

LARYNGOLOGY

Combined treatment of muscle tension dysphonia: voice therapy with instrumental postural rehabilitation

Trattamento combinato della disfonia muscolo tensiva: terapia logopedica e riabilitazione posturale strumentale

Pasqualina Maria Picciotti^{1,2}, Maria Raffaella Marchese¹, Ylenia Longobardi¹, Giuseppe Oliveto¹, Lea Calò^{1,2}, Lucia D'Alatri^{1,2}

¹ Complex Unit of Otolaryngology, Department of Aging, Neurological, Orthopedic and Head and Neck Sciences, "Agostino Gemelli" IRCCS, Rome, Italy; ² Section of Otorhinolaryngology, University Department Head-Neck and Sense Organs, Catholic University of the Sacred Heart, Rome, Italy

SUMMARY

Objectives. This investigation aimed to propose a new rehabilitation technique that combines voice exercises and instrumental postural rehabilitation for patients with muscle tension dysphonia (MTD).

Methods. We enrolled nine dysphonic patients (8 women and 1 man, aged 22-55 years). Voice assessment included stroboscopy, Maximum Phonation Time (MPT), perceptual evaluation by GRBAS scale and patient's self-rating by Italian version of the Voice Handicap Index (VHI). Vestibular function was evaluated by the Bed Side Examination and Video Head Impulse test (VHIT). Postural control was evaluated by Dynamic Posturography (DP) using the Sensory Organization Test (SOT) and analysing the Equilibrium Score (ES) and balance subsystems (somatosensorial, visual, vestibular).

Results. All cases underwent different types of voice exercises combined with balance training based on NeuroCom Balance Master Protocols, once a week for six 35-minutes sessions. After therapy, an improvement in MPT, VHI, GRBAS scores and endoscopic laryngeal features was obtained. DP results at baseline were normal and after therapy we showed a slight improvement of ES (somatosensorial and visual components).

Conclusions. A combined rehabilitation technique for MTD, by improving the attention to postural control, allows for significant improvement in vocal symptoms.

KEY WORDS: voice, muscle tension dysphonia, rehabilitation, postural control

RIASSUNTO

Obiettivi. Scopo di questo lavoro era proporre una tecnica riabilitativa che combinasse esercizi vocali e riabilitazione posturale strumentale per pazienti con disfonia muscolo tensiva (MTD).

Metodi. Abbiamo arruolato nove pazienti disfonici (8F e 1M, età 22-55 anni). La valutazione includeva: videostroboscopia, tempo massimo fonatorio (TMF), valutazione percettiva (GRBAS) e autovalutazione del paziente mediante Voice Handicap Index (VHI) per la voce; Bed Side Examination e Video Head Impulse Test (VHIT) per la funzione vestibolare; Posturografia Dinamica (DP) con Test di Organizzazione Sensoriale (SOT), analizzando l'Equilibrium Score (ES) e i sottosistemi di equilibrio (Somatosensoriale, Visivo, Vestibolare) per il controllo posturale. Tutti i casi sono stati sottoposti a esercizi vocali associati a un training sull'equilibrio basato sui protocolli NeuroCom Balance Master, una volta alla settimana per sei sedute da 35 minuti.

Risultati. Dopo la terapia è stato riscontrato un miglioramento nel TMF, nei punteggi al VHI e alla GRBAS e nel quadro endoscopico laringeo. Dopo la terapia è stato riscontrato un lieve miglioramento della componente ES, somatosensoriale e visiva.

Conclusioni. Un trattamento combinato per la MTD, migliorando l'attenzione sul controllo posturale, permette di ottenere un miglioramento significativo dei sintomi vocali.

PAROLE CHIAVE: voce, disfonia muscolo tensiva, riabilitazione, controllo posturale

Received: September 20, 2022

Accepted: March 22, 2023

Correspondence

Ylenia Longobardi

Complex Unit of Otolaryngology, Department of Aging, Neurological, Orthopedic and Head and Neck Sciences, "Agostino Gemelli" IRCCS, largo A. Gemelli 8, 00168 Rome, Italy
Tel. +39 06 30154439

E-mail: ylenia.longobardi@policlinicogemelli.it

How to cite this article: Picciotti PM, Marchese MR, Longobardi Y et al. Combined treatment of muscle tension dysphonia: voice therapy with instrumental postural rehabilitation. Acta Otorhinolaryngol Ital 2023;43:245-251. <https://doi.org/10.14639/0392-100X-N2287>

© Società Italiana di Otorinolaringoiatria e Chirurgia Cervico-Facciale



OPEN ACCESS

This is an open access article distributed in accordance with the CC-BY-NC-ND (Creative Commons Attribution-Non-Commercial-NoDerivatives 4.0 International) license. The article can be used by giving appropriate credit and mentioning the license, but only for non-commercial purposes and only in the original version. For further information: <https://creativecommons.org/licenses/by-nc-nd/4.0/deed.en>

Introduction

Muscle tension dysphonia (MTD) is one of the most common voice disorders. It occurs when the muscles around the larynx (voice box) are so tense while speaking that the voice box does not work efficiently. MTD is more prevalent among people in the 40 to 50 age group, particularly in women.

The “traditional” rehabilitation techniques include training in correct vocal hygiene, semi-occluded vocal tract, frequency modulation and nasalisation, vocal function, pneumo-phono-articulatory coordination exercises and laryngeal manipulation. All of these aim to promote improvement in intraoral and subglottal pressure, positive alterations in the glottal contact quotient, significant changes in the measurements of the fundamental frequency, an increase in the Maximum Phonation Time (MPT) and reduction in the degree of voice roughness¹. In particular, phonation exercises in air tubes and in tubes immersed in water have positive effects on subglottic, oral and transglottic pressure, as well as on the vocal folds adduction quotient². Looking beyond traditional approaches, it is well known that there is a correlation between the postural system and the phonatory system and this relationship may influence and regulate voice quality. Nevertheless, to date, the relationship between voice and posture seems contradictory.

In fact, on one hand, an anomaly in postural control can lead to a dysfunction of the glottic signal, due to both structural damage of osteoarticular elements and to an increase in perylaryngeal tension. On the other hand, it is also true that a condition of dysphonia can modify postural reflexes and awareness, increasing muscle tension and moving the head forward³.

In a recent review, Cardoso et al.³ confirmed that correct posture is important for efficient voice production and that multidisciplinary treatment can optimise the assessment and rehabilitation of functional dysphonia. The authors, in fact, highlighted that correct postural control allows better balancing of muscle tension with enhanced laryngeal movements and a benefit on voice production.

Several authors have investigated the relationship between voice characteristics and posture using a stabilometric platform⁴⁻⁸. A significant correlation between postural anomalies and increased perylaryngeal tension as well as an improvement in postural control of patients with MTD after voice rehabilitation were demonstrated⁴⁻⁶.

Postural alterations and imbalances can be treated through vestibular rehabilitation that allows functional recovery.

Starting from aforementioned notions and studies, we were inspired by an interesting paper by Lobryeau-Desnus et al.⁹ describing the improvement of rehabilitation strategies of

functional dysphonias in relation to posture after clinical assessment and recordings of posture obtained using a stabilometric platform. The rationale of this study is to combine vestibular postural rehabilitation techniques (Neuro-Com Balance Master training protocols) to voice exercises, in an attempt to optimise the effectiveness of MTD through better posture control. The limits of other treatments are related to the lack of attention to postural involvement. This condition represents both the basis and the consequence of voice alterations. We propose a new method, adding innovative postural exercises to classic rehabilitation, in order to improve both patient outcomes and compliance in an attractive manner, overcoming the limits of other treatments.

Materials and methods

Subjects affected by MTD were enrolled in the study. The recruitment took place at the Phoniatic Unit of the Fondazione Policlinico “A. Gemelli” IRCCS of Rome. Two expert otolaryngologists of the same Unit, not involved in this study, provided a diagnosis of MTD. The inclusion criteria were: age within 18-65 years, Italian mother language, onset of dysphonia for at least 6 months, absence of auditory and visual sensory deficits, negative history of smoking, BMI < 30 kg/m², no previous voice therapy. Vocal fold benign lesions, audio-vestibular diseases, habitual use of ototoxic drugs, cervical hernia, alcohol abuse, chronic inflammatory diseases of upper aerodigestive tract, gastro-oesophageal reflux, endocrinological and neurologic disorders, previous thyroid, spine or orthopaedic surgery and accident-related neck injuries were exclusion criteria. Nine subjects (8 women and 1 man) aged between 22 and 55 years were enrolled. In all cases multidimensional voice assessment was performed before and 30 days after the end of treatment.

Stroboscovideolaryngoscopy was carried out using the DIVAS XION software and a flexible fiberoptic laryngoscope (model XionGmbh Video-Nasopharyngoscope EV-NE, Germany). The presence of endoscopic features of MTD were evaluated by two examiners using the Morrison-Ramagge classification¹⁰ (Tab. I).

MPT was obtained by asking the patient to sustain the vowel /a/ as long as possible on a single breath. The longest of three attempts was calculated as the MPT.

Blind auditory-perceptual evaluation using the GRBAS (Grade, Roughness, Breathiness, Asthenia, Strain) scale¹¹ was performed on recorded voice samples by two speech therapists who were not involved in the patients’ voice treatment. Patients were asked to read aloud the first three sentences (53 words, 107 syllables) of the passage “Il deserto” by Schindler¹². Acoustic signals were digitised at 20 kHz.

Table I. Morrison-Rammage classification of muscle tension dysphonia ¹⁰.

MTD		
Type 1	The laryngeal isometric	Isometric contraction of the larynx associated with posterior adductor deficit
Type 2	Lateral hyperadduction state: supra-glottic	Supra-glottic contraction with adduction in the midline
Type 3	Supraglottic antero-posterior contraction	Anteroposterior contraction at supraglottic level with reduced space between epiglottis and arytenoids
Type 4	Squeeze	Extreme anteroposterior contraction of the larynx

Each recorded speech sample was made anonymous and distributed to the raters in a random order. Finally, patient self-assessment was carried out using the Italian version of the Voice Handicap Index (VHI) ¹³.

Vestibular evaluation included Bed Side Examination ¹⁴ (Romberg test, Fukuda test, assessment of spontaneous nystagmus, Head Shaking test, Head Impulse test, research of position and positioning nystagmus) and Video Head Impulse test ¹⁵. Patients were also submitted to balance examinations by dynamic posturography (DP) performed with Equitest, Neurocom International, Inc., Clackamas, Oregon, USA, using the Sensory Organization Test (SOT) ¹⁶. Parameters evaluated were equilibrium score (ES), numerical index of the subject's equilibrium, and sensory analysis (SA) in order to evaluate functional integrity of the 3 balance subsystems (Somatosensorial, Visual and Vestibular). In order to evaluate the presence of vestibular symptoms we used the Italian Dizziness Handicap Inventory (DHI), a questionnaire widely used in clinical practice that can quantify dizziness-related physical and emotional symptoms and restrictions in daily activities ¹⁷. We also used the Conley Scale to assess the risk of falls ¹⁸.

As for multidimensional voice assessment, vestibular function, postural control, DHI and Conley Scale were assessed before and 30 days after therapy.

All patients underwent voice exercises combined with balance training (see below) once a week for a total of 6 sessions of 35 minutes.

The equipment for combined therapy included the Neurocom Balance Master, a dual force plate system composed of 4 load cells that detect pressure, connected to a computer and monitor. The system provides a visual representation of the gravity centre of the subject.

During vocal exercises, subjects were seated on wooden supports and saw fixed or mobile targets on a monitor placed at an adequate distance to have correct visual aim.

The platform allowed the displacement of the centre of gravity necessary for patients to move and try to visually achieve

the objectives presented. Each patient was then asked to maintain or shift weight to ensure that the representation of their centre of gravity reached the targets visually presented on the monitor. The arrangement of the stimuli varied according to the exercises and the level of complexity of the training. Each exercise lasted from 60 to 120 seconds.

The movement exercises provided by the training consisted of "Pelvic Tilt" (forward and backward), "Lateral Slides" (left and right), "Weight Shifts" with trials to right, left, back and forth and finally "Circles" (Fig. 1). At the end of each exercise, a percentage score, which depended on the accuracy of the task performed, was obtained.

This experimental approach involved a body awareness path at the beginning of each session with exercises for muscle relaxation and posture perception, followed by the setting of correct diaphragmatic breathing, essential for a good pneumo-phono-articulatory coordination.

Voice exercises performed on the platform while trying to hit the target marked on the monitor, included: emissions of an occlusive alveolar consonant (/t/) + the vibrating consonant /r/ isolated or associated with the vowel /a/ or the vowel /a/ and the nasal consonant /m/; vocalisations with single vowels, in pairs and in triplets; production of continuous sound with fricatives (/f/, /s/, /ʃ/) + vowel; production of automatic series; reading of word lists with soft attack.

Statistical analysis

Statistical analysis was performed using commercially available software (Excel; Microsoft Corp; Redmond, Washington). Continuously distributed outcomes were summarised as the mean and categorical outcomes with frequencies and percentages. Quantitative data were compared using the Mann-Whitney test. Wilcoxon test for ordinal data was used to compare pre- and post-treatment GR-BAS scores. The significance level was set at 0.05.

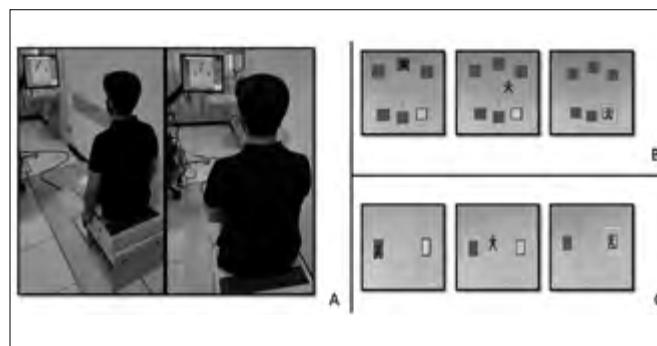


Figure 1. (A) position of the patient during combined voice therapy; (B) representation of the patient and targets on the monitor (circles); (C) representations of patients and targets on the monitor (lateral slides).

Table II. Altman's (1999) levels of agreement and symbolic codes.

Cohen's Kappa	Level of agreement	Symbol
< 0	Absent	x
0.00-0.2	Poor	#
0.21-0.4	Sufficient	*
0.41-0.6	Moderate	†
0.61-0.8	Good	¥
0.81-1	Very good	\$

Table III. Pre- and post-treatment VHI mean scores with p-values.

VHI	Pre-treatment	Post-treatment	P-values
Functional subscale	21.50 ± 9.38	9.66 ± 15.04	0.01
Emotional subscale	12.47 ± 7.14	8.32 ± 6.52	< 0.01
Physical subscale	24.33 ± 5.63	20.76 ± 8.57	0.02
Total score	58.3 ± 12.15	38.74 ± 20.13	0.03

For all subjective ratings (stroboscopy and perceptual analysis) the inter-rater reliability of each parameter was calculated with the Cohen Kappa coefficient. For the interpretation of the strength of the agreement, the nomenclature of Altman¹⁹ was used (Tab. II).

Results

Before treatment based on stroboscopy features, cases were distributed as follows: 7/9 (77.8%) MTD Type 2, 2/9 (22.2%) MTD Type 3. After treatment 8/9 (88.9%) patients showed a physiologic adduction pattern, and 1/9 (11.1%) showed a persistent lateral supraglottic contraction (MTD Type 2). The degree of inter-rater agreement at both baseline and post-treatment assessments was greater than 0.61. The mean MPT improved significantly after therapy, increasing from 10.0 (± 3.07) seconds to 12.4 (± 3.77) seconds ($p < 0.05$). The pre- and post-treatment VHI results are shown in Table III.

A significant improvement was found between pre-treatment and post-treatment scores in each subscales and in the total score.

Regarding the GRBAS scale, significant improvement of the following parameters was obtained: Grade ($p = 0.01$), Breathiness ($p = 0.01$), Asthenia ($p = 0.02$) and Strain ($p = 0.02$). Table IV reports the number of patients with a given score for each parameter in both the pre- and post-treatment settings. For all parameters of the GRBAS scale, the degree of inter-rater agreement in both the baseline and post-treatment assessments was greater than 0.61. Vestibular clinical results showed a normal vestibular function in all patients before and after therapy for both bedside examination and VHIT.

The postural control evaluated by DP was also normal: in particular, for the Equilibrium Score before therapy the median was 71 with a slight improvement after therapy (median 75). Sensory analysis showed: normal values of the somatosensory component (median 95) with an improvement after treatment (median 98). The visual component had a median of 76 before therapy and 83 after therapy, and the vestibular component was also normal with median values ranging from 65 before to 66 after therapy (Fig. 2). Finally, DHI results demonstrated normal values of functional, emotional and physical scores before and after treatment. Likewise, the Conley Scale did not demonstrate a risk of falls for patients before or after therapy.

Discussion

The aim of this study was to propose a new method of rehabilitation for MTD that combines voice exercises with an instrumental technique for rehabilitation of balance and posture. The results showed significant improvements in MPT, VHI scores and perceptual voice evaluation (GRBAS). These results were associated with a physiologic laryngeal adduction pattern highlighted by stroboscopy in all cases except one.

The rationale for the new type of treatment proposed is based on literature data on postural changes after voice treatment in subjects with dysfunctional dysphonia^{4,6}, and in particular on the positive effects that treatment for balance disorders has on voice quality²⁰.

Table IV. Number of patients with a given score for each parameter in the pre- and post-treatment settings according to the GRBAS scale.

Score	G		R		B		A		S	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
0	0	7	5	7	1	8	1	7	2	9
1	1	1	1	1	3	0	0	1	0	0
2	2	1	1	1	1	1	2	0	6	0
3	6	0	2	0	4	0	6	1	1	0
P	0.01		> 0.05		0.01		0.02		0.02	

G: Grade; R: Roughness; B: Breathiness; A: Asthenia; S: Strain.

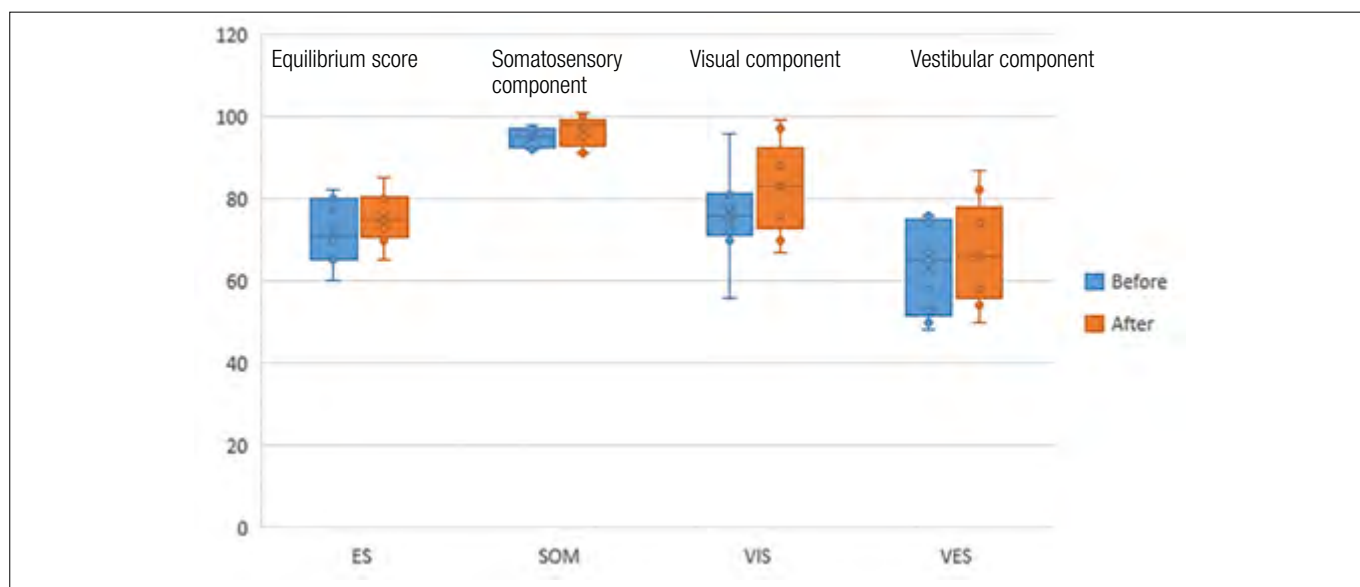


Figure 2. Results of dynamic posturography before and after combined rehabilitation.

Our results are in agreement with those of Bruno et al.⁴ and Caçador et al.^{6,20} who showed that posturographic values in dysphonic patients at baseline were within normal ranges. On the contrary, Nacci et al.⁵ and Lobryeau-Desnus et al.⁹ found postural alterations in baseline conditions with a significant improvement in the stabilometric parameters after speech rehabilitation. Postural control impairment at the baseline could be due to the vocal effort to speak of dysphonic patients, as reported by Giovanni and Grini^{7,8}. However, in another investigation, Nacci et al.⁵ did not find a pathological pattern at baseline stabilometry in dysphonic patients affected by polyps, cysts or Reinke's oedema, but only in patients with vocal cord nodules with a slight modification. Finally, after surgery, no important stabilometric changes were evident²¹.

Franco et al. in 2014²² studied sagittal spine alignment between normal and dysphonic speakers, finding significant differences. They concluded that postural measurements add important information to speech assessment protocols that is useful for treatment strategies.

Other interesting reports regarded teachers who require the use of voice for long time, without breaks and in difficult conditions during their profession. Both Cardoso et al.²³ and Kooijman et al.²⁴ investigated the associations between incorrect posture, excessive tension of the external muscles of the larynx, and voice handicap in teachers. Two studies confirmed the importance of assessment of muscular tension and body posture in the diagnosis of voice disorders. Longo et al.²⁵ recently evaluated the effect of body posture on voice parameter in professional

musician-singers singing with and without an instrument: they found that the body posture selected by the musician while playing the instrument may affect expiration and phonation.

An interesting correlation could be with laryngopharyngeal reflux (LR), which represents an important cause of voice disorders. In our small series, none of the patients referred LR and therefore no dietary recommendations could be proposed as suggested by Lechien et al.²⁶, such as low fat, low-quick-release sugar, high-protein, alkaline, and plant-based.

However, in our results we also found that somatosensory and visual inputs improved slightly after therapy. Contrary to Caçador et al.⁶, in our experience, the vestibular component did not change because the therapy itself did not improve a normal situation. The sitting position of the patients during the rehabilitation session justifies the greater improvement of visual inputs compared to the somatosensory ones found in our sample. In relation to normal vestibular function, as shown in bedside evaluation and VHIT, we only tried to improve some postural aspects that could potentially influence voice quality.

Our results after therapy with the vestibular instrumental technique for rehabilitation are also in agreement with Caçador et al.²⁰, who investigated the association between voice and balance disorders. The study analysed vocal differences (clinical, video-endostroboscopic, audio-perceptual and acoustic vocal parameters) in patients with vestibular dysfunction treated with vestibular rehabilitation. The authors demonstrated that all patients had supraglottic

hyperfunction and abnormal values on audio-perceptual evaluation before treatment. After vestibular rehabilitation, patients showed a significant improvement in laryngeal conditions and perceptual measurement of the voice. These very interesting data confirm our hypothesis for a possible application of vestibular therapy in the phoniatic field in a future multidisciplinary perspective. On the other hand, in presence of patients with vestibular disorders and voice dysfunction we can propose a single treatment for both conditions which can lead to a reduction in rehabilitation times and costs.

The bias of the present work is the limited number of patients involved, although our results encourage further studies to confirm our data. Postural rehabilitation could also be performed with different and more personalised exercises related to general conditions and patient's compliance to the rehabilitation treatment.

In conclusion, a greater focus of patients on postural rearrangement may improve the voice and our rehabilitation method can improve this attention leading to better results, with good acceptance and adherence to therapy.

Conflict of interest statement

The authors declare no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions

PMP: study conception and design; YL, GO, LC: data collection; MRM, PMP, LDA: analysis and interpretation of results; PMP, YL, LDA: draft manuscript preparation. PMP, MRM, YL, GO, LC, LDA: reviewed the results and approved the final version of the manuscript.

Ethical consideration

This study was approved by the Institution "Fondazione Policlinico Universitario A. Gemelli IRCCS - Università Cattolica del Sacro Cuore" (Prot. N. 0038806/21).

The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki.

Written informed consent was obtained from each participant/patient for study participation and data publication.

References

- ¹ Cunha Pereira G, de Oliveira Lemos I, Dalbosco Gadenz C, et al. Effects of voice therapy on muscle tension dyspho-

- nia: a systematic literature review. *J Voice* 2018;32:546-552. <https://doi.org/10.1016/j.jvoice.2017.06.015>
- ² Guzmán M, Castro C, Madrid S, et al. Air pressure and contact quotient measures during different semioccluded postures in subjects with different voice conditions. *J Voice* 2016;30:759.E1-E759.E10. <https://doi.org/10.1016/j.jvoice.2015.09.010>
- ³ Cardoso R, Lumini-Oliveira J, Meneses RF. Associations between posture, voice, and dysphonia: a systematic review. *J Voice* 2019;33:124.E1-E124.E12. <https://doi.org/10.1016/j.jvoice.2017.08.030>
- ⁴ Bruno E, De Padova A, Napolitano B, et al. Voice disorders and posturography: variables to define the success of rehabilitative treatment. *J Voice* 2009;23:71-75. <https://doi.org/10.1016/j.jvoice.2007.06.002>
- ⁵ Nacci A, Fattori B, Mancini V, et al. Posturography analysis in patients with dysfunctional dysphonia before and after speech therapy/rehabilitation treatment. *Acta Otorhinolaryngol Ital* 2012;32:115-121.
- ⁶ Caçador M, Papoila A, Brás-Geraldes C, et al. Evaluation of postural changes using dynamic posturography after speech rehabilitation in patients with voice disorders: a longitudinal study. *Folia Phoniatr Logop* 2020;72:282-289. <https://doi.org/10.1159/000500808>
- ⁷ Giovanni A, Akl L, Ouaknine M. Postural dynamics and vocal effort: preliminary experimental analysis. *Folia Phoniatr Logop* 2008;60:80-85. <https://doi.org/10.1159/000114649>
- ⁸ Grini MN, Ouaknine M, Giovanni A. Contemporary postural and segmental modification of forced voice. *Rev Laryngol Otol Rhinol (Bord)* 1998;119:253-257.
- ⁹ Lobryeau-Desnus C, Girard P, Daguenant C, et al. Stratégies rééducatives des dysphonies dysfonctionnelles et capacités posturales [Rehabilitation strategies of dysfunctional dysphonias in relation to posture]. *Rev Laryngol Otol Rhinol (Bord)* 2010;131:69-72.
- ¹⁰ Morrison MD, Rammage LA. Muscle misuse voice disorders: description and classification. *Acta Otolaryngol* 1993;113:428-434. <https://doi.org/10.3109/00016489309135839>
- ¹¹ Hirano M. Psycho-acoustic evaluation of voice. In: Hirano M, editor. *Clinical examination of voice*. New York: Springer-Verlag; 1981.
- ¹² Schindler O. *Breviario di patologia della comunicazione*. Vol. 2. Torino: Omega; 1985.
- ¹³ Schindler A, Ginocchio D, Atac M, et al. Reliability of the Italian IN-FVo scale and correlations with objective measures and VHI scores. *Acta Otorhinolaryngol Ital* 2013;33:121-127.
- ¹⁴ Straumann D. Bedside examination. *Handb Clin Neurol* 2016;137:91-101. <https://doi.org/10.1016/B978-0-444-63437-5.00007-8>
- ¹⁵ MacDougall HG, Weber KP, McGarvie LA, et al. The video head impulse test: diagnostic accuracy in peripheral vestibulopathy. *Neurology* 2009;73:1134-1141.
- ¹⁶ Hong SK, Park JH, Kwon SY, et al. Clinical efficacy of the Romberg test using a foam pad to identify balance problems: a comparative study with the sensory organization test. *Eur Arch Otorhinolaryngol* 2015;272:2741-2747. <https://doi.org/10.1007/s00405-014-3273-2>
- ¹⁷ Nola G, Mostardini C, Salvi C, et al. Validity of Italian adaptation of the Dizziness Handicap Inventory (DHI) and evaluation of the quality of life in patients with acute dizziness. *Acta Otorhinolaryngol Ital* 2010;30:190-197.
- ¹⁸ Guzzo AS, Meggiolaro A, Mannocci A, et al. Conley Scale: assessment of a fall risk prevention tool in a General Hospital. *J Prev Med Hyg* 2015;56:E77-E87.
- ¹⁹ Altman DG. *Practical statistics for medical research*. New York: Chapman & Hall/CRC Press; 1999.
- ²⁰ Caçador M, Papoila A, Brás-Geraldes C, et al. Evaluation of vocal changes after vestibular rehabilitation in patients with balance disorders. *J Vestib Res* 2020;30:109-120. <https://doi.org/10.3233/VES-200697>

- ²¹ Nacci A, Romeo SO, Berrettini S, et al. Stabilometric findings in patients affected by organic dysphonia before and after phonosurgery. *Acta Otorhinolaryngol Ital* 2017;37:286-294. <https://doi.org/10.14639/0392-100X-1035>
- ²² Franco D, Martins F, Andrea M, et al. Is the sagittal postural alignment different in normal and dysphonic adult speakers? *J Voice* 2014;28:523.E1-E8. <https://doi.org/10.1016/j.jvoice.2014.01.002>
- ²³ Cardoso R, Meneses RF, Lumini-Oliveira J, et al. Associations between Teachers' posture, muscle tension and voice complaints. *J Voice* 2021;35:933.E23-E933.E31. <https://doi.org/10.1016/j.jvoice.2020.02.011>
- ²⁴ Kooijman PGC, de Jong FICRS, Oudes MJ, et al. Muscular tension and body posture in relation to voice handicap and voice quality in teachers with persistent voice complaints. *Folia Phoniatr Logop* 2005;57:134-147. <https://doi.org/10.1159/000084134>
- ²⁵ Longo L, Di Stadio A, Ralli M, et al. Voice parameter changes in professional musician-singers singing with and without an instrument: the effect of body posture. *Folia Phoniatr Logop* 2020;72:309-315. <https://doi.org/10.1159/000501202>
- ²⁶ Lechien JR, Crevier-Buchman L, Distinguin L, et al. Is diet sufficient as laryngopharyngeal reflux treatment? A cross-over observational study. *Laryngoscope* 2022;132:1916-1923. <https://doi.org/10.1002/lary.29890>