applied sciences

MDPI

Review

Biography of Muscle Tension Dysphonia: A Scoping Review

Sol Ferrán, Octavio Garaycochea, David Terrasa, Natalia Díaz Zufiaurre, Juan Alcalde and Secundino Fernández *

Department of Otolaryngology Head and Neck Surgery, Hospital-School of Medicine, University of Navarra, 31008 Pamplona, Spain; sferran@unav.es (S.F.); ogaraycoche@unav.es (O.G.); dterrasa@unav.es (D.T.); ndiazzu@unav.es (N.D.Z.); jalcalde@unav.es (J.A.)

* Correspondence: sfgonzalez@unav.es; Tel.: +34-948-255-400

Abstract: Background: Muscle Tension Dysphonia is a relatively new clinical entity that, despite being one of the most frequent causes of functional dysphonia, is little-known by many otorhinolaryngologists. **Objective**: The objective of the current work is to describe the evolution of Muscle Tension Dysphonia—the concepts and the ways it has been diagnosed and treated—from its first descriptions to our current knowledge. **Design**: A scoping review was conducted using the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist. A search of three bibliographic databases was performed to identify original articles on Muscle Tension Dysphonia. Study selection and characterization was conducted by three independent reviewers and was further reviewed by a fourth individual. In case of relocating any of the studies, it was performed by agreement of two reviewers. We excluded articles not written in English or Spanish, letters to the editor, review articles, studies of the pediatric population, articles related to dysphagia, and other publications that were not relevant. **Results**: The search identified 1144 articles published from 1983 to December 2022. A total of 581 studies were repeated and another 462 were excluded because they were not written in English or Spanish, were not original articles, or were not relevant to the objective of the study. Finally, 101 articles were included in the review. The articles included in the review were divided into three groups considering the objective and conclusions of each study: 21 articles were classified as "Etiology and Physiopathology", 29 articles as "Diagnosis", and 51 articles were included in the "Treatment" group. **Conclusions**: The concept of Muscle Tension Dysphonia has been developed during the last forty years. For its diagnosis, endoscopic visualization of the larynx is crucial, but must be combined with the patient's clinical history and other methods can also be useful. This entity should be addressed in a multidisciplinary approach, with the active participation of speech therapists. Most therapeutic options include voice education, vocal hygiene, and rehabilitation of the voice.

Keywords: muscle tension dysphonia; speech therapy; hyperfunction

Citation: Ferrán, S.; Garaycochea, O.; Terrasa, D.; Díaz Zufiaurre, N.; Alcalde, J.; Fernández, S. Biography of Muscle Tension Dysphonia: A Scoping Review. *Appl. Sci.* **2024**, *14*, 2030. https://doi.org/10.3390/app14052030

Academic Editor: Michael Döllinger

Received: 13 February 2024
Revised: 22 February 2024
Accepted: 27 February 2024
Published: 29 February 2024

1. Introduction

The term known as "Muscle Tension Dysphonia" (MTD) is relatively new. It has taken a matter of years to reach the entity that we know today with this name, due to the lack of knowledge of its pathophysiology. A few years ago, all dysphonia devoid of organic lesions in the vocal folds were classified as functional voice disorders, and certain psychological characteristics were assumed in these patients [1].

Over the last decade, MTD has been defined as a functional voice disorder characterized by excessive tension in the extrinsic laryngeal musculature during phonation but without organic or neurological alterations [1]. The increase in muscular tension generates an abnormal laryngeal position during phonation: the larynx is elevated, and there is some degree of glottic and/or supraglottic compression. This affects the position of cartilaginous structures and, therefore, affects the intrinsic musculature of the larynx, the vocal folds, and

glottic closure during phonation, resulting in changes in qualities of the voice. A decade ago, it comprised approximately 10–40% of clinical cases in voice centers [2,3].

Based on the mechanism that unleashes this increase in muscular tension, MTD is classified in the "Classification manual for voice disorders-I, 2006" into primary or secondary types. Primary MTD is characterized by an increase in tension that is independent of any external mechanism: it is an alteration of the phonation mechanism itself. In secondary MTD, the mechanism responsible for the increase in muscular tension is a compensatory reaction to a mechanism that alters the function or structure of the glottis [4].

Thanks to new diagnostic methods, it is possible to achieve a better comprehension of dysphonia caused by excessive muscle tension. The aim of this scoping review is to provide a historical review of Muscle Tension Dysphonia, including definition, assessment methods, and treatment approaches, as these have evolved over the years. Knowledge of them will undoubtedly help voice specialist to understand the process that each patient is undergoing and to propose specific treatments in order to improve their situation.

History

The origin and foundations of what is currently known as Muscle Tension Dysphonia (MTD) lie in the early 1980s. In 1982, Koufman and Blalock [5], in an attempt to better define and organize functional disorders of the voice, proposed a way to classify these disorders by dividing them into five big groups: conversion reaction, postviral chronic hoarseness, inappropriate falsetto, postoperative dysphonia, and vocal misuse/abuse syndromes. Half of the patients belonged to the group with vocal misuse or abuse syndromes (VMS). Moreover, most of the patients in the VMS group had altered skeletal laryngeal muscle tension, characterized by chronic intermittent dysphonia and vocal fatigue. On this basis, the authors decided to refer to this disorder as laryngeal tension–fatigue syndrome (TFS). This type of disorder affected, according to the authors, 25% of all functional voice disorders [5]. Moreover, the authors differentiated TFS in the voices professional and non-professional subjects. According to the authors, in the former, the tone of the voice is very low, while, in the non-professionals, the tone of the voice is variable. TFS syndrome in voice professionals was labeled as Bogart–Bacall syndrome [6].

TFS was the predecessor of what is currently known as Muscle Tension Dysphonia (MTD), since TFS is a functional voice disorder characterized by an alteration of tone but with a normal appearance of the larynx by physical examination. The concept of TFS, however, was limited by the fact that it only applied to cases in which the origin of the dysphonia was VMS; it did not cover other possible etiological factors [1].

The term MTD was first used in 1983 by Morrison and Rammage [7]. In their work, these authors described the clinical characteristics of young people who made excessive use of the voice under stress. As in TFS, the authors found an increase in muscle tension in MTD. They assessed this muscle tension by palpation of the extrinsic laryngeal musculature and by means of laryngeal fibroscopy when evaluating the behavior of the larynx during phonation [8]. However, the principal difference between MTD and TFS, and the reason why the new term came to be more-widely used internationally, is that MTD denotes a pathological condition in which the increased laryngeal and/or para-laryngeal muscle tension can be caused by diverse etiological factors. The newer term covers a clinical disorder that can arise from various factors and not just VMS [1].

We chose to conduct a scoping review because our topic of interest is very broad, and this type of study allows us to systematically summarize findings and identify gaps in the literature among studies with heterogeneous methods. This scoping review was guided by the following questions: (1) What is the historical origin and background of what we know today as MTD? (2) How is the diagnosis of MTD made, and what tools do we currently have in daily clinical practice? (3) What are the actual treatment options for MTD?

2. Materials and Methods

For the elaboration of the scoping review, we have followed the recommendations established in "PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation" by Triccoa et al. [9]. The initial search was implemented in December 2022 in three electronic databases: Pubmed, Scopus, and Web of Science. These databases were selected as they are the most widely used in our field. The search query consisted of the Medical Subject Heading (MeSH): "Muscle Tension Dysphonia".

The search included all papers published up to April 2023. Studies were eligible for inclusion only if they included non-pediatrics subjects with the diagnosis of MTD. Letters to the editor, review articles, case reports, book chapters, and other non-original articles were excluded from the analysis. Only articles published in English and Spanish were included, because these are the languages that could be reviewed by the authors. The search and selection strategy were carried out by one of the study investigators and was subsequently discussed with the rest of the research group. Four reviewers, working in pairs, sequentially evaluated the titles, abstracts, and full text of all publications identified by our searches for potentially relevant publications. Disagreements about study selection and data extraction were solved by agreement after discussion with other reviewers and, if necessary, a fifth author resolved the conflict.

The articles included in the review were divided into three groups considering the objective and conclusions of each study: Etiology and Physiopathology, Diagnosis, and Treatment. For each group, a series of common variables were extracted (author, year, title, type of study, number of participants, and conclusion of the work). For the Diagnosis group, the diagnostic method used was added, and for the Treatment group, the therapeutic measure studied and the method used to assess the results of the treatment were also added. Two reviewers filled in the data independently, discussed the results, and updated the tables shown in the study results.

3. Results

The search returned a total of 1144 articles published between 1983 and April 2023. A total of 581 studies were repeated. We excluded letters to the editor (3), notes (2), review articles (57), book chapters (8), case reports (8), conference papers (9), "how I do it" articles (1), patient pages (1), and the studies involving the pediatric population (11), because it is a population that should be studied separately from young people and adults [10]. Articles related to dysphagia (10), spasmodic dysphonia (37), vocal fold lesions (16), laryngopharyngeal reflux (7), vocal paralysis (10), and laryngeal hypersensitivity syndrome (4) were excluded. Other non-organic laryngeal dysfunctions, different treatments and/or diagnosis techniques in studies not including MTD patients, and other publications that were not relevant to the review (247) were also excluded because they did not focus exclusively on MTD or did not refer to a specific type of dysphonia. At the end of the process, 101 articles remained and were included in the review (Figure 1).

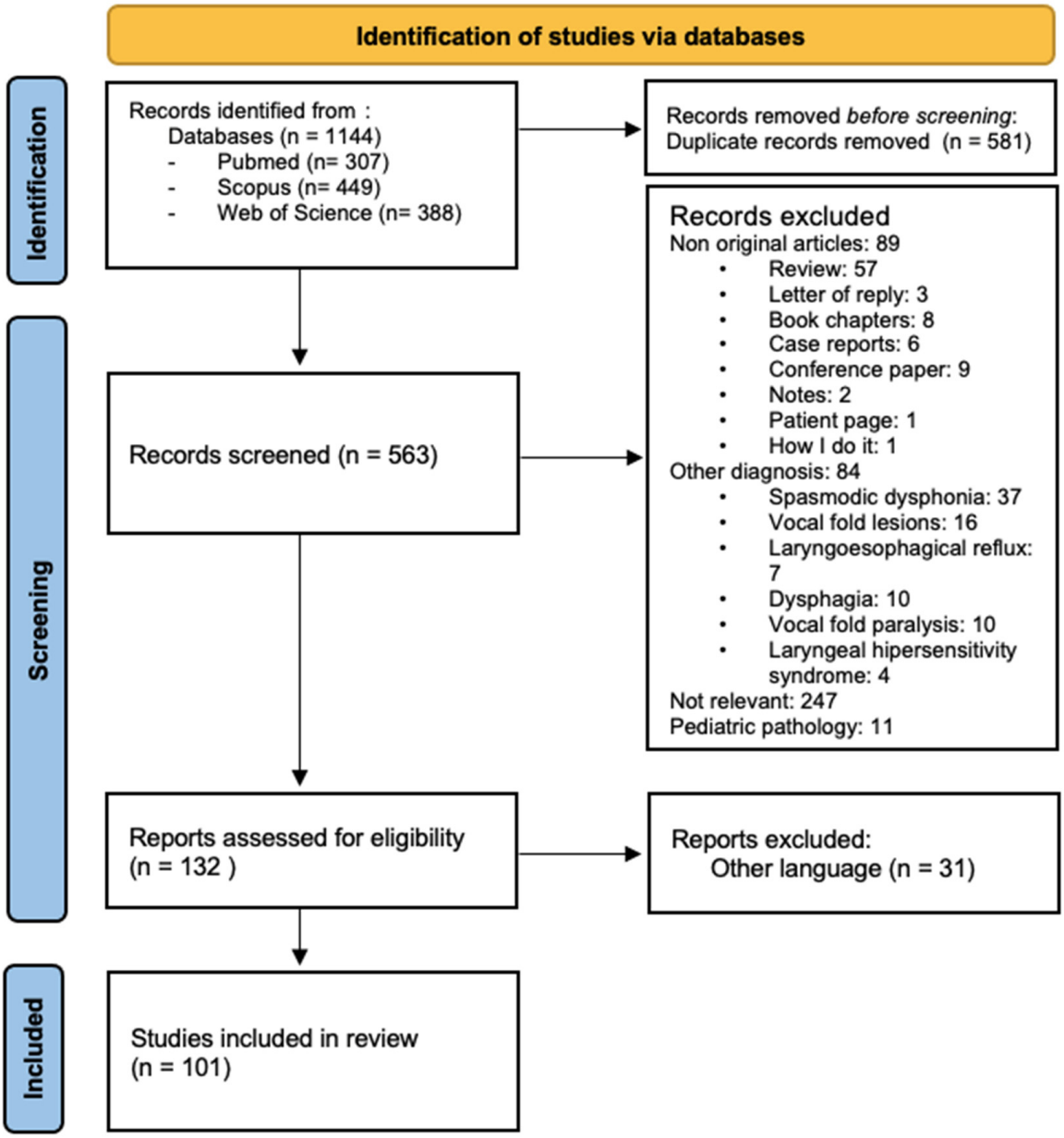

Figure 1. Literature search strategy. Based on the PRISMA method.

3.1. Etiology and Physiopathology

Table 1 shows the 21 articles that were classified in the group "Etiology and Physiopathology". Two of these studies could have also been included in the diagnostic group [11] or in the treatment group [12], but the pathophysiology group was considered more appropriate because the findings shed light on pathophysiological factors involved in this pathology. The knowledge of the etiology of this pathology has been progressing since it was first described.

Alterations in the position of the larynx and the hyoid bone have been found in patients with MTD at a higher rate than in healthy subjects [13–15]. Postural strategy has also been shown to be a factor to consider in the development (and even in the treatment) of this pathology [11].

In addition to increased tension in the paralaryngeal and supraglottic musculature [13], MTD has also been associated with glottic insufficiency [16], with involuntary glottic closure during inspiration [17], and with various respiratory attitudes such as "breath

holding" [18]. It has also been shown that the smaller the ventricular gap, the greater the glottic resistance [19].

Table 1. Summary of articles about etiology and physiopathology.

No.	Author	Year	Title	Type of Study	N	Results/Conclusions
1	Belisle	1983	Anatomic Correlation for Muscle Tension Dysphonia	Quasi-experimental	6 human larynx	Dysphonia resulting from increased muscular tension in the larynx and neck is associated with palpably increased phonatory muscle tension in the paralaryngeal and suprahyoid muscles, elevation of the larynx in the neck on increasing vocal pitch, an open posterior glottic chink between the arytenoid cartilages on phonation, and variable degrees of mucosal changes.
2	Morrison	1983	Muscular Tension Dysphonia	Cross-sectional	500	Morrison–Rammge Classification system.
3	Koufman	1988	Vocal Fatigue and Dysphonia in the Professional Voice User: Bogart–Bacall syndrome.	Cross-sectional	67	There is a particular variation of tension–fatigue syndrome in professional voice users. The pattern is distinguishable from other medical and neurological conditions. The diagnosis is primarily clinical. There must be an otolaryngologist and a voice therapist to approach and treat the condition.
4	Stager	2000	Supraglottic Activity: Evidence of Vocal Hyperfunction or Laryngeal Articulation?	Case-Control	32	There is no evidence that supraglottic activity may be a precursor to developing vocal fold nodules, as the nodule patients did not exhibit a higher incidence or consistency of A–P or FVF compression than patients with hyperfunctional voicing patterns in this study.
5	Belafsky	2002	Muscle Tension Dysphonia as a Sign of Underlying Glottal Insufficiency	Cross-sectional	100	Vocal fold bowing is common in persons with underlying glottal insufficiency. Clinicians should be aware that compensatory MTD profiles may mask an underlying organic condition.
6	Vertigan	2006	Involuntary Glottal Closure During Inspiration in Muscle Tension Dysphonia	Case-Control	30	There is a higher prevalence in MTD patients than in healthy controls of abnormal glottic closure during inspiration similar to PVFM, which suggests that they either had previously undiagnosed coexisting PVFM or that the condition of MTD could be expanded to include descriptions of aberrant glottic function during respiration.
7	Duong	2009	Muscle Tension Dysphonia in Vietnamese Female Teachers	Cross-sectional	47	The findings implied the potential contribution of linguistic-specific factors and teaching-related factors to the presentation of this voice disorder in this group of teachers.
8	Lowell	2012	Position of the Hyoid and Larynx in People with Muscle Tension Dysphonia	Case-Control	20	Hyoid and laryngeal positions during phonation are higher in people with primary MTD as compared to people without voice disorders.

Table 1. *Cont.*

No.	Author	Year	Title	Type of Study	N	Results/Conclusions
9	Van Houtte	2012	UES Pressure During Phonation Using High-resolution Manometry and 24-h Dual-probe pH-metry in Patients with Muscle Tension Dysphonia	Case-Control	28	This study was not able to detect differences in phonation-induced UES pressures between patients with MTD and normal speakers using a standard water-perfusion high-resolution manometry assembly.
10	Gillespie	2013	Aerodynamic Profiles of Women With Muscle Tension Dysphonia/Aphonia	Cohort	90	This study identified five distinct subgroups of aerodynamic profiles in women with MTD/A and quantitatively identified the "breath holding" phenomenon. The results suggest that diverse respiratory and laryngeal functions may underlie phonatory patterns associated with MTD/A.
11	Alipour	2014	Aerodynamic and Acoustic Effects of Ventricular gap	Experimental	7 excised canine larynx	Wide ventricular gaps were associated with increases in fundamental frequency and decreases in glottal resistance. Ventricular compression may interact with true vocal fold posture and vibration, resulting in predictable changes in aerodynamic, physiological, acoustic, and perceptual measures of phonation.
12	Faralli	2017	The Effect of Speech Rehabilitation Therapy for Muscle Tension Dysphonia on Global Postural Strategy	Cross-sectional	26	There was a statistically significant improvement of all previously altered posturographic parameters. This study shows that MTD might interfere with global postural strategy through the involvement of all cervical muscles' proprioception.
13	Kryshtopava	2017	Brain Activity During Phonation in Women With Muscle Tension Dysphonia: An fMRI Study.	Case-Control	25	The findings in this study provide insight into phonation and exhalation control in patients with MTD. The imaging results demonstrated that, in patients with MTD, altered brain activities may result in laryngeal tension and vocal hyperfunction.
14	McKenna	2020	Voice Onset Time in Individuals With Hyperfunctional Voice Disorders: Evidence for Disordered Vocal Motor Control	Case-Control	64	Speakers with VH exhibited greater variability in phonemic voicing targets compared to vocally healthy speakers, supporting the hypothesis for disordered vocal motor control in VH.
15	Ali	2020	Muscle Tension Dysphonia: Experience from a Conflict Zone	Cross-sectional	72	Stress scores were considerably higher for individuals with MTD as compared to the healthy population. Also, scores were much higher in women as compared to men. Emotional stress might play a major role in the upkeep of MTD.

Table 1. *Cont.*

No.	Author	Year	Title	Type of Study	N	Results/Conclusions
16	Dabirmo-ghaddam	2021	Comparative Study of Increased Supraglottic Activity in Normal Individuals and Those with Muscle Tension Dysphonia (MTD)	Case-Control	125	On the four aMTPs, results revealed that one must exercise caution in diagnosing MTD based on MTP 2 (medial compression of ventricular folds), and this must not be the sole criterion for diagnosis. Moreover, cepstral peak prominence and MPT analyses are of high clinical significance.
17	Abur	2021	Impaired Auditory Discrimination and Auditory–Motor Integration in Hyperfunctional Voice Disorders.	Case-Control	124	There is strong evidence for auditory–motor disruptions in a substantial portion of both singers and non-singers with HVDs. The HVD group demonstrated worse auditory discrimination and a greater frequency of atypical adaptive responses, which suggests impairments in how auditory feedback errors are detected and how the auditory–motor feedforward plan is updated in HVDs.
18	Falanga	2021	Psychological Distress in a Sample of Adult Italian Patients Affected by Vocal Nodules and Muscle-Tension Dysphonia: Preliminary Results	Case-Control	200	This study identified a high prevalence of psychological distress among patients with vocal disorders without any prior specific psychiatric diagnosis, especially in terms of anxiety and perceived stress.
19	McDowell	2022	Clinical Characteristics and Effects of Vocal Demands in Occupational Voice Users With and Without Primary Muscle Tension Dysphonia	Case-Control	30	Greater vocal effort, discomfort, instability, and perturbation within the vocal system may better define pMTD than laryngeal configuration in occupational voice users with pMTD. Similar laryngeal configurations between groups were found.
20	Sarin	2023	Muscle Tension Dysphonia: A Sequeale of Chemoradiother-apy in Patients of Head and Neck Cancer	Cohort	128	There was hyperadduction and strain of ventricular bands in almost all the cases. There was hyperactivity and compression of both true and false cords in 80.5% of the cases.
21	Dahl	2023	Effects of Cognitive Stress on Voice Acoustics in Individuals With HVDs	Case-Control	132	Cognitive stress and presumed autonomic arousal affect the voice similarly in female speakers with and without HVDs.

A–P: anterior to posterior; FVF: false vocal fold; PVFM: paradoxical vocal fold movement; UES: upper esophageal sphincter; VH: vocal hyperfunction; aMTPs: abnormal muscle tension pattern; MPT: maximum phonation time; HVD: hyperfunctional voice disorders; pMTD: primary Muscle Tension Dysphonia.

There have been several studies in the last decade that mention factors at the Central Nervous System level which have an influence on these patients, with altered brain activity demonstrated by fMRI [20], disordered vocal motor control in patients with vocal

hyperfunction [21], and worse auditory discrimination in these patients [22]. The influence of cognitive stress on the voice has also been studied, although no differences have been found between healthy patients and those with vocal hyperfunction [23].

Finally, different studies suggest that psychological factors such as emotional stress [24] or anxiety [25] are more prevalent in patients with MTD than in the healthy population.

3.2. Diagnosis

Table 2 shows all the 29 articles that were included in the Diagnostic group. The methods studied were voice perceptual assessment questionnaires (6), laryngeal endoscopy (4), surface electromyography (7), acoustic analysis (12), aerodynamic analysis (5), laryngeal palpatory techniques (3), and others, such as electroglottography (1), Eulerian video magnification (EVM) (1), and real-time elastosonography (RTE) (1).

Table 2. Summary of articles about diagnosis ratio.

No.	Author	Year	Title	Type of Study	N	Diagnostic Method	Conclusions
1	Hočevar-Boltežar	1998	Role of Surface EMG in Diagnostics and Treatment of Muscle Tension Dysphonia	Case-Control	16	sEMG	The results show a 6- to 8-fold increase in EMG activity and/or an alternation of the EMG activity level in the perioral and supralaryngeal muscles before and during phonation in most of the patients with MTD, but it is not clear why these muscles are activated.
2	Sama	2001	The Clinical Features of Functional Dysphonia	Control-Blinded, Cross-sectional	103	Laryngeal endoscopy during phonation	The laryngoscopy features commonly associated with FD are frequently prevalent in the nondysphonic population.
3	Hsiao	2001	Vocal Fold Abnormalities in Laryngeal Tension-Fatigue Syndrome	Cross-sectional	301	Videostrobo-laryngoscopy	The results of this study suggest that chronic vocal overuse under excessive laryngeal muscle tension can cause phonotrauma and result in biomechanical property changes in the vocal fold's cover.
4	Van Lierde	2007	Long-Term Outcome of Hyperfunctional Voice Disorders Based on a Multiparameter Approach	Cohort	27	Aerodynamic and acoustical analyses, VHI, DSI	The laryngovideostroboscopic images indicated that 51% of the subjects still show pathological laryngological findings. The DSI decreased from −1 to −3.2, mainly due to the increase in the lowest intensity. The VHI-score indicates an unimportant psychosocial impact of the voice disorder.
5	Duong	2009	Effects of Muscle Tension Dysphonia on Tone Phonation: Acoustic and Perceptual Studies in Vietnamese Female Teachers	Case-Control	72	Acoustic analysis	In the MTD group, tonal F(0) was lower in teachers with longer career durations. The teachers with MTD showed different patterns of laryngealization compared with the control group. MTD impairs lexical tone phonation.

Table 2. *Cont.*

No.	Author	Year	Title	Type of Study	N	Diagnostic Method	Conclusions
6	Stepp	2010	The Impact of Vocal Hyperfunction on Relative Fundamental Frequency During Voicing Offset and Onset	Case-Control	115	Relative fundamental frequency (RFF)	Altered offset and onset RFF in patients with hyperfunction-related voice disorders can be interpreted as a byproduct of heightened levels of laryngeal muscle tension.
7	Stepp	2010	A Virtual Trajectory Model Predicts Differences in Vocal Fold Kinematics in Individuals with Vocal Hyperfunction	Case-Control	30	A simple, one degree of freedom, virtual trajectory model of vocal fold kinematics after endoscopy	These modeling results suggested that increases in gesture rate would affect kinematic features to a smaller degree in patients with vocal hyperfunction. This is due to the presence in these individuals of increased stiffness of the intrinsic laryngeal muscles and structures during typical phonation.
8	Stepp	2010	Neck Surface Electromyography as a Measure of Vocal Hyperfunction Before and After Injection Laryngoplasty	Cross-sectional	13	sEMG	Anterior neck sEMG values were not significantly reduced after the procedure; the results do not support the use of anterior neck sEMG measures to assess vocal hyperfunction.
9	Stepp	2011	Comparison of Neck Tension Palpation Rating Systems With Surface Electromyographic and Acoustic Measures in Vocal Hyperfunction	Cross-sectional	16	sEMG	Palpation rating scales do not reliably capture changes that may occur in neck muscle tension of typical voice therapy patients over one session. Consequently, little can be concluded from correlations between sEMG and palpation ratings.
10	Hosokawa	2012	Effectiveness of the Computed Analysis of Electroglottographic Signals in Muscle Tension Dysphonia	Case-Control	57	Electroglotto-graphy (EGG)	The disturbance measures of both signals in the MTD group were either as high as or significantly higher than those in the organic group or the control group, respectively. EGG parameters after therapy significantly decreased, so they are useful for the diagnosis and estimation of voice therapy outcomes in MTD.
11	Zheng	2012	Laryngeal Aerodynamic Analysis in Assisting With the Diagnosis of Muscle Tension Dysphonia	Case-Control	53	Aerodynamic analysis	For male samples, MTD patients had higher SGP, higher GR, lower MFR, and shorter MPT, whereas, for female samples, the difference between cases and controls was statistically significant in SGP and MPT.
12	Van Houtte	2013	An Examination of Surface EMG for the Assessment of Muscle Tension Dysphonia	Case-Control	62	sEMG	sEMG was not able to detect an increase in muscle tension in patients with MTD. The results of this study do not support the use of sEMG as a diagnostic tool for distinguishing patients with and without MTD.

Table 2. *Cont.*

No.	Author	Year	Title	Type of Study	N	Diagnostic Method	Conclusions
13	Izadi	2013	Comparison Between Palpatory Findings of the Hyoid Position and Their Acoustic, Videostroboscopic, and Perceptual Attributes in Patients With Muscle Tension Dysphonia (With and Without Organic Lesions)	Cross-sectional random triple-blinded study	39	Palpatory, acoustic, audioperceptual, and stroboscopic evaluation	There is a general congruence between the hyoid pulled direction and its perceptual, acoustic, and videostroboscopic findings in patients with MTD. The dominant perceptual vocal characteristic of patients with pulled-up hyoid position was rough, and the degrees of jitter and shimmer were higher in patients with pulled-up hyoid positions than in patients with pulled-down hyoid positions.
14	Roy	2016	Exploring the Clinical Utility of Relative Fundamental Frequency as an Objective Measure of Vocal Hyperfunction	Case-Control	131	Relative fundamental frequency	RFF onset appears to be sensitive to the presence and degree of suspected vocal hyperfunction before and after therapy.
15	Shim	2016	Spectral and Cepstral Based Acoustic Features of Voices with Muscle Tension Dysphonia	Case-Control	60	Cepstral and spectral acoustic features	By applying cepstral and spectral analysis and identifying the acoustic features of patients with MTD, this study demonstrated the feasibility and usefulness of cepstral parameters in clinical practice.
16	Khoddami	2017	Validity and Reliability of Surface Electromyography in the Assessment of Primary Muscle Tension Dysphonia	Cross-sectional	30	sEMG	The sEMG is a reliable tool to measure the RMS, the peak activity, and the activity duration in primary MTD. However, it is not able to discriminate the patients with primary MTD from healthy subjects.
17	Khoram-shahi	2018	Responsiveness of Persian Version of Consensus Auditory Perceptual Evaluation of Voice (CAPE-V) Persian Version of Voice Handicap Index (VHI), and Praat in Vocal Mass Lesions with Muscle Tension Dysphonia	Cross-sectional	30	Consensus Auditory–Perceptual Evaluation of Voice (ATSHA), VHI and Praat scales	This study showed high internal responsiveness for the all target parameters of the ATSHA, the total score of the VHI, and two parameters of the Praat. The target voice scale changes were not able to predict the videostroboscopy changes as an external standard.
18	Garay-cochea	2019	Muscle Tension Dysphonia: Which Laryngoscopic Features Can We Rely on for Diagnosis?	Cross-sectional	30	Fiberoptic nasal endoscopy, acoustic and aerodynamic voice assessment.	The laryngoscopic features most strongly related to an aerodynamic profile of MTD were anteroposterior and lateral compression of the larynx and vestibular fold contribution to phonation.

Table 2. *Cont.*

No.	Author	Year	Title	Type of Study	N	Diagnostic Method	Conclusions
19	Jafari	2020	A Novel Laryngeal Palpatory Scale (LPS) in Patients with Muscle Tension Dysphonia	Cross-sectional	55	LPS	The LPS is a reliable and valid instrument for assessing patients with MTD.
20	Adleberg	2020	Detection of Muscle Tension Dysphonia Using Eulerian Video Magnification: A Pilot Study	Case-Control	23	Eulerian Video Magnification software	A change in perfusion of 0% or less to infrahyoid muscles was 75% sensitive and 70% specific for diagnosis of MTD. Eulerian Video Magnification can be used in the diagnosis of MTD by focusing on the difference in perfusion to the infrahyoid muscles between rest and phonation.
21	Fernández	2020	Does More Compression Mean More Pressure? A New Classification for Muscle Tension Dysphonia.	Cross-sectional	37	Fibroendoscopy, VHI, acoustic and aerodynamic voice assessment.	Because the grade of anteroposterior compression correlates with SGP, these grades can be used for diagnosis and follow-up of MTD patients. New classification for MTD.
22	Mateos-Serrano	2021	Subjective voice analysis in patients with muscular tension dysphonia: comparison between clinician and patient evaluation.	Cross-sectional	75	VHI-10	The use of assessment scales based on the opinion of both the clinician and patient must be considered as complementary clinical tools in order to perform a complete assessment of dysphonia (a moderate correlation was found).
23	Shembel	2021	Characterization of Primary Muscle Tension Dysphonia Using Acoustic and Aerodynamic Voice Metrics	Case-Control	766	Acoustic and aerodynamic analysis	Computational models and multivariate statistical testing on 15 acoustic and aerodynamic voice metrics were unable to adequately characterize pMTD and determine differences between the two groups (pMTD and non-pMTD).
24	Jafari	2021	Comparison of Laryngeal Palpatory Scale (LPS), With Surface Electromyographic Measures in Patients with Muscle Tension Dysphonia	Cross-sectional	21	LPS, neck sEMG.	Low–moderate positive correlations between sEMG and LPS ratings were found with particular strength for LPS ratings of tightness and ratings made during dynamic tasks.
25	Lu	2021	Exploring the Characteristics of Functional Dysphonia by Multimodal Methods	Case-Control	69	GRBAS, VHI, acoustic analysis, psychological scales assessment, sEMG, nasal airflow and thoracoabdominal studies	Functional dysphonia occurs mainly in middle-aged women, and there are many triggers. The Hamilton Anxiety/Depression Rating Scale scores were higher, and the subjective symptoms were more serious than in objective evaluation.

Table 2. *Cont.*

No.	Author	Year	Title	Type of Study	N	Diagnostic Method	Conclusions
26	Martinez	2021	Vocal Parameters, Muscle Palpation, Self-Perception of Voice Symptoms, Pain, and Vocal Fatigue in Women with Muscle Tension Dysphonia.	Cross-sectional	45	Voice Symptoms Scale, Vocal Fatigue Index, and Nordic Musculoskeletal Questionnaire protocols	Women with MTD presented vocal symptoms, vocal fatigue, muscle pain, resistance to palpation, and deviated vocal parameters when compared to vocally healthy women.
27	Belsky	2021	Do Phonatory Aerodynamic and Acoustic Measures in Connected Speech Differ Between Vocally Healthy Adults and Patients Diagnosed with Muscle Tension Dysphonia?	Case-Control	170	Acoustic and aerodynamic analysis	Large variability in aerodynamic and acoustic measurements were observed in patients with primary MTD with no salient differences at the group level compared to vocally healthy participants.
28	Aghadoost	2022	Effect of Muscle Tension Dysphonia on Self-perceived Voice Handicap and Multiparametric Measurement and Their Relation in Female Teachers	Cross-sectional	50	VHI, DSI	Teachers with MTD demonstrated higher voice handicap and lower voice quality compared to the teachers without MTD.
29	Azizi Ata	2022	Strain Elastosonography Measurement in Patients with Primary Muscle Tension Dysphonia Compared with Healthy Speakers: A Pilot Study	Cross-sectional	20	Real-time elastosonography (RTE)	The RTE can discriminate patients with primary MTD from healthy subjects in some laryngeal muscles, especially suprahyoid and cricothyroid.

sEMG: surface electromyography; FD: functional dysphonia; VHI: voice handicap index; DSI: dysphonia severity index; SGP: subglottal pressure; GR: glottal re-sistance; MFR: mean airflow rate; MPT: maximum phonation time; RMS: root mean square; pMTD: primary Muscle Tension Dysphonia.

3.2.1. Subjective and Perceptual Auditory Voice Evaluation

Questionnaires and scales are commonly used to assess the quality of the patient's voice and its impact on his or her quality of life. The most generalized is the Voice Handicap Index (VHI). Seven of the Twenty-nine studies in this group use this questionnaire as a complementary instrument for the diagnosis of MTD. Only one study has used the shortened version of this questionnaire, where Mateos-Serrano [26] found a moderate correlation between the VHI-10 (on this scale, the cut-off point is above 11 out of a total of 40 points [27]) and the clinician's perceptual assessment using the GRABS scale. They recommend the combined assessment of the patient and the clinician to perform an adequate evaluation of dysphonia.

Other studies use the Persian Version of the Consensus Auditory–Perceptual Evaluation of Voice (ATSHA) [28], the Voice Symptoms scale, or the Vocal Fatigue Index [29].

3.2.2. Laryngeal Endoscopy during Phonation

There were five studies based on the visual/laryngoscopic characteristics of the vocal folds during phonation. Hsiao [30] reviewed videostrobolaryngoscopic recordings of patients with laryngeal tension–fatigue syndrome—defined as a functional dysphonia due to chronic vocal overuse under excessive laryngeal muscle tension—and observed the changes of the mucosa lining the vocal folds during vibration, looking for biomechanical causes in this type of dysphonia. He concluded that excessive laryngeal muscle tension can lead to phonotrauma and change the mechanical properties of the vocal folds.

Garaycochea [31] evaluated the laryngoscopic characteristics of these patients using a fiberoptic nasal endoscopy. He also performed an acoustic and aerodynamic voice evaluation on each patient, and he concluded that anteroposterior (AP) supraglottic contraction, supraglottic lateral contraction (LC), and the presence of a posterior glottic gap (PGG) are the most frequent profiles in MTD. AP compression is more prevalent than LC in patients with non-organic dysphonia, and it changes less when compared to LC over the course of phonation.

Fernández [32], by means of laryngoscopic vision through a fiberoptic nasal endoscopy and the performance of an aerodynamic analysis, verified that the degree of anteroposterior compression correlates with subglottic pressure.

Surface Electromyography

The first work evaluating this diagnostic method dates to 1998 [33] and found increased EMG activity in the perioral and supralaryngeal muscles before and during phonation in patients with MTD. Since then, six more studies have analyzed the role of this technique in this pathology. Some of them studied the anterior cervical muscles [34] and their correlation with the cervical tension scale [35]. The rest of the works have not found in this technique to be a method to discriminate between patients with MTD and healthy subjects.

3.2.3. Acoustic Study of the Voice

Twelve of the thirty articles in this group analyze the acoustic analysis of patients with MTD. Variations in certain acoustic parameters have been described in comparison to patients with MTD and healthy subjects or patients with other pathology. An increase in the fundamental frequency, f0, attributed to an increase in the tension and subglottal pressure, and a reduction in high frequencies, attributed to the lack of relaxation in the laryngeal muscles [36], have been described. In addition, variations have been reported in other acoustic parameters, such as shimmer, jitter, NHR (noise to harmonic; Table 2 is a summary of articles about the diagnosis ratio), and other noise-related parameters. However, the effect size of these parameters is very variable and not constant [37].

The cepstral peak prominence (CPP) is regarded as an acoustic measure of voice quality and the severity of dysphonia. Shim et al. [38] found that patients with MTD had significantly lower cepstral peak prominence (CPP) and CPP F0. They also had a significantly higher cepstral and spectral index of dysphonia (CSID) and a low- to high-frequency spectral energy ratio. Patients with MTD have also been found to have lower values of smoothed cepstral peak prominence (CPPs).

Several studies agree that acoustic analysis by itself is not useful in differentiating patients with MTD from healthy patients [39,40].

Relative fundamental frequency (RFF) is a parameter extracted from acoustic analysis that is being studied as a diagnostic indicator of MTD [41,42]. It measures changes in the fundamental frequency at transitional moments in the voice. Stepp concludes that altered values in the RFF of the cycles immediately preceding the production of a voiceless consonant (onset) and those immediately following (offset) in patients with hyperfunctional voice patterns can be interpreted as high levels of muscle tension, while Roy finds onset RFF values to be more sensitive.

3.2.4. Aerodynamic Study of the Voice

By means of aerodynamic parameters, it is possible to evaluate the characteristics and the behavior of air during phonation. The principal parameters registered and measured are SgP, mean transglottal flow (GF), and laryngeal resistance (LR). Five articles analyze the results in patients with MTD. The profile most characteristic in a patient with MTD is increased SgP together with normal or increased GF [5,29,43]. According to Zheng et al. [44], SgP enables objective diagnosis in up to 92.5% of MTD patients. They found differences between men and women; in their analysis, men with MTD had a lower mean airflow rate (MFR) and reduced maximum phonation time (MPT).

3.2.5. Laryngeal Palpatory Techniques

Laryngeal palpation (LP) techniques have been described as a method to evaluate the increase in muscular tension in MTD. Most techniques are carried out, using the thumb and middle finger, with the patient seated and with the larynx either static or dynamic. The principal parameters evaluated are the height of the larynx, resistance to movement of the larynx, pain or discomfort on exerting pressure, and subjective improvement in the voice on lowering of the larynx. The main limitation of LP is its high subjectivity [15].

Stepp tries to correlate the Neck Tension Palpation Rating Systems with the sEMG and acoustic measurements, but he does not come to any clear conclusion because they do not reliably capture the changes that can occur in neck muscle tension during a Voice Therapy session [35].

Jafari developed the Laryngeal Palpatory Scale (LPS) for patients with MTD, finding it to be valid and reproducible for this type of patient, and finding low–moderate correlations with the sEMG, with particular strength for LPS ratings of tension and ratings made during dynamic tasks (vowel/i/prolongation and counting) [45].

3.2.6. Other Types of Instrumental Evaluation

Electroglottography: Only one study has been found studying the usefulness of electroglottography in this type of patient (although there are others that use it to assess the results after treatment, as will be seen below). The parameter most described in the context of MTD is the contact quotient (CQ). Hosokawa described an increase in the standard deviation in CQ (CQSD) in patients with MTD [46] and a decrease in CQSD after treatment [47].

Eulerian video magnification (EVM): It can be used to evaluate the degree of infrahyoid musculature activation based on changes in blood perfusion [48], with 75% sensitivity and 70% specificity, according to the work performed by Adleberg et al. [49].

Real-time elastosonography (RTE): This is a recently introduced ultrasound technique allowing the investigation of elastic properties of tissues. It was used to measure strain of the (para)laryngeal muscles in patients with primary Muscle Tension Dysphonia (MTD) and healthy speakers, and they found statistically significant differences between patients with MTD and healthy subjects in some laryngeal muscles, especially suprahyoid and cricothyroid [50].

3.3. Treatment

In this last group, there were 51 papers included, which are shown in Table 3. There are two large treatment groups: vocal and manual therapy. There were 21 studies that dealt with different vocal therapy methods for patients with MTD, 12 that studied different manual therapy techniques for these patients, and 4 studies that compared or combined both treatments. However, there were 14 other papers studying the effects of various treatments.

Table 3. Summary of articles about treatment.

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
1	Prosek	1978	EMG Biofeedback in the Treatment of Hyperfunctional Voice Disorders	Cross-sectional	6	EMG biofeedback	Laryngeal EMG activity	Three of the subjects reduced the laryngeal EMG activity used during speech production with a concomitant improvement in voice quality. EMG biofeedback is an effective adjunct to traditional therapy methods for treating selected patients with hyperfunctional voice disorders.
2	Andrews	1986	EMG Biofeedback and Relaxation in the Treatment of Hyperfunctional Dysphonia	Longitudinal	10	EMG biofeedback and progressive relaxation	Electromyogram, control of vocal fold vibration and an acoustic analysis	A significant improvement in all measures occurred for both programs, which was maintained at follow-up. No significant difference between the two approaches emerged.
3	Roy	1997	Manual Circumlaryngeal Therapy for Functional Dysphonia: An Evaluation of Short- and Long-Term Treatment Outcomes	Longitudinal	25	Manual circumlaryngeal therapy	Auditory–perceptual and acoustical analysis	Pre- and post-treatment comparisons demonstrated significant voice improvements. No significant differences were observed between post-treatment measures, suggesting that vocal gains were maintained.
4	Dworkin	2000	Use of Topical Lidocaine in the Treatment of Muscle Tension Dysphonia	Longitudinal	3	Topical lidocaine	Clinical symptoms, videostroboscopy	All three patients studied experienced rapid recovery of normal phonation skills following this procedure, and carryover was excellent.
5	Ogawa	2003	Evaluation of Therapeutic Effect of Voice Therapy on Muscle Tension Dysphonia Using Scoring of Endoscopic Laryngeal Findings During Phonation of Sustained Vowels	Longitudinal	31	Voice Therapy	Transnasal endoscopic examination	Data strongly suggest that voice therapy has a therapeutic effect on Muscle Tension Dysphonia.
6	Van Lierde	2004	Outcome of Laryngeal Manual Therapy in Four Dutch Adults With Persistent Moderate-to-Severe Vocal Hyperfunction: A Pilot Study	Longitudinal	4	Laryngeal manual therapy (LMT)	Videolaryngos-troboscopic, GRBAS, aerodynamic, acoustic, and DSI measurements	All of the subjects selected for LMT showed improvement in perceptual vocal quality and DSI values.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
7	Hsiung	2004	The Characteristic Features of Muscle Tension Dysphonia Before and After Surgery in Benign Lesions of the Vocal Fold	Retrospective cohort	260	Surgery for benign lesions	Videolaryngo-stroboscopic evaluation	Characteristic features of MTD cannot be adequately resolved through surgery, and treatment should be supplemented by speech therapy to achieve the greatest effect in causal type I MTD.
8	Bhalla	2005	How We Do It: Adjunctive Intravenous Midazolam: Diagnosis and Treatment of Therapy-Resistant Muscle Tension Dysphonia	Longitudinal	7	Intravenous Midazolam	Perceptory Auditory voice Evaluation	In seven resistant cases treated in this way, six required no further speech therapy 1 month after intervention.
9	Dromey	2008	Articulatory Changes Following Treatment of Muscle Tension Dysphonia: Preliminary Acoustic Evidence	Retrospective cohort	111	Manual Circumlaryngeal Therapy (MCT)	Acoustic analysis	MTD patients experience changes in both articulatory and phonatory behavior following Manual Circumlaryngeal Therapy.
10	Roy	2009	Articulatory Changes in Muscle Tension Dysphonia: Evidence of Vowel Space Expansion Following Manual Circumlaryngeal Therapy	Retrospective cohort	111	Manual Circumlaryngeal Therapy	Acoustic analysis	Results revealed significant increases in VSA and VAI, which suggest that the manual circumlaryngeal treatment may have desirable effects on both the phonatory and articulatory systems.
11	Mathieson	2009	Laryngeal Manual Therapy: A Preliminary Study to Examine Its Treatment Effects in the Management of Muscle Tension Dysphonia	Longitudinal	10	Laryngeal manual therapy	Acoustic measurements, VTD scale	Relative average perturbation during connected speech was significantly reduced after LMT. The severity and frequency of VTD was shown to have reduced after LMT.
12	Van Lierde	2010	The Treatment of Muscle Tension Dysphonia: A Comparison of Two Treatment Techniques by Means of an Objective Multiparameter Approach	Longitudinal	10	vocalization with abdominal breath support and MCT	DSI	There were significant difference between the objective overall vocal quality before and after MCT.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
13	Stepp	2011	Effects of Voice Therapy on Relative Fundamental Frequency During Voicing Offset and Onset in Patients With Vocal Hyperfunction	Longitudinal	16	Voice therapy	RFF	After successful completion of voice therapy, RFF values increased toward patterns seen previously in individuals with healthy typical voice.
14	Kandogan	2012	Effects of Omeprazole Over Voice Quality in Muscle Tension Dysphonia Patients with Laryngopharyngeal Reflux	Longitudinal	9	Omeprazole	Objective and subjective voice parameters	After treatment with omeprazol, all the parameters showed an improvement in voice quality; however, only VHI and shimmer were statistically significant.
15	Guzmán	2012	Therapeutic Effect of Semi-Occluded Vocal Tract Exercises in Patients with Type I Muscle Tension Dysphonia	Longitudinal	11	Semi-occluded postures of the vocal tract and phonation into resonance tubes	Flexible laryngoscopy and acoustic analysis.	The results indicate that the use of resonance tubes and semi-occluded postures of the vocal tract can have a therapeutic effect in patients with type I Muscle Tension Dysphonia.
16	Ogawa	2013	Immediate Effectiveness of Humming on the Supraglottic Compression in Subjects with Muscle Tension Dysphonia	Cross-sectional	23	Humming	Supraglottic compression	Humming corrects both the lateral and AP components of supraglottic compression in most MTD patients.
17	Guzmán	2013	Laryngeal and Pharyngeal Activity During Semi-occluded Vocal Tract Postures in Subjects Diagnosed With Hyperfunctional Dysphonia	Cross-sectional	20	Semi-occluded Vocal Tract Postures	Laryngeal endoscopy during phonation	VLP, A–P laryngeal compression, and pharyngeal width can be modified by semi-occluded vocal tract exercises in subjects diagnosed with nonorganic hyperfunctional dysphonia. A low larynx, narrow aryepiglottic opening, and wide pharynx may be reached by using these types of exercises.
18	Ogawa	2014	Immediate Effects of Humming on Computed Electroglottographic Parameters in Patients With Muscle Tension Dysphonia	Cross-sectional	43	Humming	Acoustic analysis, electroglottography	Perturbation parameters of EGG signals and the standard deviation of the contact quotient exhibited significant decreases associated with either of humming or um-hum phonation.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
19	Ziegler	2014	Perceptions of Voice Therapy From Patients Diagnosed with primary Muscle Tension Dysphonia and Benign Mid-Membranous Vocal Fold Lesions	Cross-sectional	45	Voice therapy	Patient Perception of Voice Therapy questionnaire, VHI-10	In this study, patients valued direct voice therapy in which they worked on altering vocal behaviors more than indirect voice therapy that aimed to educate patients about their voice.
20	Watts	2015	A Randomized Controlled Trial of Stretch-and-Flow Voice Therapy for Muscle Tension Dysphonia	Randomized controlled trial	20	Stretch-and-flow voice therapy	VHI, GRBAS, Acoustic analysis,	Application of SnF to patients with MTD for six treatment sessions over a 6-week period resulted in a significant reduction in vocal handicap and improvement in measures of maximum phonatory performance and phonatoryphysiology.
21	Craig	2015	Combining Voice Therapy and Physical Therapy: A Novel Approach to Treating Muscle Tension Dysphonia	Retrospective Cohort	153	Physical therapy with voice therapy	VHI	Voice therapy alone had significantly greater median improvement in VHI than those treated with physical therapy.
22	Pacheco	2015	False Vocal Cord Botulinum Toxin Injection for Refractory Muscle Tension Dysphonia: Our Experience with Seven Patients	Cross-sectional	7	False vocal cord botulinum toxin injection	VRQOL, GRBAS	FVC Botox offers benefit to patients with refractory MTD. The best results are obtained with continued voice therapy following injection.
23	Tomlinson	2015	Manual Therapy and Exercise to Improve Outcomes in Patients With Muscle Tension Dysphonia: A Case Series	Longitudinal	9	Manual therapy, exercise, and stress management education	NRS, PSFS, and VHI. Cervical and jaw range of motion	Most of the patients had no pain after treatment. All of the patients demonstrated an improvement in PSFS score, and some of them also had a clinically meaningful change in VHI scores. All of them demonstrated improvement in cervical flexion, lateral flexion, and jaw opening.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
24	Rangarathnam	2015	Telepractice Versus In-Person Delivery of Voice Therapy for Primary Muscle Tension Dysphonia	Prospective cohort	14	Telepractice for delivering flow phonation exercises	Auditory-perceptual, acoustic, aerodynamic, and quality-of-life measures	The results of this study indicate that flow phonation exercises can be successfully used for patients with MTD using telepractice.
25	Ziade	2017	Changes in Abnormal Muscle Tension Pattern After Fiberoptic Injection Laryngoplasty	Longitudinal	16	Fiberoptic injection laryngoplasty	Stroboscopic frames	The mean percentage of frames showing MTP in patients with MTP significantly decreased 1 month after the injection.
26	Sielska-Badurek	2017	Combined Functional Voice Therapy in Singers With Muscle Tension Dysphonia in Singing	Prospective cohort	40	Combined functional voice therapy	Videolaryngo-stroboscopy, palpation, perceptual speaking and singing voice assessment, acoustic analysis, MPT, and VHI	After combined functional voice therapy in the study group, great improvement was noticed in palpation of the vocal tract structures, perceptual voice assessment, phonetograms, and singing range obtained from acoustic analysis of glissando.
27	Lemos	2017	Effects of a Voice Therapy Program for Patients with Muscle Tension Dysphonia	Longitudinal	30	Voice therapy	Perceptual-auditory protocol GRBASI, measures of maximum phonation times, s/z ratio, and acoustic voice analysis	All parameters assessed using the GRBASI protocol improved following treatment. The average overall MPT increased. A positive difference was observed for vocal jitter and shimmer. Speech therapy favored lower phonation effort, lowered vocal strain, and adequacy of adjustment of laryngeal muscles.
28	Jafari	2017	Vocal Function Exercises for Muscle Tension Dysphonia: Auditory-Perceptual Evaluation and Self-Assessment Rating	Longitudinal	15	vocal function exercises (VFEs)	VHI and GRBAS	Significant improvement after therapy for participants was observed by the aid of auditory–perceptual ratings of voice quality and the patient's self-assessment ratings measurements.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
29	Rad	2018	Efficacy of Manual Circumlaryngeal Therapy in Patients With Muscle Tension Dysphonia	Cross-sectional	20	Manual circumlaryngeal therapy	Acoustic analysis	Following MCT, jitter and shimmer showed a significant reduction, while HNR improved significantly versus pretreatment.
30	Khatoonabadi	2018	Patient-Based Assessment of Effectiveness of Voice Therapy in Vocal Mass Lesions with Secondary Muscle Tension Dysphonia	Longitudinal	33	Voice therapy	VHI	The findings of this study indicate a statistically significant improvement after the voice therapy protocol, and they recommend a combination of direct and indirect voice therapy in the vocal rehabilitation of patients with secondary MTD and vocal mass lesions.
31	Dehqan	2019	Positive Effects of Manual Circumlaryngeal Therapy in the Treatment of Muscle Tension Dysphonia (MTD): Long Term Treatment Outcomes	Longitudinal	28	Manual Circumlaryngeal Therapy	CAPE-V, Acoustic analysis	Improvements in the acoustic analysis and CAPE-V were persistent over a 6-month-duration follow-up.
32	Mansuri	2019	Effects of Voice Therapy on Vocal Tract Discomfort in Muscle Tension Dysphonia	Longitudinal	25	Voice therapy	Acoustic voice analysis, auditory–perceptual assessment and VTDp	After voice therapy, significant improvements were observed in the acoustic characteristics.
33	Gillespie	2019	Efficacy of conversation training therapy for patients with benign vocal fold lesions and Muscle Tension Dysphonia compared to historical matched control patients	Prospective cohort	96	Conversation Training Therapy	VHI-10, acoustic, aerodynamic, and auditory–perceptual outcomes.	Training voice techniques in the context of spontaneous conversational speech improves patient perception of voice handicap and acoustic, aerodynamics, and auditory–perceptual voice outcomes both immediately following treatment and at long-term follow-up.
34	Watts	2019	Intervention Outcomes of Two Treatments for Muscle Tension Dysphonia: A Randomized Controlled Trial.	Randomized Controlled Trial	21	Stretch-and-flow voice therapy and resonant voice therapy (RVT)	VHI, AVQI, the smoothed cepstral peak prominence, and CAPE-V.	Both SnF and RVT produced positive treatment response in speakers with Muscle Tension Dysphonia, with no statistically significant difference in the outcome measures between the two treatments.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
35	Reetz	2019	Do Standard Instrumental Acoustic, Perceptual, and Subjective Voice Outcomes Indicate Therapy Success in Patients With Functional Dysphonia?	Longitudinal	39	Combined voice therapy	Acoustic analysis, DSI, VHI, GRBAS	Significantly improved subjective and perceptual findings verify positive combined voice therapy effects in patients with functional dysphonia.
36	Mansuri	2020	Application of High-Frequency Transcutaneous Electrical Nerve Stimulation in Muscle Tension Dysphonia Patients With the Pain Complaint: The Immediate Effect	Randomized Controlled Trial	30	Transcutaneous electrical nerve stimulation (TENS)	Auditory–perceptual assessments, acoustic voice analysis, VTD, and musculoskeletal pain	High-frequency TENS can be used in the voice treatment program of patients with MTD. MTD patients with pain complaints reported that their VTD and pain were decreased following the high-frequency TENS. Notably, these positive effects were obtained after a single session of high-frequency TENS application.
37	Mansuri	2020	Transcutaneous Electrical Nerve Stimulation Combined With Voice Therapy in Women With Muscle Tension Dysphonia	Longitudinal	20	TENS with Voice Therapy	GRBAS, Acoustic analysis, VTD, and musculoskeletal pain	TENS is recommended as a complementary therapy for patients with MTD, especially when these patients have more complaints about VTD and musculoskeletal pain.
38	Aghadoost	2020	A Study of Vocal Facilitating Techniques Compared to Manual Circumlaryngeal Therapy in Teachers With Muscle Tension Dysphonia	Randomized clinical trial	16	Vocal facilitating techniques and manual circumlaryngeal therapy	VHI and DSI	The greatest improvement obtained on the DSI following VFTs and for the physical aspect of VHI after MCT demonstrated that a voice therapist can use appropriate techniques based on the voice complaints and results of voice assessments in MTD.
39	Novakovic	2020	Injection Laryngoplasty as Adjunct Treatment Method for Muscle Tension Dysphonia: Preliminary Findings.	Longitudinal	37	Injection laryngoplasty (IL)	Laryngeal endoscopy during phonation, VHI-10, acoustic analysis	IL resulted in positive changes in voice-related quality of life in MTD patients with and without glottal insufficiency. Acoustically, only those with glottal insufficiency demonstrated an increase in HNR following IL.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
40	Madill	2021	Active Ingredients of Voice Therapy for Muscle Tension Voice Disorders: A Retrospective Data Audit	Longitudinal	68	Voice therapy: OPT and SVQ, task variation and NP	Auditory–perceptual outcome measures, acoustic outcome measures	Implementation of individual techniques that promote improved voice quality and processes that support learning resulted in improved habitual voice quality.
41	Fallah	2021	Effect of Mathieson Laryngeal Manual Therapy in Patients with Muscle Tension Dysphonia After a Therapeutic Course	Longitudinal	12	Mathieson laryngeal manual therapy (MLMT) following a therapeutic course	Videostroboscopy, perceptual voice assessment and VTDp	After MLMT, the frequency of supraglottic activity decreased, and perceptual voice parameters significantly changed, but the VTDp showed no significant difference The MLMT can remarkably improve the supraglottic activity and perceptual characteristics of the voice in primary MTD after a therapeutic course.
42	Wenke	2021	Effectiveness of Intensive Voice Therapy Versus Weekly Therapy for Muscle Tension Dysphonia: A Noninferiority Randomized Controlled Trial With Nested Focus Group	Randomized Controlled Trial	20	Intensive Voice Therapy Versus Weekly Therapy	Videostroboscopy, perceptual voice assessment, VTDp	After MLMT, the frequency of supraglottic activity decreased, and perceptual voice parameters significantly changed, but the VTDp showed no significant difference. The MLMT can remarkably improve the supraglottic activity and perceptual characteristics of the voice in primary MTD after a therapeutic course.
43	Tate	2021	Physical Therapy for Muscle Tension Dysphonia with Cervicalgia.	Longitudinal	178	Specialized manual physical therapy (PT) program	VHI-10	Among patients diagnosed with MTD with cervicalgia, treatment with a specialized PT program was associated with improvement in VHI-10 scores regardless of whether they had VT.
44	Tierney	2021	Characterization of Functional Dysphonia: Pre- and Post-Treatment Findings	Cross-sectional	109	Voice Therapy	VHI	Most individuals with functional dysphonia improved after specialized voice therapy once correctly diagnosed, but correct diagnosis and proper treatment were often significantly delayed.
45	Sambhu	2022	Evaluating the Use of Baclofen as Adjunct Treatment for Muscle Tension Dysphonia	Prospective cohort	52	Baclofen and voice therapy	VHI-10, Reflux Symptom Index, and other survey elements	There was no significant difference in voice psychometric outcomes between non-baclofen and baclofen groups.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
46	Lowell	2022	Isolated and Combined Respiratory Training for Muscle Tension Dysphonia: Preliminary Findings	Longitudinal	6	Respiratory lung volume-based training (RLVT) and laryngeal-based training	Respiratory plethysmography and acoustic analysis	Results from this preliminary study support the feasibility of RLVT for improving speech breathing behavior, and they suggest that it, alone, can improve objectively measured dysphonia severity.
47	Ahmadi	2022	The Effect of Breathing Exercises Combined with Manual Therapy on Muscle Tension Dysphonia in Traditional Singers: A Blinded Randomized Controlled Trial.	Blinded randomized controlled trial	60	Breathing exercises combined with manual therapy	MPT and Stroboscopy Evaluation Rating Form. Persian version of Singing Voice Handicap Index (SVHIp).	The combination of breathing exercises and manual therapy significantly improved the laryngeal function, breathing performance, and voice handicap in traditional singers suffering from MTD.
48	Nasrin	2022	The Effects of Cricothyroid Visor Maneuver (CVM) Therapy on the Voice Characteristics of Patients with Muscular Tension Dysphonia: A Case Series Study.	Longitudinal	6	Cricothyroid visor maneuver (CVM) therapy	Acoustic analysis and auditory perceptual assessment	CVM can be an effective method for promoting significant improvements in acoustic measurements, auditory–perceptual measurements, and self-assessment scales in patients with MTD.
49	Ahmadi N	2022	Effects of Laryngeal Manual Therapy on Primary Muscle Tension Dysphonia (MTD-1): Implications for MTD-1 Type. J Voice.	Longitudinal	32	Laryngeal manual therapy	Visual ratings of the larynx, acoustic analyses, auditory–perceptual assessments of voice, and the PSVH-I	The distribution of MTD-1 type changed after treatment in many cases, converting from one type to another. Acoustic as well as glottal closure measures for several participants revealed closure insufficiency after treatment, unveiled as hyperfunction, and was unloaded with LMT.
50	Vahid M	2022	Immediate Effects of Combining Kinesio Tape with Voice Therapy in Patients with Muscle Tension Dysphonia	Cross-sectional	20	Combining Kinesio Tape (KT) with Voice Therapy (VT)	CAPE-V, acoustic voice analysis, and assessments of vocal tract discomfort and pain	MTD patients treated with KT + VT did not experience more significant improvements compared to those treated with VT alone.

Table 3. *Cont.*

No.	Author	Year	Title	Type of Study	N	Treatment Measure	Outcome Measure	Conclusions
51	Rangarathnam	2023	A Randomized Controlled Trial of the Effects of Flow Phonation Voice Treatment for Primary Muscle Tension Dysphonia	Randomized controlled trial	17	Flow phonation voice treatment	Visual–perceptual, auditory–perceptual, acoustic, aerodynamic, and voice-related quality-of-life measures	Flow phonation exercises can potentially be favorably employed for individuals with MTD1.

EMG: electromyogram; VSA: vowel space area; VAI: vowel articulation index; VTD: vocal tract discomfort (scale); RFF: relative fundamental frequency; AP: anteroposterior; VLP: vertical laryngeal position; EGG: electroglottography; VHI-10: reduced version of Voice Handicap Index; SnF: stretch-and-flow; VRQOL: voice-related quality of life; FVC: false vocal cords; NRS: numeric rating scale; PSFS: Patient-Specific Functional Scale; MPT: maximum phonation time; HNR: harmonics-to-noise ratio; CAPE-V: Consensus Auditory–Perceptual Evaluation of Voice instrument; VTDp: Persian version of vocal tract discomfort; AVQI: acoustic voice quality index; DSI: Dysphonia Severity Index; OPT: optimal phonation task; SVQ: sob voice quality; NP: negative practice; PSVH-I: Persian Singing Voice Handicap Index.

3.3.1. Vocal Education and Voice Therapy

Within the works that evaluate vocal therapy in MTD, we find different techniques: vocal function exercises, conversation training therapy, stretch and flow voice therapy, resonant voice therapy, vocal facilitation techniques, optimal phonation task, sob voice quality, task variation, negative practice, respiratory lung volume and larynx-based training, semi-occluded vocal tract postures, humming, and combined functional vocal therapy. All of them compare different pre- and post-treatment measures and observe improvements in the measured parameters in patients after vocal therapy.

3.3.2. Manual Therapy

With respect to manual therapy, different techniques have also been used, such as manual circumlaryngeal therapy (MCT), Mathieson laryngeal manual therapy (MLMT), and the cricothyroid visor maneuver (CVM). With all of them, improvements have been observed in the measurement parameters used pre- and post-treatment, and Roy [51] and Dehqan [52] observe these improvements were maintained in the long term follow-up.

There are four studies comparing both therapies. Van Lierde [53] compared vocalization with abdominal breath support with MCT and found statistically significant differences in voice quality—measured by the DSI—before and after treatment with MCT. Craig [2] compared physical therapy with vocal therapy, measuring VHI pre- and post-treatment, and concluded that patients treated with vocal therapy had better results in VHI than those treated with physical therapy. Aghadoost [54] compared vocal facilitating techniques (VFTs) with MCT and found a greater improvement in voice quality—by measuring the DSI—after treatment with VFTs and in the physical aspect of the VHI after MCT. Therefore, they concluded that one or the other technique should be used depending on the patient's symptomatology. Ahmadi [55] compared breathing exercises with manual therapy, and found a significant improvement of laryngeal function, breathing, and VHI in singers with MTD.

3.3.3. Other Treatments

In cases of secondary MTD, multiple treatments have been described that are aimed at resolving the cause of the dysphonia, but they do not resolve the hyperfunction itself.

Surgery has been described in MTD secondary to an organic lesion (polyp or vocal cysts), but Hsiung [56] states that this treatment alone is insufficient, recommending complementing it with vocal therapy.

Injection laryngoplasty has shown positive changes in both stroboscopic imaging [57], voice quality in patients with and without glottic insufficiency, and in acoustic parameters in those with glottic insufficiency (unilateral paralysis or sulcus vocalis) [58].

Other treatments described are topical application of lidocaine [59], transcutaneous electrical nerve stimulation [60,61], botulinum toxin infiltration [62], intravenous injection of midazolam [63], EMG biofeedback [64,65], and omeprazole [66] in patients with concomitant pharyngolaryngeal reflux. The use of adjuvant baclofen has also been studied, without finding differences between the group with and without baclofen [67].

4. Discussion

4.1. Etiology and Physiopathology

As has already been mentioned, MTD can be primary or secondary. The alteration in muscular activity in primary MTD has been associated with inappropriate use of the voluntary muscles used in phonation related to the personality. Imaging studies of brain function have demonstrated the presence of functional alterations in the limbic–motor system and in the behavioral inhibition system [20,68]. In secondary MTD, the mechanism responsible for the increase in muscular tension is a compensatory reaction to a mechanism that alters the function or structure of the glottis. The principal mechanisms that have been shown to lead to secondary MTD are upper respiratory tract infections [63], glottic

insufficiency [1,58,69], laryngopharyngeal reflux [69,70], structural lesions of the VC [71], spasmodic dysphonia [72], and hormonal alterations [73,74].

The phonatory hyperfunction characteristic of MTD can contribute to the development of traumatic lesions such as nodules or polyps on the VC [8]. However, in those cases in which MTD is associated with organic lesions, it remains to be elucidated whether it is the MTD that brings about the organic pathology or whether the MTD is the result of that pathology. Therefore, it is not always easy to distinguish between a primary or a secondary MTD.

4.2. Diagnosis

The principal symptoms of MTD are dysphonia and vocal fatigue. Patients with MTD usually manifest increased phonatory effort, accompanied by a reduction or worsening in voice quality. Some patients have symptoms such as tension, pain in the cervical region, and sensations of itchiness, dryness, irritation, or even the presence of a foreign body in the larynx area. Although the symptoms are always a subjective parameter in the diagnosis, there are some scales that can be used to assess them, such as the Vocal Tract Discomfort scale [75]. VHI results show worse scores in patients with this pathology [32,76].

Observation of the larynx during phonation is indispensable in the diagnosis. It can rule out an underlying organic pathology or a secondary MTD, and it can determine the type of MTD.

Garaycochea [31] discusses the three most frequent laryngoscopic profiles in these patients. Anteroposterior supraglottic contraction involves the reduction in the visibility of the vocal cords (VC) at both their anterior and posterior borders. The reduction in visibility of the posterior border is related to approximation of the arytenoids due to an increase in their rotation. At the anterior level, the increase in tension and increased elevation of the laryngeal musculature produces bowing of the epiglottic petiole towards the laryngeal lumen, which makes it difficult to see the anterior border of the VC, starting with visual obstruction of the anterior commissure [1,32]. Supraglottic lateral contraction results in reduction in the visibility of the width of the VC. The reduction ranges from visual obstruction of the laryngeal ventricle to complete visual obstruction of the vocal cords by the ventricular bands, (False VC phonation). To date, the muscle structure and innervation of the ventricular bands remain poorly understood and areas of controversy; the same applies to the role of the ventricular bands (VB) in normal phonation and in phonation by people with voice alterations. Posterior glottic gap (PGG) refers to an incomplete closure of the VC at their posterior edge. This originates from an attempted contraction of the lateral and interarytenoid cricoarytenoid muscle accompanied by insufficient relaxation of the posterior cricoarytenoid muscle [7]. The low incidence of PGG relative to that of supraglottic compression in patients with MTD is attributable to the difficulty, in many cases, of observing PGG when there is concomitant supraglottic compression [31].

There have been different proposals of classification systems based on the laryngoscopic profiles during phonation. The first system was written by Morrison in 1986 [8]. While this initial classification did differentiate patients with MTD from patients with psychogenic functional dysphonia, it has been progressively modified by different authors over the last few years. Sama considers psychogenic functional dysphonia profiles as profiles of MTD and excludes those profiles related to organic lesions [77]. Belafsky excludes the presence of "bowing" during phonation because bowing is related to underlying glottic insufficiency and not to hyperfunction [16,78]. A second scoring system was described by Van Lawrence in 1987 [79], and a third was described by Koufman in 1991 [80]. In 2020, Fernández et al. [32] published a new classification (Universidad de Navarra) based on subglottal pressure (SgP) values, which has been demonstrated to be related to the degree of anteroposterior (AP) compression (Figure 2). The higher the SgP value, the higher the degree of AP compression. This classification system uses the endoscopic profiles mentioned above and assumes that AP contraction is present. While the classic classifications only allow choosing between one of the phonatory profiles, excluding the other ones, the

latest classification proposed by Fernández et al. is based on a single laryngoscopic profile, but it makes it possible to associate LC or PGG, if present, and provide a more detailed description from the physical examination.

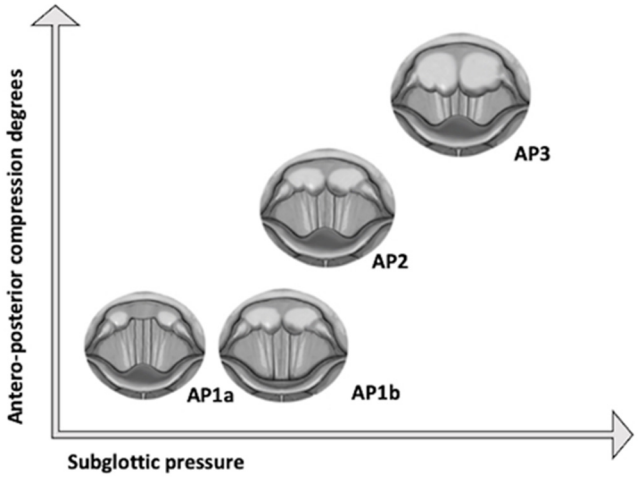

Figure 2. Classification of Universidad de Navarra.

Considering these more frequent profiles in MTD, it should be noted that, in some cases, increased rotation of the arytenoids may compress the VB and create the appearance of a vocal false folds phonation. Therefore, it is important to know how to interpret the role of this phenomenon in patients with dysphonia, including MTD, since there is not enough evidence to justify attributing any clinical value to this characteristic. While it is true that lateral compression (LC) can be present in MTD, according to work carried out by Stager and Behrman, this is not necessarily related to the degree, the seriousness, or the stage of dysphonia; as a clinical and diagnostic indicator, LC has less value than AP compression [80,81]. As it has been found and reported previously, the best way to conduct the physical examination is with a transnasal fiberoptic laryngoscopy, because it is not possible to evaluate compression of the supraglottis well with a fixed lens. Stroboscopy is limited by the supraglottic compression, which can block the vision of the VC [82].

In patients with MTD, the higher the SgP value, the higher the degree of AP compression. AP1a: The anterior commissure is not visible during phonation; AP1b: Vocal processes are not visible during phonation due to the medial approximation of the arytenoids; AP2: only 2/3 of the vocal fold length is visible during phonation.

As for acoustic analysis, although there are few studies that focus exclusively on this technique for the diagnosis of MTD, most of them include it. Although there is no characteristic pattern for this pathology, or a specific parameter with a characteristic alteration in patients with MTD, it is a technique that will always provide useful information on the phonatory function of a patient.

A possible use of acoustic analysis in patients with MTD is to differentiate between MTD and spasmodic dysphonia (SD). Interruptions in an acoustic signal are highly suggestive of SD and can be a determining factor when differentiating between SD and MTD in severe cases [72,83].

There is a parameter that began to be studied in 2010 by Stepp et al. [41], the RFF, from which it seems that biomechanical elements can be inferred. It is defined as the fundamental frequency of the cycles immediately preceding and following the production of a voiceless consonant, normalized by the "steady-state" fundamental frequencies of the voicing preceding and following the consonant (during a vowel–voiceless consonant–vowel (VCV) utterance). After several studies on this parameter, there is evidence that it may be an acoustic indicator of laryngeal tension. The studies that have compared the RFF of healthy subjects with that of patients with vocal hyperfunction have found significantly lower RFF values in the latter, although it is still not clear which values provide more

information on laryngeal tension: those prior to the voiceless consonant or those after it. There is also evidence of its usefulness as a clinical follow-up tool to quantify progress before and after therapy [41,84,85]. However, its analysis has not yet been standardized in clinical voice evaluation, partly because it is currently very time-consuming to perform manually, and also because it requires lengthy training to properly identify the last cycles of a vocal transition [86]. More research is needed to prove its clinical utility and to better understand its underlying physiology, but it may be a very interesting parameter in the study of MTD.

Aerodynamic analysis has proven to be a very useful tool in the evaluation of voice alterations. Among the parameters studied, SgP has the lowest variance in subjects without a voice alteration, and, in contrast to GF, SgP is not affected significantly by age or sex [39,40]. In addition, as already mentioned, its relationship with the degree of anteroposterior compression has been demonstrated, so its study is of great value for the diagnosis of MTD. Espinoza et al. [43] studied the aerodynamic pattern in women with vocal hyperfunction, distinguishing between phonotraumatic (PVH) and non-phonotraumatic (NPVH) VH, and found that, in those women with PVH, all measured parameters (subglottal air pressure, peak-to-peak airflow, maximum flow declination rate, and open quotient) had significantly reduced sound pressure level (SPL)-normalized values than the control group, while women with NPVH had lower values for SgP and open quotient. This means that higher than normal levels of these parameters are needed to achieve a given SPL. Other aerodynamic profiles described in patients with MTD in which there is no increase in SgP are the presence of reduced GF or increased LR.

EMG can detect changes in the activity of extrinsic musculature in patients with vocal hyperfunction and MTD. However, these are not constant in all patients, only evaluate extrinsic musculature, are affected to varying degrees by the thickness of subcutaneous and contraction of the platysma, and they cannot reveal whether vocal pathology is due to an increase in tension of extrinsic musculature or due to an increase in tension of intrinsic musculature [33,48].

As previously mentioned, in this pathology there is an abnormal laryngeal position during phonation, with the larynx higher than normal. The use of X-rays provides an objective measure of the height of the larynx during phonation. The main downside to this technique is the radiation that the patient is exposed to [14].

Lastly, the administration of intravenous midazolam has been proposed not only as a treatment, but also as a diagnostic method for MTD by subjective and perceptual improvement of voice quality [63].

In parallel with all the diagnostic techniques studied, it is important to make a thorough differential diagnosis and to rule out neurological, psychiatric, and organic alterations that can explain the dysphonia of a patient.

4.3. Treatment

Treatment approaches can be classified as indirect (vocal education) or direct interventions. Intervention usually involves a combination of direct and indirect treatment approaches for successful outcomes and begins by addressing vocal hygiene [87].

The patient must understand that his or her voice is a combination of multiple factors, including possible psychological influences. Vocal education includes a series of general measures (environmental, behavioral, and related to vocal use) that seek to modify and avoid possible factors that are related to altered vocal behavior. Some examples would be talking as little as possible in an environment where there is a lot of background noise, avoiding shouting, trying not to whisper, or using good breathing techniques [1].

Direct approaches to voice therapy aim at modifying the physiology of the vocal mechanism through symptomatic vocal therapy or the physiological principles of vocal therapy [87].

Physiological voice therapy programs strive to balance the three subsystems of voice production (respiration, phonation, and resonance) rather than working directly on isolated

voice symptoms [88]. They include techniques such as the Accent Method, Conversation Training Therapy (CTT), Expiratory Muscle Strength Training (EMST), Lee Silverman Voice Treatment (LSVT), Manual Circumlaryngeal Techniques, Phonation Resistance Training Exercises (PhoRTE), Resonant Voice Therapy (RVT), Stretch and Flow Phonation, and Vocal Function Exercises (VFEs).

As previously shown, results with many of these techniques have been published for the treatment of MTD. The RVT deserves a special mention for being one of the most widely used. The goal of RVT is to produce the most powerful and "clean" voice possible with the least effort and impact between the vocal folds to minimize the likelihood of injury and maximize the likelihood of vocal health [87]. It attempts to have patients produce an oral voice localized to the anterior alveolar ridge or adjacent facial plates [89], which is derived from the principles of a semi-occluded vocal tract [90]. Semi-occlusion occurs at the ends of the resonant cavities, which reduces unnecessary pressure at the vocal fold level [87]. One of the exercises included in this program is humming, used as a treatment for MTD with improvements in supraglottic compression and EGG parameters [47,91].

Within the manual laryngeal techniques (first described in 1993) [92], there are also many different maneuvers described. MCT was developed by Aronson and Roy and Leeper [93], and it is based on the application of pressure, massage, to different points of the larynx. It starts with a circular compression on the hyoid bone, the thyrohyoid space, and the posterior borders of the thyroid cartilage. Lastly, the whole larynx is moved down and laterally. During the technique, the patient vocalizes sustained vowels or hums so that changes in vocal quality can be tracked [92]. The objective of MCT is to reduce the increased tension and muscular contraction, especially around the hio-laryngeal musculature [52,54,92,94]. The LMT proposed by Mathieson (MLMT) consists of rotational massage, kneading, and stretching of the perilaryngeal muscles (sternocleidomastoid muscles). Although these muscles are not directly related to laryngeal function, patients frequently complain of stiffness and tenderness in them in association with their voice disorders [95]. The cricothyroid visor maneuver (CVM) was proposed by Dehqan et al. [96] based on the findings of Harris and Lieberman [97], who reported that abnormal patterns of muscle activity can develop in the cricothyroid muscle and visor mechanism, which may contribute to voice problems, and manipulation of this muscle and articulation can lead to remarkable improvement in the voice. A lower range of action of the cricothyroid visor has also been identified in patients with MTD, probably associated with a reduced efficiency of cricothyroid muscle activity.

There are also multiple techniques focused on the modification of vocal symptoms or perceptual voice components, which are also used for the treatment of patients with MTD: Amplification, Auditory Masking, Biofeedback, Chant Speech, Confidential Voice, Inhalation Phonation, Posture, Relaxation, Semi-Occluded Vocal Tract (SOVT) Exercises, Twang Therapy, and Yawn–Sigh [98].

In secondary MTD, part of the treatment must be oriented towards treating the cause involved in the genesis of the increase in muscular tension. Surgical treatment is usually complemented with both vocal education and rehabilitation. Medical treatment has been described in MTD in the context of respiratory tract infections, sinusitis, allergy, and laryngopharyngeal reflux [66].

5. Limitations

The present scoping review only includes studies published in English or Spanish; there are works published in other languages that have not been included. Only three databases were searched (Pubmed, Scopus, and Web of science), and only one MESH term has been included in the search; hence, some work related to MTD may not be present in the review. The studies covered here are not methodologically the same and neither are the samples they study.

6. Conclusions

Today, MTD might be defined as a spectrum of functional disorders that share the principal characteristic of hyperfunction of laryngeal musculature during phonation. It is one of the most frequent causes of functional dysphonia, so it may be surprising that it was not until the 1980s that it began to be studied in greater depth. This may be due to the development of new diagnostic techniques. For its diagnosis, endoscopic visualization of the larynx is crucial, but it is important to point out that laringoscopy-based profiles seen in patients with MTD can also be found in people without symptoms and without any voice alteration. The diagnosis, therefore, cannot be based exclusively on endoscopic visualization, but must be combined with the patient's clinical history, and other types of pathologies must be ruled out. In recent times, considerable progress has been made in the knowledge of its pathophysiology, which has made possible the development of objective measures that help us both for diagnosis and for treatment control. Vocal education and voice therapy should be part of the treatment and may also be accompanied by other treatments depending on the specific characteristics of each patient, which evidences that this entity should be addressed through a multidisciplinary approach with the active participation of speech therapists, who will be, in most cases, the main actors in the rehabilitation process.

Author Contributions: S.F. (Sol Ferrán) had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: S.F. (Sol Ferrán), O.G., J.A. and S.F. (Secundino Fernández). Acquisition, analysis, and interpretation of data: S.F. (Sol Ferrán), O.G., N.D.Z. and D.T. Drafting of the manuscript: S.F. (Sol Ferrán) and O.G. Critical revision of the manuscript for important intellectual content: S.F. (Sol Ferrán), O.G., J.A. and S.F. (Secundino Fernández). Administrative, technical, and material support: S.F. (Sol Ferrán), O.G., N.D.Z. and D.T. Supervision: J.A. and S.F. (Secundino Fernández). All authors have read and agreed to the published version of the manuscript.

Funding: The authors received no financial support for the research, authorship, and/or publication of this article.

Institutional Review Board Statement: This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent Statement: Not applicable.

Data Availability Statement: All data generated or analyzed during this study are included in this article.

Acknowledgments: We would like to thank the entire team that belongs to the Voice Laboratory of the University of Navarra for their work, especially Beatriz del Río, whose dedication makes possible the development of the lines of research carried out there.

Conflicts of Interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

1. Van Houtte, E.; Van Lierde, K.; Claeys, S. Pathophysiology and Treatment of Muscle Tension Dysphonia: A Review of the Current Knowledge. *J. Voice* **2011**, *25*, 202–207. [CrossRef] [PubMed]
2. Craig, J.; Tomlinson, C.; Stevens, K.; Kotagal, K.; Fornadley, J.; Jacobson, B.; Garrett, C.G.; Francis, D.O. Combining voice therapy and physical therapy: A novel approach to treating muscle tension dysphonia. *J. Commun. Disord.* **2015**, *58*, 169–178. [CrossRef] [PubMed]
3. Bhattacharyya, N. The Prevalence of Voice Problems among Adults in the United States. *Laryngoscope* **2014**, *124*, 2359–2362. Available online: https://pubmed.ncbi.nlm.nih.gov/24782443/ (accessed on 20 February 2024). [CrossRef] [PubMed]
4. Verdolini, A.K.; Rosen, C.A.; Branski, R.C. *Classification Manual for Voice Disorders-I*; Psychology Press: East Sussex, UK, 2006.
5. Sambhu, M.; Goh, T.; Golan, H.; Pisegna, J.; Noordzij, J.P. Evaluating the use of baclofen as adjunct treatment for muscle tension dysphonia. *Am. J. Otolaryngol.* **2022**, *43*, 103309. [CrossRef] [PubMed]
6. Koufman, J.A.; Blalock, P.D. Classification and Approach to Patients with Functional Voice Disorders. *Ann. Otol. Rhinol. Laryngol.* **1982**, *91*, 372–377. [CrossRef] [PubMed]

7. Koufman, J.A.; Blalock, P.D. Vocal fatigue and dysphonia in the professional voice user: Bogart-bacall syndrome. *Laryngoscope* **1988**, *98*, 493–498. [CrossRef]
8. Morrison, M.D.; A Rammage, L.; Belisle, G.M.; Pullan, C.B.; Nichol, H. Muscular tension dysphonia. *J. Otolaryngol.* **1983**, *12*, 302–306.
9. Tricco, A.C.; Lillie, E.; Zarin, W.; O'Brien, K.K.; Colquhoun, H.; Levac, D.; Moher, D.; Peters, M.D.; Horsley, T.; Weeks, L.; et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann. Intern. Med.* **2018**, *169*, 467–473. [CrossRef]
10. Stathopoulos, E.T.; Huber, J.E.; Sussman, J.E. Changes in Acoustic Characteristics of the Voice Across the Life Span: Measures from Individuals 4–93 Years of Age. *J. Speech Lang. Hear. Res.* **2011**, *54*, 1011–1021. [CrossRef]
11. Van Houtte, E.; Van Lierde, K.; D'haeseleer, E.; Van Imschoot, B.; Claeys, S. UES pressure during phonation using high-resolution manometry and 24-h dual-probe pH-metry in patients with muscle tension dysphonia. *Dysphagia* **2012**, *27*, 198–209. [CrossRef]
12. Faralli, M.; Lapenna, R.; Pagliari, J.; Longari, F.; D'ascanio, L.; Ricci, G. The effect of speech rehabilitation therapy for muscle tension dysphonia on global postural strategy. *Hear. Balance Commun.* **2017**, *15*, 271–281. [CrossRef]
13. Belisle, G.M.; Morrison, M.D. Anatomic Correlation for Muscle Tension Dysphonia. *J. Otolaryngol.* **1983**, *12*, 319–321. Available online: https://europepmc.org/article/med/6644861 (accessed on 21 November 2021). [PubMed]
14. Lowell, S.Y.; Kelley, R.T.; Colton, R.H.; Smith, P.B.; Portnoy, J.E. Position of the hyoid and larynx in people with muscle tension dysphonia. *Laryngoscope* **2012**, *122*, 370–377. [CrossRef] [PubMed]
15. Izadi, F.; Salehi, A. Comparison Between Palpatory Findings of the Hyoid Position and Their Acoustic, Videostroboscopic, and Perceptual Attributes in Patients with Muscle Tension Dysphonia (With and Without Organic Lesions). *J. Voice* **2013**, *27*, 78–83. [CrossRef] [PubMed]
16. Belafsky, P.C.; Postma, G.N.; Reulbach, T.R.; Holland, B.W.; Koufman, J.A. Muscle Tension Dysphonia as a Sign of Underlying Glottal Insufficiency. *Otolaryngol. Head Neck Surg.* **2002**, *127*, 448–451. [CrossRef]
17. Vertigan, A.E.; Gibson, P.G.; Theodoros, D.G.; Winkworth, A.L.; Borgas, T.; Reid, C. Involuntary Glottal Closure during Inspiration in Muscle Tension Dysphonia. *Laryngoscope* **2006**, *116*, 643–649. [CrossRef]
18. Gillespie, A.I.; Gartner-Schmidt, J.; Rubinstein, E.N.; Abbott, K.V. Aerodynamic Profiles of Women with Muscle Tension Dysphonia/Aphonia. *J. Speech Lang. Hear. Res.* **2013**, *56*, 481–488. [CrossRef] [PubMed]
19. Alipour, F.; Karnell, M. Aerodynamic and Acoustic Effects of Ventricular Gap. *J. Voice* **2014**, *28*, 154–160. [CrossRef] [PubMed]
20. Kryshtopava, M.; Van Lierde, K.; Meerschman, I.; D'Haeseleer, E.; Vandemaele, P.; Vingerhoets, G.; Claeys, S. Brain Activity During Phonation in Women with Muscle Tension Dysphonia: An fMRI Study. *J. Voice* **2017**, *31*, 675–690. [CrossRef]
21. McKenna, V.S.; Hylkema, J.A.; Tardif, M.C.; Stepp, C.E. Voice Onset Time in Individuals with Hyperfunctional Voice Disorders: Evidence for Disordered Vocal Motor Control. *J. Speech Lang. Hear. Res.* **2020**, *63*, 405–420. [CrossRef]
22. Abur, D.; Subaciute, A.; Kapsner-Smith, M.; Segina, R.K.; Tracy, L.F.; Noordzij, J.P.; Stepp, C.E. Impaired auditory discrimination and auditory-motor integration in hyperfunctional voice disorders. *Sci. Rep.* **2021**, *11*, 13123. [CrossRef]
23. Dahl, K.L.; Stepp, C.E. Effects of Cognitive Stress on Voice Acoustics in Individuals with Hyperfunctional Voice Disorders. *Am. J. Speech-Lang. Pathol.* **2022**, *32*, 264–274. [CrossRef]
24. Ali, I.; Hussain, R.T.; Wagay, F.A.; Ahmad, R. Muscle Tension Dysphonia: Experience from a Conflict Zone. *Indian J. Otolaryngol. Head Neck Surg.* **2022**, *74* (Suppl. 2), 2082–2087. [CrossRef]
25. Falanga, C.; Costa, G.; Volpe, U.; Saracino, D.; Lechien, J.R.; Estomba, C.M.C.; Tripodi, M.; Cammaroto, G.; Angelillo, N.; Nacci, A.; et al. Psychological Distress in a Sample of Adult Italian Patients Affected by Vocal Nodules and Muscle-Tension Dysphonia: Preliminary Results. *J. Voice* **2020**, *37*, 300.e21–300.e29. [CrossRef]
26. Mateos-Serrano, B.; García-López, I.; Toledano, A.; Gavilán, J. Subjective voice analysis in patients with muscular tension dysphonia: Comparison between clinician and patient evaluation. *J. Laryngol. Otol.* **2021**, *135*, 458–463. [CrossRef]
27. Arffa, R.E.; Krishna, P.; Gartner-Schmidt, J.; Rosen, C.A. Normative Values for the Voice Handicap Index-10. *J. Voice* **2012**, *26*, 462–465. [CrossRef]
28. Khoramshahi, H.; Khatoonabadi, A.R.; Khoddami, S.M.; Dabirmoghaddam, P.; Ansari, N.N. Responsiveness of Persian Version of Consensus Auditory Perceptual Evaluation of Voice (CAPE-V), Persian Version of Voice Handicap Index (VHI), and Praat in Vocal Mass Lesions with Muscle Tension Dysphonia. *J. Voice* **2018**, *32*, 770.e21–770.e30. [CrossRef]
29. Martinez, C.C.; Lemos, I.d.O.; Madazio, G.; Behlau, M.; Cassol, M. Vocal parameters, muscle palpation, self-perception of voice symptoms, pain, and vocal fatigue in women with muscle tension dysphonia. *CoDAS* **2021**, *33*, e20200035. [CrossRef] [PubMed]
30. Hsiao, T.Y.; Liu, C.M.; Hsu, C.J.; Lee, S.Y.; Lin, K.N. Vocal Fold Abnormalities in Laryngeal Tension-Fatigue Syndrome. *J. Formos Med. Assoc.* **2001**, *100*, 837–840. Available online: https://europepmc.org/article/med/11802526 (accessed on 3 January 2023). [PubMed]
31. Garaycochea, O.; Navarrete, J.M.A.; del Río, B.; Fernández, S. Muscle Tension Dysphonia: Which Laryngoscopic Features Can We Rely on for Diagnosis? *J. Voice* **2019**, *33*, 812.e15–812.e18. [CrossRef] [PubMed]
32. Fernández, S.; Garaycochea, O.; Martinez-Arellano, A.; Alcalde, J. Does More Compression Mean More Pressure? A New Classification for Muscle Tension Dysphonia. *J. Speech Lang. Hear. Res.* **2020**, *63*, 2177–2184. [CrossRef] [PubMed]
33. Hocevar-Boltezar, I.; Janko, M.; Zargi, M. Role of Surface EMG in Diagnostics and Treatment of Muscle Tension Dysphonia. *Acta Oto-Laryngol.* **1998**, *118*, 739–743. [CrossRef] [PubMed]

34. Stepp, C.E.; Heaton, J.T.; Jetté, M.E.; Burns, J.A.; Hillman, R.E. Neck surface electromyography as a measure of vocal hyperfunction before and after injection laryngoplasty. *Ann. Otol. Rhinol. Laryngol.* **2010**, *119*, 594–601. [CrossRef] [PubMed]
35. Stepp, C.E.; Heaton, J.T.; Braden, M.N.; Jetté, M.E.; Stadelman-Cohen, T.K.; Hillman, R.E. Comparison of Neck Tension Palpation Rating Systems with Surface Electromyographic and Acoustic Measures in Vocal Hyperfunction. *J. Voice* **2011**, *25*, 67–75. [CrossRef] [PubMed]
36. Nguyen, D.D.; Kenny, D.T. Effects of Muscle Tension Dysphonia on Tone Phonation: Acoustic and Perceptual Studies in Vietnamese Female Teachers. *J. Voice* **2009**, *23*, 446–459. [CrossRef]
37. Dabirmoghaddam, P.; Aghajanzadeh, M.; Erfanian, R.; Aghazadeh, K.; Sohrabpour, S.; Firouzifar, M.; Maroufizadeh, S.; Nikravesh, M. Comparative Study of Increased Supraglottic Activity in Normal Individuals and Those with Muscle Tension Dysphonia (MTD). *J. Voice* **2019**, *35*, 554–558. [CrossRef]
38. Shim, H.-J.; Jung, H.; Koul, R.; Ko, D.-H. Spectral and Cepstral Based Acoustic Features of Voices with Muscle Tension Dysphonia. *Clin. Arch. Commun. Disord.* **2016**, *1*, 42–47. [CrossRef]
39. Shembel, A.C.; Lee, J.; Sacher, J.R.; Johnson, A.M. Characterization of Primary Muscle Tension Dysphonia Using Acoustic and Aerodynamic Voice Metrics. *J. Voice* **2021**, *37*, 897–906. [CrossRef]
40. Belsky, M.A.; Rothenberger, S.D.; Gillespie, A.I.; Gartner-Schmidt, J.L. Do Phonatory Aerodynamic and Acoustic Measures in Connected Speech Differ Between Vocally Healthy Adults and Patients Diagnosed with Muscle Tension Dysphonia? *J. Voice* **2020**, *35*, 663.e1–663.e7. [CrossRef]
41. Stepp, C.E.; Hillman, R.E.; Heaton, J.T. The Impact of Vocal Hyperfunction on Relative Fundamental Frequency During Voicing Offset and Onset. *J. Speech Lang. Hear. Res.* **2010**, *53*, 1220–1226. [CrossRef] [PubMed]
42. Roy, N.; Fetrow, R.A.; Merrill, R.M.; Dromey, C. Exploring the Clinical Utility of Relative Fundamental Frequency as an Objective Measure of Vocal Hyperfunction. *J. Speech Lang. Hear. Res.* **2016**, *59*, 1002–1017. [CrossRef]
43. Espinoza, V.M.; Zañartu, M.; Van Stan, J.H.; Mehta, D.D.; Hillman, R.E. Glottal Aerodynamic Measures in Women with Phonotraumatic and Nonphonotraumatic Vocal Hyperfunction. *J. Speech Lang. Hear. Res.* **2017**, *60*, 2159–2169. [CrossRef]
44. Zheng, Y.-Q.; Zhang, B.-R.; Su, W.-Y.; Gong, J.; Yuan, M.-Q.; Ding, Y.-L.; Rao, S.-Q.; Zheng, Y.-Q.; Zhang, B.-R.; Su, W.-Y.; et al. Laryngeal Aerodynamic Analysis in Assisting with the Diagnosis of Muscle Tension Dysphonia. *J. Voice* **2012**, *26*, 177–181. [CrossRef]
45. Jafari, N.; Izadi, F.; Ebadi, A.; Talebian, S.; Dabirmoghadam, P.; Jordens, K.; Bahmani, K.; Van Lierde, K. Comparison of Laryngeal Palpatory Scale (LPS), With Surface Electromyographic Measures in Patients with Muscle Tension Dysphonia. *J. Voice* **2021**, *38*, 245.e37–245.e48. [CrossRef]
46. Hosokawa, K.; Yoshida, M.; Yoshii, T.; Takenaka, Y.; Hashimoto, M.; Ogawa, M.; Inohara, H. Effectiveness of the Computed Analysis of Electroglottographic Signals in Muscle Tension Dysphonia. *Folia Phoniatr. Logop.* **2012**, *64*, 145–150. [CrossRef]
47. Ogawa, M.; Hosokawa, K.; Yoshida, M.; Iwahashi, T.; Hashimoto, M.; Inohara, H. Immediate Effects of Humming on Computed Electroglottographic Parameters in Patients with Muscle Tension Dysphonia. *J. Voice* **2014**, *28*, 733–741. [CrossRef] [PubMed]
48. Van Houtte, E.; Claeys, S.; D'haeseleer, E.; Wuyts, F.; Van Lierde, K. An Examination of Surface EMG for the Assessment of Muscle Tension Dysphonia. *J. Voice* **2013**, *27*, 177–186. [CrossRef]
49. Adleberg, J.; Ferster, A.P.O.; Benito, D.A.; Sataloff, R.T. Detection of Muscle Tension Dysphonia Using Eulerian Video Magnification: A Pilot Study. *J. Voice* **2019**, *34*, 622–628. [CrossRef] [PubMed]
50. Ata, N.A.; Khoddami, S.M.; Babaei-Ghazani, A.; Izadi, F.; Maroufizadeh, S. Strain Elastosonography Measurement in Patients with Primary Muscle Tension Dysphonia Compared with Healthy Speakers: A Pilot Study. *J. Voice* **2022**, *36*, 290.e7–290.e15. [CrossRef]
51. Roy, N.; Bless, D.M.; Heisey, D.; Ford, C.N. Manual circumlaryngeal therapy for functionaldysphonia: An evaluation of short- and long-term treatment outcomes. *J. Voice* **1997**, *11*, 321–331. [CrossRef] [PubMed]
52. Dehqan, A.; Scherer, R.C. Positive Effects of Manual Circumlaryngeal Therapy in the Treatment of Muscle Tension Dysphonia (MTD): Long Term Treatment Outcomes. *J. Voice* **2019**, *33*, 866–871. [CrossRef]
53. Van Lierde, K.M.; De Bodt, M.; Dhaeseleer, E.; Wuyts, F.; Claeys, S. The Treatment of Muscle Tension Dysphonia: A Comparison of Two Treatment Techniques by Means of an Objective Multiparameter Approach. *J. Voice* **2010**, *24*, 294–301. [CrossRef]
54. Aghadoost, S.; Jalaie, S.; Khatoonabadi, A.R.; Dabirmoghaddam, P.; Khoddami, S.M. A Study of Vocal Facilitating Techniques Compared to Manual Circumlaryngeal Therapy in Teachers with Muscle Tension Dysphonia. *J. Voice* **2019**, *34*, 963.e11–963.e21. [CrossRef]
55. Ahmadi, N.; Abbott, K.V.; Rajati, F.; Khoddami, S.M.; Torabinezhad, F.; Takamjani, I.E.; Vasaghi-Gharamaleki, B. Effects of Laryngeal Manual Therapy on Primary Muscle Tension Dysphonia (MTD-1): Implications for MTD-1 Type. *J. Voice* **2022**, *in press*. [CrossRef]
56. Hsiung, M.-W.; Hsiao, Y.-C. The Characteristic Features of Muscle Tension Dysphonia before and after Surgery in Benign Lesions of the Vocal Fold. *ORL J. Otorhinolaryngol. Relat. Spec.* **2004**, *66*, 246–254. [CrossRef]
57. Ziade, G.; Haddad, G.; Assaad, S.; Kasti, M.; Hamdan, A.-L.; Li, J.; Zhao, S.; Yang, L.; Li, Y.; Ma, X.; et al. Changes in Abnormal Muscle Tension Pattern after Fiberoptic Injection Laryngoplasty. *Ear Nose Throat J.* **2017**, *96*, 472–476. [CrossRef] [PubMed]
58. Novakovic, D.; Nguyen, D.D.; Chacon, A.; Madill, C. Injection laryngoplasty as adjunct treatment method for muscle tension dysphonia: Preliminary findings. *Laryngoscope* **2020**, *130*, 980–985. [CrossRef] [PubMed]

59. Dworkin, J.P.; Meleca, R.J.; Simpson, M.L.; Garfield, I. Use of topical lidocaine in the treatment of muscle tension dysphonia. *J. Voice* **2000**, *14*, 567–574. [CrossRef] [PubMed]
60. Mansuri, B.; Torabinejhad, F.; Jamshidi, A.A.; Dabirmoghaddam, P.; Vasaghi-Gharamaleki, B.; Ghelichi, L. Transcutaneous Electrical Nerve Stimulation Combined with Voice Therapy in Women with Muscle Tension Dysphonia. *J. Voice* **2018**, *34*, 490.e11–490.e21. [CrossRef]
61. Mansuri, B.; Torabinezhad, F.; Jamshidi, A.A.; Dabirmoghadam, P.; Vasaghi-Gharamaleki, B.; Ghelichi, L. Application of High-Frequency Transcutaneous Electrical Nerve Stimulation in Muscle Tension Dysphonia Patients with the Pain Complaint: The Immediate Effect. *J. Voice* **2020**, *34*, 657–666. [CrossRef]
62. Pacheco, P.; Karatayli-Ozgursoy, S.; Best, S.; Hillel, A.; Akst, L. False vocal cord botulinum toxin injection for refractory muscle tension dysphonia: Our experience with seven patients. *Clin. Otolaryngol.* **2015**, *40*, 60–64. [CrossRef]
63. Bhalla, R.; Wallis, J.; Kaushik, V.; de Carpentier, J. How we do it: Adjunctive intravenous midazolam: Diagnosis and treatment of therapy-resistant muscle tension dysphonia. *Clin. Otolaryngol.* **2005**, *30*, 367–369. [CrossRef]
64. Prosek, R.A.; Montgomery, A.A.; Walden, B.E.; Schwartz, D.M. EMG Biofeedback in the Treatment of Hyperfunctional Voice Disorders. *J. Speech Hear. Disord.* **1978**, *43*, 282–294. [CrossRef]
65. Andrews, S.; Warner, J.; Stewart, R. EMG biofeedback and relaxation in the treatment of hyperfunctional dysphonia. *Int. J. Lang. Commun. Disord.* **1986**, *21*, 353–369. [CrossRef]
66. Kandogan, T.; Aksoy, G.; Dalgic, A. Effects of Omeprazole Over Voice Quality in Muscle Tension Dysphonia Patients with Laryngopharyngeal Reflux. *Iran. Red Crescent Med. J.* **2012**, *14*, 787–791. [CrossRef] [PubMed]
67. Morrison, M.D.; Nichol, H.; Rammage, L.A. Diagnostic criteria in functional dysphonia. *Laryngoscope* **1986**, *96*, 1–8. [CrossRef] [PubMed]
68. Roy, N.; Dietrich, M.; Blomgren, M.; Heller, A.; Houtz, D.R.; Lee, J. Exploring the Neural Bases of Primary Muscle Tension Dysphonia: A Case Study Using Functional Magnetic Resonance Imaging. *J. Voice* **2019**, *33*, 183–194. [CrossRef]
69. Angsuwarangsee, T.; Morrison, M. Extrinsic Laryngeal Muscular Tension in Patients with Voice Disorders. *J. Voice* **2002**, *16*, 333–343. [CrossRef] [PubMed]
70. Cohen, S.M.; Garrett, C.G. Hoarseness: Is It Really Laryngopharyngeal Reflux? *Laryngoscope* **2008**, *118*, 363–366. [CrossRef] [PubMed]
71. Altman, K.W.; Atkinson, C.; Lazarus, C. Current and Emerging Concepts in Muscle Tension Dysphonia: A 30-Month Review. *J. Voice* **2005**, *19*, 261–267. [CrossRef] [PubMed]
72. Roy, N. Differential diagnosis of muscle tension dysphonia and spasmodic dysphonia. *Curr. Opin. Otolaryngol. Head Neck Surg.* **2010**, *18*, 165–170. [CrossRef]
73. D'haeseleer, E.; Depypere, H.; Claeys, S.; Van Borsel, J.; Van Lierde, K. The menopause and the female larynx, clinical aspects and therapeutic options: A literature review. *Maturitas* **2009**, *64*, 27–32. [CrossRef] [PubMed]
74. Abitbol, J.; Abitbol, P.; Abitbol, B. Sex hormones and the female voice. *J. Voice* **1999**, *13*, 424–446. [CrossRef] [PubMed]
75. Torabi, H.; Khoddami, S.M.; Ansari, N.N.; Dabirmoghaddam, P. The Vocal Tract Discomfort Scale: Validity and Reliability of the Persian Version in the Assessment of Patients with Muscle Tension Dysphonia. *J. Voice* **2016**, *30*, 711–716. [CrossRef]
76. Aghadoost, S.; Jalaie, S.; Dabirmoghaddam, P.; Khoddami, S.M. Effect of Muscle Tension Dysphonia on Self-perceived Voice Handicap and Multiparametric Measurement and Their Relation in Female Teachers. *J. Voice* **2022**, *36*, 68–75. [CrossRef]
77. Sama, A.; Carding, P.N.; Price, S.; Kelly, P.; Wilson, J.A. The Clinical Features of Functional Dysphonia. *Laryngoscope* **2001**, *111*, 458–463. [CrossRef]
78. Vaca, M.; Cobeta, I.; Mora, E.; Reyes, P. Clinical Assessment of Glottal Insufficiency in Age-related Dysphonia. *J. Voice* **2017**, *31*, 128.e1–128.e5. [CrossRef]
79. Van Lawrence, L. Suggested Criteria for Fibre-Optic Diagnosis of Vocal Hyperfunction. In *Care of the Professional Voice Symposium*; The British Voice Association: London, UK, 1987.
80. Stager, S.V.; Bielamowicz, S.; Gupta, A.; Marullo, S.; Regnell, J.R.; Barkmeier, J. Quantification of Static and Dynamic Supraglottic Activity. *J. Speech Lang. Hear Res.* **2001**, *44*, 1245–1256. [CrossRef] [PubMed]
81. Behrman, A.; Dahl, L.D.; Abramson, A.L.; Schutte, H.K. Anterior-Posterior and medial compression of the supraglottis: Signs of nonorganic dysphoniaor normal postures? *J. Voice* **2003**, *17*, 403–410. [CrossRef]
82. Koufman, J.A.; Blalock, P. Functional Voice Disorders. *Otolaryngol. Clin. N. Am.* **1991**, *24*, 1059–1073. [CrossRef]
83. Sapienza, C.M.; Walton, S.; Murry, T. Adductor spasmodic dysphonia and muscular tension dysphonia: Acoustic analysis of sustained phonation and reading. *J. Voice* **2000**, *14*, 502–520. [CrossRef]
84. Stepp, C.E.; Merchant, G.R.; Heaton, J.T.; Hillman, R.E.; Murray, E.S.H.; Segina, R.K.; Woodnorth, G.H.; Park, Y.; Van Stan, J.H.; Mehta, D.D.; et al. Effects of Voice Therapy on Relative Fundamental Frequency During Voicing Offset and Onset in Patients with Vocal Hyperfunction. *J. Speech Lang. Hear Res.* **2011**, *54*, 1260–1266. [CrossRef] [PubMed]
85. Kagan, L.S.; Heaton, J.T. The Effectiveness of Low-Level Light Therapy in Attenuating Vocal Fatigue. *J. Voice* **2017**, *31*, 384.e15–384.e23. [CrossRef] [PubMed]
86. McKenna, V.S.; Vojtech, J.M.; Previtera, M.; Kendall, C.L.; Carraro, K.E. A Scoping Literature Review of Relative Fundamental Frequency (RFF) in Individuals with and without Voice Disorders. *Appl. Sci.* **2022**, *12*, 8121. [CrossRef]
87. Theis, S.M.; Carlson, A. Voice Therapy. *Int. J. Head Neck Surg.* **2022**, *13*, 27–31. [CrossRef]

88. Stemple, J.C.; Glaze, L.E.; Klaben, B.G. *Clinical Voice Pathology: Theory and Management*, 4th ed.; Plural Publishing: San Diego, CA, USA, 2010.
89. Chen, F.C.; Ma, E.P.-M.; Yiu, E.M.-L. Facial Bone Vibration in Resonant Voice Production. *J. Voice* **2014**, *28*, 596–602. [CrossRef]
90. Titze, I.R. Voice Training and Therapy with a Semi-Occluded Vocal Tract: Rationale and Scientific Underpinnings. *J. Speech Lang. Hear Res.* **2006**, *49*, 448–459. [CrossRef]
91. Ogawa, M.; Hosokawa, K.; Yoshida, M.; Yoshii, T.; Shiromoto, O.; Inohara, H. Immediate Effectiveness of Humming on the Supraglottic Compression in Subjects with Muscle Tension Dysphonia. *Folia Phoniatr. Logop.* **2013**, *65*, 123–128. [CrossRef]
92. Roy, N.; Leeper, H.A. Effects of the manual laryngeal musculoskeletal tension reduction technique as a treatment for functional voice disorders: Perceptual and acoustic measures. *J. Voice* **1993**, *7*, 242–249. [CrossRef]
93. Ribeiro, V.V.; Pedrosa, V.; Silverio, K.C.A.; Behlau, M. Laryngeal Manual Therapies for Behavioral Dysphonia: A Systematic Review and Meta-analysis. *J. Voice* **2018**, *32*, 553–563. [CrossRef]
94. Dromey, C.; Nissen, S.L.; Roy, N.; Merrill, R.M. Articulatory Changes Following Treatment of Muscle Tension Dysphonia: Preliminary Acoustic Evidence. *J. Speech Lang. Hear Res.* **2008**, *51*, 196–208. [CrossRef]
95. Mathieson, L.; Hirani, S.; Epstein, R.; Baken, R.; Wood, G.; Rubin, J. Laryngeal Manual Therapy: A Preliminary Study to Examine its Treatment Effects in the Management of Muscle Tension Dysphonia. *J. Voice* **2009**, *23*, 353–366. [CrossRef]
96. Dehqan, A.; Ballard, K.J. An evaluation of Short-term Treatment Outcomes of Cricothyroid Visor Maneuver: A Proof-of-Concept Pilot Study. *J. Voice* **2021**, *35*, 330.e1–330.e7. [CrossRef]
97. Roy, N. Assessment and treatment of musculoskeletal tension in hyperfunctional voice disorders. *Int. J. Speech-Lang. Pathol.* **2008**, *10*, 195–209. [CrossRef]
98. Boone, D.R.; McFarlane, S.C.; Von Berg, S.L.; Zraick, R.I. *The Voice and Voice Therapy*; Pearson Education: Upper Saddle River, NJ, USA, 2013.