficacy of (phonosurgical) treatments and evaluating new assessment techniques. *Eur Arch Otorhinolaryngol*. 2001;258:77–82.
17. Schindler A, Ginocchio D, Ricci Maccarini A, et al. CAPE-V (Consensus Auditory-Perceptual Evaluation of Voice): versione Italiana. *Acta Phon Lat*. 2006;28:383–391.
18. Kempster GB, Gerratt B, Verdolini-Abbot K, et al. Consensus Auditory-Perceptual Evaluation of Voice: Development of a Standardized Clinical Protocol. *Am J Speech Lang Pathol*. 2008;18:124–132.
19. Forti S, Amico M, Zambarbieri A, et al. Validation of the Italian Voice Handicap Index-10. *J Voice*. 2014;28:263.e17–263.e22.
20. Núñez-Batalla F, Corte-Santos P, Señaris-González B, et al. Adaptation and validation to the Spanish of the Voice Handicap Index (VHI-30) and its shortened version (VHI-10). In: *Acta Otorrinolaringologica*, Vol. 58, Issue 9. English ed. 2007:386392.
21. Arffa RE, Krishna P, Gartner-Schmidt J, et al. Normative values for the Voice Handicap Index-10. *J Voice*. 2012;26:462–465.
22. Verdolini-Marston K, Sandage M, Titze IR. Effect of hydration treatments on laryngeal nodules and polyps and related voice measures. *J Voice*. 1994;8:30–47.
23. Verdolini K, Titze IR, Fennell A. Dependence of phonatory effort on hydration level. *J Speech Hear Res*. 1994;37:1001–1007.
24. Verdolini K. Case study: resonant voice therapy. In: Stemple J, ed. *Voice Therapy: Clinical Studies*. 2nd ed. San Diego: Singular Publishing Group, Inc; 2000:46–62.
25. Alexander RM. Energy-saving mechanisms in walking and running. *J Exp Biol*. 1991;160:55–69.
26. Titze I. Voice training and therapy with a semi-occluded vocal tract: rationale and scientific underpinnings. *J Speech Lang Hear Res*. 2006;49:448–459.
27. Guzman M, Rubin A, Muñoz D, et al. Changes in glottal contact quotient during resonance tube phonation and phonation with vibrato. *J Voice*. 2013;27:305–311.
28. Fantini M, Succo G, Crosetti E, et al. Voice quality after a semi-occluded vocal tract exercise with a ventilation mask in contemporary commercial singers: acoustic analysis and self-assessments. *J Voice*. 2017;31:336–341.
29. Kornecki S, Zschorlich V. The nature of the stabilizing functions of skeletal muscles. *J Biomech*. 1994;27:215–225.
30. Yong M-S, Lee H-Y, Lee M-Y. Correlation between head posture and proprioceptive function in the cervical region. *J Phys Ther Sci*. 2016;28:857–860.