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The Efficacy of the Manual Circumlaryngeal Therapy for Muscle Tension Dysphonia: A Systematic Review and Meta-analysis

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Objective: Muscle tension dysphonia (MTD) is the most common functional voice disorder. Behavioral voice therapy is the front-line treatment for MTD, and laryngeal manual therapy may be a part of this treatment. The objective of this study was to investigate the effect of manual circumlaryngeal therapy (MCT) on acoustic markers of voice quality (jitter, shimmer, and harmonics-to-noise ratio) and vocal function (fundamental frequency) through a systematic review with meta-analysis.

Data Sources: Four databases were searched from inception to December 2022, and a manual search was performed.

Review Methods: The PRISMA extension statement for reporting systematic reviews incorporating a meta-analysis of health care interventions was applied, and a random effects model was used for the meta-analyses.

Results: We identified 6 eligible studies from 30 studies (without duplicates). The MCT approach was highly effective on acoustics with large effect sizes (Cohen's d > 0.8). Significant improvements were obtained in jitter in percent (mean difference of −.58; 95% CI −1.00 to 0.16), shimmer in percent (mean difference of −5.66; 95% CI −8.16 to 3.17), and harmonics-to-noise ratio in dB (mean difference of 4.65; 95% CI 1.90–7.41), with the latter two measurements continuing to be significantly improved by MCT when measurement variability is considered.

Conclusion: The efficacy of MCT for MTD was confirmed in most clinical studies by assessing jitter, shimmer, and harmonics-to-noise ratio related to voice quality. The effects of MCT on the fundamental frequency changes could not be verified. Further contributions of high-quality randomized control trials are needed to support evidence-based practice in laryngology.

Key Words: manual circumlaryngeal therapy, meta-analysis, muscle tension dysphonia, voice therapy.

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INTRODUCTION

Voice disorders can be classified into etiological categories of organic and functional dysphonia. Organic voice disorders are caused by morphological-pathological changes occurring primarily within the larynx.[1] Functional voice disorders are caused by vocal behaviors that are tied to neuromuscular activity influenced by conscious and unconscious mechanisms.[2] The most commonly diagnosed type of functional voice disorder is muscle tension dysphonia (MTD).[3]

MTD can present in primary form where no structural, neurological, or systemic changes to the vocal folds are present, or in secondary form where the maladaptive vocal behaviors are a secondary reaction to some primary organic diagnosis.[2] As with most voice disorders, MTD may affect vocal intensity, quality, pitch, resonance, flexibility, and stamina, in which a large variation in dysphonia severity from one individual to the next can be highly disparate.[1,4–6]

The primary treatment approach for MTD is voice therapy based on conservative behavioral voice management.[5–7] There are many different approaches, associated with five voice rehabilitation management concepts (hygienic-, symptomatic-, psychogenic-, physiological-, and eclectic voice treatment),[8] to the treatment of MTD with the existing evidence base stronger for some approaches compared with others.

Manual therapy approaches are associated with symptomatic voice treatment.[9,10] Symptomatic voice treatment focuses on modifying dysphonic symptoms or unfavorable voice components identified during voice diagnostics.[11] These symptoms include inappropriate pitch, breathy or rough phonation, and vocal tract discomfort.[11] During this treatment, the voice clinician attempts to use direct voice therapy techniques to help patients find and use their best voice production.

The aim of manual therapy approaches is to reduce muscle tension associated with vocal hyperfunction and deactivate the excessive tension of the muscles surrounding the larynx to improve voice production. This can be accomplished in some cases after just one treatment session[9,10] Manual circumlaryngeal therapy

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(MCT)—also referred to as manual laryngeal musculoskeletal tension reduction technique— has a robust evidence base.[12] MCT has a long-standing history as a primary voice treatment approach for muscle tension dysphonia, as evidenced by the early descriptions of Aronson[13] and more recent development of systematic approaches by Roy[3,9] and also Mathieson.[10] The anatomical regions targeted in MCT are the hyoid bone, thyroid space, larynx, and medial and lateral suprahyoid muscles.[9] Techniques include circular massage, kneading, stretching using thumb, and index finger movements. Phonation such as humming, counting, or text reading are also included in the approach. Treatment begins with circular pressure on the hyoid bone (unimanual), repeating the procedure in the thyrohyoid space and over the posterior edges of the thyroid cartilage. Subsequently, the larynx is pulled downward with the fingers over the superior border of the thyroid cartilage, and finally, the larynx may occasionally be moved laterally or pressure applied to push the hyoid bone posteriorly.[9,10]

As mentioned earlier, dysphonia associated with MTD is characterized by a wide range of vocal complaints, maladaptive vocal behaviors, and dysphonia severity degrees. A multidimensional voice assessment is thus recommended, in which acoustics are one of the primary domains of voice assessment.[14] Acoustic analyses of the voice signal are one of the most widely used diagnostic tools for quantifying and describing voice disorders in research.[15] This diagnostic tool remains a gold standard in clinical voice care when evaluating the treatment effects for voice therapy approaches.[16] The overall purpose of acoustic measurements is to quantify the perceived voice characteristics and to objectively describe the severity of dysphonia in a way that reliably and validly correlates with patient and clinician perceptions. Some of the most popular and frequently used perturbation and spectral parameters in voice quality assessment are jitter, shimmer, and harmonics-to-noise ratio.[17] Typically, when jitter and/or shimmer decrease or harmonics-to-noise ratio increases, the corresponding perceptual impression is less dysphonic severity.[2,17]

In addition, the fundamental frequency of habitual pitch is another important acoustic variable that is commonly used to assess physiological vocal function. Voice physiology and voice quality may fluctuate over time, so it is important to understand that the consistency of acoustic measures within and between speakers may vary across single- and multiple voice recordings.[18,19]

The primary aim of this meta-analysis was to investigate the treatment effect of MCT on four acoustic parameters relating to voice quality and vocal function in patients with MTD. A secondary objective was to examine the residual/corrected treatment effect when controlling for acoustic measurement variability due to multiple voice production trials. Datasets with multiple voice recordings for acoustic measurements, which are attainable through meta-analysis, are important for determining the practical significance of potential treatment effects based on pre-to-post treatment differences.

METHODS

Data Sources and Searches

The reporting guideline of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used.[20] The primary research question was based on the PICO (population, intervention, control, and outcomes) format: How effective is the manual circumlaryngeal therapy (I) as treatment method for functional dysphonia (P) under consideration of the outcome (O) of four acoustic parameters (fundamental frequency, jitter, shimmer, and harmonics-to-noise ratio)?

This study aimed to determine the treatment effect arising solely from the MCT approach, and therefore, (C) no control group was involved. Secondary (O) outcomes of interest included residual/corrected treatment effects on acoustic measures to account for the variability due to multiple voice production trials.

A systematic search in four databases (MEDLINE, CENTRAL, CINAHL, and OVID-Medline) from inception to 17th December 2022 was conducted. The search strategies used a combination of various key words (e.g., muscle tension dysphonia, manual circumlaryngeal therapy, and acoustic) based on the PICO format, and they are presented in detail in Table S1.

Potential articles were identified by title and abstract. Finally, a manual search was utilized in grey literature sources. The hand search was used in bibliographies of included studies. The hand search strategy of relevant scientific reports for the meta-analysis was performed for studies published in various languages which are included in the databases. In addition, treatment efficacy had to be measured on sustained vowel with the acoustic measures of jitter in %, shimmer in %, harmonics-to-noise ratio in dB, and fundamental frequency in Hz.

Study Selection

The search did not exclude any available form of clinical intervention study with a pre-post design of patients with muscle tension dysphonia considering minimal multiple cases. The clinical parameters of this meta-analysis included the most commonly used quantitative acoustic measures of an internationally agreed battery of voice examinations[14]: jitter (%), shimmer (%), harmonics-to-noise ratio (dB), and fundamental frequency (Hz). Studies eligible for this meta-analysis had to involve at least one of these acoustic measures for voice assessment evaluating on habitual sustained vowel voice production.

To avoid specification and reliability differences due to the application of different acoustic software packages, only studies that performed acoustic measurements with Praat (Paul Boersma and David Weenink; Institute of Phonetic Sciences, University of Amsterdam, The Netherlands: http://www.praat.org/) and TF32 or formerly CSpeech (Paul Milenkovic, University of Wisconsin, Madison, WI) were included. High-correlation coefficients were revealed between both software packages in fundamental frequency, jitter, shimmer, and harmonics-to-noise ratio (equal to signal-to-noise ratio in TF32/CSpeech) outcomes in the evaluation of vocally healthy voices ($r = 0.969$, $r = 0.946$, $r = 0.899$, and $r = 0.950$; all p-values < 0.001).[21] In dysphonic voices, the reliability results of these four acoustic measures between Praat and TF32 were mostly comparable with those of vocally healthy voices (fundamental frequency: $r = 0.911$, jitter: $r = 0.959$, shimmer: $r = 0.642$, and harmonics-to-noise ratio/signal-to-noise ratio: $r = 0.962$; all p-values < 0.001).[21] The correlation coefficients with its highly significant levels are sufficiently reliable for all four acoustic parameters in various voice severity levels. Therefore, clinical trials that used Praat or TF32/CSpeech for treatment evaluation of the four different acoustic measures can be considered for the present meta-analysis.

Risk of Bias Assessments

To assess risk of bias of the included studies, the RoB 2 tool[22] for randomized studies and ROBINS-I tool[23] for non-randomized studies were used. The following domains were evaluated to conclude an overall risk of bias for RoB2 (i.e., low, some concerns, or high): randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. ROBINS-I used the following domains evaluating the overall risk of bias from low, moderate, serious, critical to no information: confounding, selection of participants into the study, classification of interventions, deviations from intended interventions, missing data, measurement of outcome, and selection of the reported result.

Data Extraction

Data were extracted by two reviewers (B.B.v.L. and C.R.W.) and tabulated as reported in the analysis and discussion. Disagreements were resolved by way of discussion. The collected data were extracted from the included studies relating to article information (authors, year of publication, journal, study title), study information (study design, sample size, MTD duration, acoustic data processing methodology, voice therapy plan, and session intensity), patient demographics (gender and age), and outcomes (fundamental frequency, jitter, shimmer, and harmonics-to-noise ratio).

Statistics

Statistical analyses were performed with the following programs: MedCalc software (version 19.6) and SAS software (version 9.4).

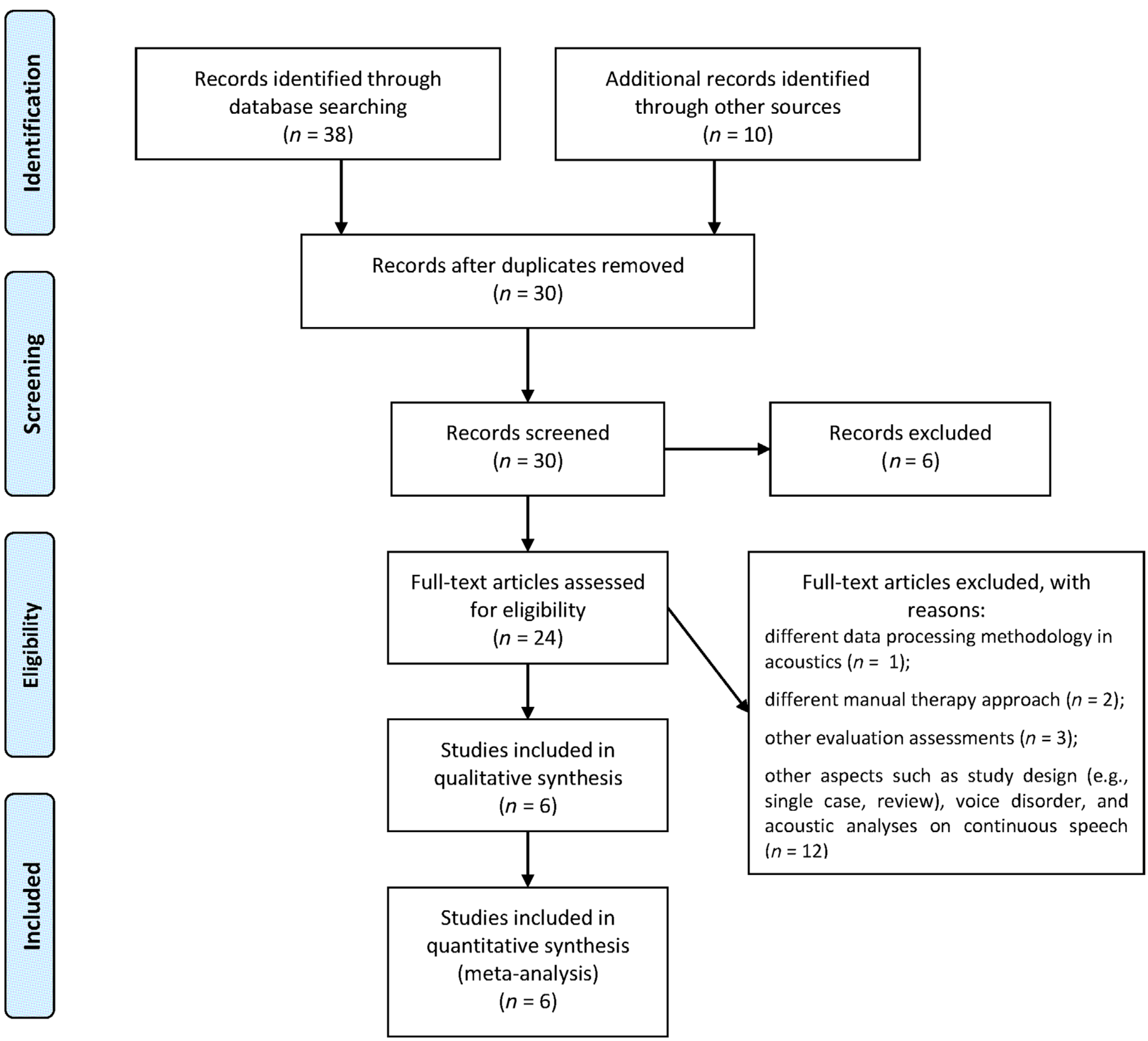

Fig. 1. PRISMA flow chart. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

First, the differences between the mean values of voice quality parameters ($\overline{x}_{post} - \overline{x}_{pre}$) and standard errors (SE) were calculated $SE = \frac{(S_1+S_2)/2}{\sqrt{n}}$.

Second, meta-analyses were performed using MedCalc software for the four acoustic measures. The mean difference (MD) was presented with the 95% confidence interval (CI) per study and the pooled analyses were presented in a forest plot. Heterogeneity among studies was presented with the I^2 index. An I^2 index value between 0% and 25% represents insignificant heterogeneity; >25%–50% represents low heterogeneity; >50%–75% represents moderate heterogeneity; and >75% represents high heterogeneity.[24] The random effects model was used to analyze the pooled data so that heterogeneity between studies was accounted for. Studies were weighted according to DerSimonian & Laird[25] using the random effects model.

Third, Cohen's d was calculated as effect size of voice measures, where by convention 0.2–0.5 is considered a small, 0.5–0.7 a medium, and >0.8 a large effect.[26]

TABLE I.
Characteristics of Clinical Trials in the Meta-analysis.

Study Characteristics							MCT Characteristics	
Study Reference	OCEBM Level of Evidence[27]	Study Design	Sample Size	Age (in Years)/ Gender of the MCT Group	MTD Duration	Acoustic Data Processing Methodology	Voice Therapy Plan	Session Intensity
Roy & Leeper[28]	4	Single-group pretest–posttest study	Total: $N = 17$	Mean/range 46.9 (20–70) F/M = 16/1	Mean (min – max) 8.3 months (4 days – 3 years)	CSpeech: jitter (ms), shimmer (%), signal-to-noise ratio (dB)	A single treatment approach	60 min to 3 h (voice assessment, interview protocol and treatment protocol according to Aronson's guidelines)
Roy et al.[29]	4	Single-group pretest–posttest study	Total: $N = 25$	Mean/SD 40.9 (±13.03) F/M = 25/0	Mean (min – max) 8.8 months (5 days – 4 years)	CSpeech: jitter (%), shimmer (%), signal-to-noise ratio (dB)	A single treatment approach	50 min to 3 h (voice assessment, interview protocol and treatment protocol according to Aronson's guidelines)
Rad et al.[30]	4	Single-group pretest–posttest study	Total: $N = 20$	Mean/range F = 34.1 (23–42) M = 37.6 (34–41) F/M = 12/8	Mean (min – max) 2.8 year (6 months – 4 years)	Praat: fundamental frequency (Hz), first formant frequency (Hz), jitter (%), shimmer (%), harmonics-to-noise ratio (dB)	A single treatment approach	N/A (voice assessment, interview protocol and treatment protocol according to Aronson's guidelines)
Dehqan & Scherer[31]	4	Single-group pretest–posttest study	Total: $N = 28$	Mean/range 32.1 (18–40) F/M = 28/0	Mean (min–max) 9.35 months (6 months – N/A)	Praat: fundamental frequency (Hz), first formant frequency (Hz), jitter (%), shimmer (%), harmonics-to-noise ratio (dB)	15 therapy sessions for 5 weeks	Treatment protocol according to Aronson's guidelines: 3 × 30 min
Aghadoost et al.[32]	2	Randomized control trial	Total: $N = 16$ MCT: $N = 8$	Mean/SD 39.8 (±4.6) F/M = 16/0	N/A	Praat: dysphonia severity index with also its single parameters (maximum phonation time (sec), highest fundamental frequency (Hz), lowest intensity (dB), and jitter (%))	10 therapy sessions for 5 weeks	Treatment protocol according to Aronson's guidelines: 2 × 40 min
Dehqan & Ballard[33]	2	Randomized control trial	Total: $N = 88$ MCT: $N = 30$	Mean/SD 28.7 (±4.95) F/M = 30/0	Mean (min–max) 8.20 months (6 months–N/A)	Praat: cepstral peak prominence smoothed (dB), jitter (%), shimmer (%), harmonics-to-noise ratio (dB)	A single treatment approach	50 min to 1 h (voice assessment and treatment protocol according to Aronson's guidelines)

Fourth, to better assess the effect of the pre-to-post differences in the four measurement parameters, the variability of the voice measurements from vocally healthy voices was subtracted from the pooled mean difference. The pooled mean difference from the meta-analysis was reduced by the specified proportion of the coefficient of variation (CV) from Pierce et al.[19] resulting in the corrected mean differences. The newly corrected *p*-value was calculated using the z-transformation. For this, the pooled mean differences were subtracted from 0 and divided by the standard deviation. The further the pooled mean differences are from 0, the more significant is the difference between pre and post values of the acoustic parameters. SAS software was used for this analysis.

RESULTS

Study Characteristics

We identified 30 non-duplicate manuscripts from our searches (Fig. 1). Of these, 6 studies were eligible for inclusion in the present review, and the study characteristics of these included studies are presented in Table I.[28–33] Of them, four studies were observational studies of a single MCT group with a pre-to-post design. In total, 128 participants were treated with MCT ranging from 8 to 30 participants in intervention groups. The duration and intensity of the MCT sessions varied between a single treatment with 50–180 min and up to 15 therapy sessions for 5 weeks approximating up to 450 min of total therapy.

The included studies mostly reported on female voices. Only one study assessed the effect of MCT for males and females in two groups.[30] Another study included only one male by analyzing pre-to-post differences for aspects of voice quality.[28] According to minimal gender effects for voice quality parameters of jitter, shimmer, and harmonics-to-noise ratio,[34] the small number of male voices can be included for analyzing voice quality in the present meta-analysis. Only fundamental frequency was analyzed on female voices in the present meta-analysis, because of highly different gender effects on habitual pitch.[35] Furthermore, the data of the estimated range of acoustic measurement variability from multiple voice recordings by Pierce et al.[19] were thus used for this meta-analysis as well, although female voices were investigated for this dataset. In addition, in the present meta-analysis and in the data set of Pierce et al.[19] the Praat software was used for signal processing analysis for the four acoustic measures.

The results of the risk of bias analysis are shown in Table II. For the randomized trials, the risk of bias was some concerns[32] and high[33] for the two studies. For the observational studies, the overall risk of bias was moderate for all four studies.[28–31]

TABLE II.
Risk of Bias Analysis of Observational Studies and Randomized Clinical Trial Studies.

Study	D1	D2	D3	D4	D5	Overall
Aghadoost et al. (2020)	X	-	+	-	X	X
Dehqan & Ballard (2021)	-	-	+	+	-	-

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement: X High; - Some concerns; + Low

Study	D1	D2	D3	D4	D5	D6	D7	Overall
Roy & Leeper (1993)	+	-	+	+	+	-	-	-
Roy et al. (1997)	+	-	+	+	+	+	-	-
Rad et al. (2018)	+	-	+	+	+	-	-	-
Dehqan & Scherer (2019)	+	-	+	+	+	-	+	-

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Judgement: - Moderate; + Low

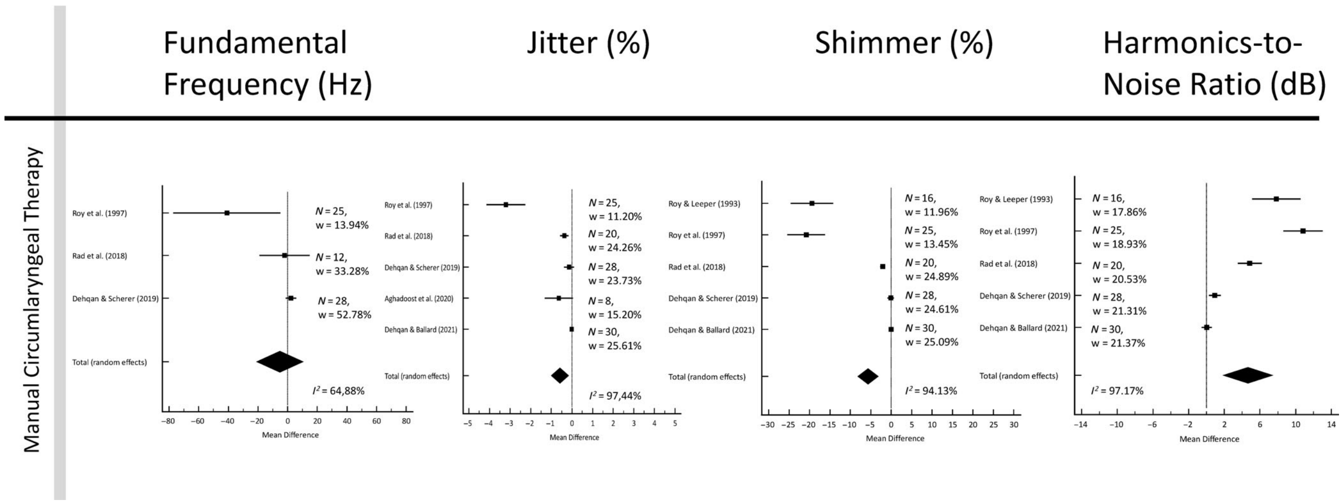

Fig. 2. Forest plots of the measurements.

Meta-analysis

Figure 2 and Table III show the results for the four parameters: fundamental frequency, jitter, shimmer, and harmonics-to-noise ratio. For mean fundamental frequency, only female voices were analyzed, in which the treatment effect (MD = −5.18 Hz; 95% CI: −20.82 Hz to −10.46 Hz) was not significant. The other three acoustic measures showed a significant improvement: jitter (MD = −.58%; 95% CI: −1.00% to 0.16%), shimmer (MD = −5.66%; 95% CI: −8.16% to 3.17%), and harmonics-to-noise ratio (MD = 4.65 dB; 95% CI: 1.90 dB to −7.41 dB).

All Cohen's *d* values of the four acoustic measures were above 0.8.

Moderate heterogeneity was revealed for fundamental frequency ($I^2 = 64.88\%$). This was different for the three acoustic voice quality parameters, where I^2 was >75%. To account for these heterogeneity results, the random effects model was used.

Pooled Mean Difference Correction

The pooled mean differences from the meta-analysis were reduced by the voice variations of data by Pierce et al.[19] (fundamental frequency: CV = 15%, jitter: CV = 53%, shimmer: CV = 48%, and harmonics-to-noise ratio: CV = 14%), resulting in corrected mean differences (fundamental frequency: MD = −4.40, jitter: MD = −.27, shimmer: MD = −2.94, and harmonics-to-noise ratio: MD = 4.00) (Table III).

The corrected difference for fundamental frequency remained nonsignificant ($p = 0.581$). The parameter jitter was no longer significant after correction ($p = 0.193$), but the mean differences of shimmer and harmonics-to-noise ratio were significant after correction ($p = 0.021$, and $p = 0.005$).

DISCUSSION

The purpose of this review was to investigate the treatment effect of MCT on four acoustic parameters relating to voice quality and vocal function in patients with MTD. Vocal function changes associated with habitual fundamental frequency after MCT could not be confirmed. After statistical correction accounting for variability in the number of recording trials (via method of Pierce et al.[19]), the pooled mean differences for shimmer and harmonics-to-noise ratio were reduced but were still significantly improved. By this correction, all mean differences values of the acoustic parameters were corrected downwards due to the variability. Because shimmer and harmonics-to-noise ratio already showed stronger effects than jitter in the mean differences before the correction, this confirmed that only shimmer and harmonics-to-noise ratio were statistically and practically significant in the present meta-analysis.

TABLE III.
Meta-analysis by Treatment and by Voice Measures (Random Effects Model), Cohen's *d*, and Corrected Results After Subtraction of the Range of Acoustic Measurement Variability from Multiple Voice Recordings Based on the Results of Pierce et al.[19]

Acoustic Parameter	*N*	Mean Difference (95% CI)	Cohen's *d* (95% CI)	Corrected Mean Difference	*p*-Value Corrected
Fundamental frequency	65	−5.18 Hz (−20.82 Hz to 10.46 Hz)	1.20 (−2.26 to 4.65)	−4.40 Hz	0.581
Jitter	111	−0.58% (−1.00% to −.16%)	2.64 (0.99 to 4.30)	−0.27%	0.193
Shimmer	120	−5.66% (−8.16% to −3.17%)	4.24 (0.51 to 7.96)	−2.94%	**0.021**
Harmonics-to-noise ratio	120	4.65 dB (1.90 dB to 7.41 dB)	4.93 (2.03 to 7.84)	4.00 dB	**0.005**

Bold values signifies $p < 0.05$.

Our meta-analysis included two RCT studies and four single-group pretest–posttest studies revealing some concerns of bias and a large degree of heterogeneity in three of four acoustic parameters. All six studies showed a moderate risk of bias in the overall assessment or a high risk of bias in one case, but no indirectness could be determined. Although large degrees of variability were evident in the pooled data set, representing the characteristic heterogeneity of voice quality encountered from patient to patient in clinical settings, the statistical analysis revealed that MCT was an effective treatment for dysphonia as measured by acoustic analysis.

Previous meta-analyses of manual voice therapies have attempted to confirm intersections of the various manual approaches with different primary outcome variables.[36,37] Ribeiro et al.[36] included in their meta-analysis the laryngeal manual therapy approach of two randomized control trial studies evaluating the perceived overall severity of vocal deviation and the intensity of vocal and laryngeal symptoms. The treatment effect of laryngeal manual therapy from this meta-analysis revealed no differences from transcutaneous electrical nerve stimulation and vocal training composed of the tongue or lip trill, humming, overarticulation, and chewing techniques.[36] The other meta-analysis was not limited to study designs and combined the results of acoustic measures on various manual therapy methods during the search period of January 2000 to December 2020.[37] Although MCT was the most frequent therapy approach in this study (75%), two other manual treatment approaches were included as well.[37] The treatment effect was evaluated with g-Hedge's without considering interstudy differences of data processing methodology from acoustics.[37] These differences of data processing include bias because acoustic measures will vary based on the various acoustic software platforms utilized, such as Multi Dimensional Voice Program, Praat, TF32, Dr. Speech, and WPCVox.[21,38,39] Data differences among the software platforms are due to the fact that each platform uses different algorithms for specific acoustic measurements. One of the few exceptions is fundamental frequency which does not show significant differences among different data acquisition and processing methodologies.[21,39–42] All in all, a combination of different data processing methods in acoustics should be strictly avoided, as only a few programs provide comparable results for the same parameter.

To evaluate the efficacy of treatment approaches of muscle tension dysphonia, the present study and previous meta-analysis by Kim[37] provide evidence that MCT is an effective treatment option. In this context, three additional meta-analyses identified six voice therapy programs that demonstrated significant voice improvements in the treatment of dysphonia associated with muscle tension dysphonia based on statistical network analyses. These include vocal function exercises, stretch-and-flow phonation, resonant voice, an eclectic voice therapy program from Brazil, Novafon local vibration voice therapy, and water resistance therapy.[43–45] Further strong direct voice therapy concepts (such as the voice therapy expulsion, the Seong-Tae Kim's multiple voice therapy technique, vocal function exercises, and resonant voice) were yielded in treating vocal fold polyps, which are mostly based on secondary (with phonotraumatic lesions) muscle tension dysphonia.[46]

In the primary care of voice patients with increased laryngeal tension leading to primary hoarseness, MCT may be considered a preferred approach because positive outcomes, in some patients, can be established after a single therapy session, as shown by four of six studies in the present meta-analysis. The reason for the effectiveness of this approach may lie in the position of the larynx in many cases of MTD. Patients with MTD can present habitually elevated hyoid and laryngeal positions at rest but especially during voicing, reflecting increased tension of the extrinsic laryngeal muscles. The added tension and altered position of the larynx may limit phonation flexibility and vibratory dynamics, resulting in dysphonia.[2] Through repositioning and massaging the laryngeal region, MCT is thought to reduce laryngeal tension, better position the larynx for voice production, and restore phonation flexibility and physiology.

Caveats, Limitations, and Future Directions

Limitations of the present meta-analysis may not only concern the generalizability of its results, but also provide a direction for future research.

Representativeness of the current meta-analysis. First, there was moderate to high heterogeneity of studies in the present meta-analysis (ranging from $I^2 = 64.88\%–97.44\%$), which may be due to selection bias regarding mostly observational studies with a single group of pretses–posttest design.

Second, a moderate to high risk of bias was evaluated in the included six studies in which the most of them were observational studies. In the future, more efforts need to be made providing prospective studies to evaluate efficacy in RCT studies considering high-quality study designs based on the criteria of RoB2 assessment.

Third, multidimensional assessments are needed for the evaluation of treatment outcomes in voice disorders. Therefore, a consistent standardization of diagnostic voice assessments or a compliance with already established standards is important for the performance of both voice treatments and high-quality comparative studies on the outcome of different voice treatments. Several attempts at consensus were made in the selection of methods for assessing voice production such as five aspects of voice assessment, namely, a visual analysis, an auditory-perceptual judgment, an aerodynamic analysis, an acoustic analysis, and a self-assessment.[14,47] All of these assessment modalities are independent of each other and are appropriate for evaluating voice disorders and their treatment outcomes.[48,49]

Methodological limitations. First, the intensity and frequency of MCT sessions were heterogenous because some studies included only one instance and others multiple (up to 15 sessions). The variability in the number of sessions in MCT could be explained by the wide variation in dysphonia severity from muscle tension dysphonia, which vary significantly from one person to another in aspects of vocal intensity, quality, pitch, resonance, flexibility, and stamina. However, according to standardization and principals of evidence-based medicine, an effective and efficient voice therapy approach reduces treatment session time, increases the patient's motivation, and promotes patient compliance.[50]

Second, the evaluation of acoustic measures, that are correlated to voice quality, were limited to jitter, shimmer, and harmonics-to-noise ratio. These acoustic measures have a long tradition and are still used today as objective markers of voice quality, with jitter and shimmer representing the periodicity of vocal fold vibration related to fundamental frequency and vocal intensity, respectively, and harmonics-to-noise ratio related to the degree of aperiodic noise in the acoustic voice energy. However, the clinical utility of these three acoustic measures is limited for several reasons, for example, lower validity level in the assessment of hoarseness[51] or other subtypes[17] in comparison with cepstral measures, and some dysphonic voices cannot be analyzed at all for these acoustic measurements based on insufficient periodic structure.[52]

CONCLUSION

The present meta-analysis provides evidence that MCT is effective in treating muscle tension dysphonia with largest effects on shimmer and harmonics-to-noise ratio. In general, voice quality based on acoustic measurements can be significantly improved after using MCT approach, but no effect could be confirmed in habitual fundamental frequency. Further research on high-quality intervention studies is recommended to support clinical practice in laryngology.

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