The Treatment of Muscle Tension Dysphonia: A Comparison of Two Treatment Techniques by Means of an Objective Multiparameter Approach

*,†Kristiane M. Van Lierde, Marc De Bodt, *,†Evelien Dhaeseleer, ‡Floris Wuyts, and *,†Sofie Claeys, *Gent and †Antwerp, Belgium

Summary: The purpose of the present study is to measure the effectiveness of two treatment techniques—vocalization with abdominal breath support and manual circumlaryngeal therapy (MCT)—in patients with muscle tension dysphonia (MTD). The vocal quality before and after the two treatment techniques was measured by means of the dysphonia severity index (DSI), which is designed to establish an objective and quantitative correlate of the perceived vocal quality. The DSI is based on the weighted combination of the following set of voice measurements: maximum phonation time (MPT), highest frequency, lowest intensity, and jitter. The repeated-measures analysis of variance (ANOVA) revealed a significant difference between the objective overall vocal quality before and after MCT. No significant differences were measured between the objective overall vocal quality before and after vocalization with abdominal breath support. This study showed evidence that MCT is an effective treatment technique for patients with elevated laryngeal position, increased laryngeal muscle tension, and MTD. The precise way in which MCT has an effect on vocal quality has not been addressed in this experiment, but merits study. Further research into this topic could focus on electromyography (EMG) recordings in relation to vocal improvements with larger sample of subjects.

Key Words: Muscle tension dysphonia–Voice therapy–Manual circumlaryngeal therapy–Dysphonia severity index.

INTRODUCTION

The purpose of voice therapy is the improvement of the vocal quality by teaching the patient to use his/her vocal mechanism more efficiently. The voice therapist can use various indirect approaches (vocal hygiene education) and direct voice techniques (by working on breathing, glottic closure, lowering the larynx, and others) to establish a more efficient vocal quality. Although functional voice disorders are the most frequently occurring laryngeal pathologies,1,2 very few data are available to measure the short-term effectiveness of different vocal techniques.

Muscle tension dysphonia (MTD) is a functional voice disorder caused by imbalanced laryngeal or perilaryngeal muscle activity that can result in vocal fold hyperadduction, constriction, or bowing.3,4 According to Rubin et al.,5 there are four basic patterns that are termed muscle tension patterns (MTPs): type I is glottal, and types II, III, and IV are supraglottal. The etiologic factors for MTD are: inappropriate vocal behavior, gastroesophageal reflux, psychologic and personality factors that increase vocal fold tension.6 An elevated larynx and hyoid bone owing to increased perilaryngeal muscle tension appeared to predominate in individuals presenting with MTD.

In literature, there are few treatment efficacy data for voice disorders, and even fewer examining the relative effects of approaches (vocal hygiene education) and direct voice techniques (by working on breathing, glottic closure, lowering the larynx, and others) to establish a more efficient vocal quality. Although functional voice disorders are the most frequently occurring laryngeal pathologies, very few data are available to measure the short-term effectiveness of different vocal techniques.

Muscle tension dysphonia (MTD) is a functional voice disorder caused by imbalanced laryngeal or perilaryngeal muscle activity that can result in vocal fold hyperadduction, constriction, or bowing. According to Rubin et al., there are four basic patterns that are termed muscle tension patterns (MTPs): type I is glottal, and types II, III, and IV are supraglottal. The etiologic factors for MTD are: inappropriate vocal behavior, gastroesophageal reflux, psychologic and personality factors that increase vocal fold tension. An elevated larynx and hyoid bone owing to increased perilaryngeal muscle tension appeared to predominate in individuals presenting with MTD.

In literature, there are few treatment efficacy data for voice disorders, and even fewer examining the relative effects of treatments, such as the effect of laryngeal manual therapy. The primary aim of laryngeal manual therapy is to relax the excessively tensed laryngeal and perilaryngeal musculature, which inhibits normal phonatory function. The term laryngeal manual therapy has been used throughout this study as an umbrella term, which can be used to refer to any manual laryngeal treatment to decrease laryngeal and perilaryngeal tension. To date, there exist two techniques of laryngeal manual therapy: (1) the classic laryngeal manual therapy approach; and (2) the manual circumlaryngeal therapy (MCT) approach. The MCT is based on the laryngeal musculoskeletal reduction approach, as described by Aronson. Mathieson et al. described the variations and similarities of the classic laryngeal manual therapy and MCT. The main differences between classic laryngeal manual therapy and MCT consist of whether or not palpatory evaluation is conducted by the clinician before (classic laryngeal manual therapy) or during the procedure (MCT), the active intervention is carried out using chiefly both hands (classic laryngeal manual therapy) or one hand (MCT), and the patient is asked to vocalize after (classic laryngeal manual therapy) or during manual therapy (MCT). A notable distinction between the two techniques is that, whereas MCT addresses a diminished thyrohyoid space by circular massage in this area, classic laryngeal manual therapy does not. In this study, the effect of MCT in patients with MTD is described. The MCT for the laryngeal area involves kneading the laryngeal musculature (and does not involve laryngeal reposturing maneuvers) in specific locations while observing changes in voice. The specific therapeutic approach of MCT in this study is described in the methods. Few studies investigated the impact of these manual laryngeal therapies on the vocal quality in pretreatment and post-treatment situations, as shown in Table 1. Roy et al. measured the effect of MCT (as described by Aronson) in several patients with functional dysphonia associated with increased laryngeal muscle tension. Perceptual and acoustical measures of vocal function were used. These vocal measures indicated a significant change in the direction of normal vocal...
<table>
<thead>
<tr>
<th>Reference</th>
<th>n</th>
<th>Speech Sample</th>
<th>Duration and Type of Treatment</th>
<th>Method</th>
<th>Results After Single Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roy and Leeper (1993)³</td>
<td>17 (m.a.: 46.9 y)</td>
<td>Rainbow passage Sustained /a/</td>
<td>Single treatment approach (range: 60 min–3 h) Voice assessment: pre- and posttreatment MCT</td>
<td>Perceptual evaluation Acoustical analysis (cspeech)</td>
<td>Significant decrease of severity ratings Marked improvement of jitter, shimmer, and SNR measures in connected speech and sustained vowels No change in ( F_0 )</td>
</tr>
<tr>
<td>Roy et al. (1997)⁹</td>
<td>25 (m.a.: 40 y)</td>
<td>Rainbow passage Sustained vowels /a//i//u/</td>
<td>Single treatment approach (range: 50 min–3 h) Voice assessment: pre- and posttreatment MCT</td>
<td>Perceptual evaluation Acoustical analysis (cspeech)</td>
<td>Significant decrease of severity ratings (maintained over two follow-up sessions) Significant improvement of jitter, shimmer, and SNR measures No change in ( F_0 )</td>
</tr>
<tr>
<td>Roy and Ferguson (2001)⁶</td>
<td>75 (m.a.: 46 y)</td>
<td>Sustained vowel /a/</td>
<td>Single treatment approach Voice assessment: pre- and posttreatment and two follow-up sessions MCT</td>
<td>Acoustical analysis ( (MDVP) )</td>
<td>Significant decrease of first three formants (hypothesis: decrease of laryngeal height and lengthening vocal tract)</td>
</tr>
<tr>
<td>Van Lierde et al (2004)¹⁰</td>
<td>4 (m.a.: 48.7 y)</td>
<td>Sustained vowel /a/</td>
<td>Twice a week 25 therapeutic sessions (50 min) Voice assessment pre- and posttreatment (after 25 sessions) Classic laryngeal manual therapy + facilitation techniques</td>
<td>Laryngologic evaluation Perceptual evaluation ( (GRBAS scale) ) Maximum phonation time Voice range Acoustic analysis ( (MDVP) ) DSI measurement</td>
<td>Improvement Improved (but not normal): S factor decreased Improved in 3/4 subjects Highest frequency higher ( F_0 ) closer to the norm, improved jitter and shimmer Improved</td>
</tr>
<tr>
<td>Mathieson et al. (2007)⁴</td>
<td>10 (m.a.: 30.3 y)</td>
<td>Sustained vowel /a/ Reading passage: “Arthur the Rat”</td>
<td>Single treatment approach (45 min) Voice assessment: pre- and posttreatment and 1 wk after treatment Classic laryngeal manual therapy</td>
<td>Acoustic analysis ( (MDVP) ) Formant frequency analysis (PRAAT) Vocal tract discomfort scale</td>
<td>Average perturbation during connected speech was significantly reduced (indicating a reduction in ab normal function) No changes Discomfort reduced</td>
</tr>
</tbody>
</table>

m.a. = mean age; SNR = signal-to-noise ratio; GRBAS scale = G: overall grade of hoarseness, R = rough, B = breathy, A = asthenic, S = strained.
function in most patients after a single treatment approach. Furthermore, the results of the study of Mathieson et al.\textsuperscript{10} showed positive evidence for manual laryngeal therapy as a method of therapy in the treatment for hyperfunctional voice disorders. The effect of manual laryngeal therapy was proven with a measurable acoustic change and a decrease of vocal tract discomfort. In the study of Van Lierde et al.\textsuperscript{10} the outcome of manual laryngeal therapy was modeled by means of the dysphonia severity index (DSI), an objective and quantitative correlate of the perceived vocal quality. The four selected subjects showed improvement in perceptual vocal quality and DSI values after a well-defined manual laryngeal therapy program of 25 sessions.

In none of the aforementioned studies a controlled comparison of alternative treatment techniques was performed. Moreover, most studies focused on the perceptual evaluation of the voice in combination with the results of change of some acoustic parameters. Perceptual evaluation is one of the most controversial topics in voice research with a wide variety of rating scales.\textsuperscript{11} Furthermore, the normal limits of acoustic parameters are, in general, very broad. Only values that deviate from normal may be conclusive for clinical purposes. Only in one study,\textsuperscript{10} an objective measure of vocal quality based on a multiparameter approach by means of the DSI was used. The DSI consists of a specific weighted combination of the highest fundamental frequency, the lowest intensity, the maximum phonation time (MPT), and the jitter. The DSI for perceptually normal voices equals +5 and for severely dysphonic voices, −5. The more negative the patient’s index, the worse is his or her vocal quality.\textsuperscript{11} Given the growing interest of laryngeal manual therapy in Europe as a component of voice therapy for patients with increased laryngeal muscle tension and MTD and the poverty of data (in a modified pretest–posttest design using a controlled comparison of alternative treatment techniques) describing its effectiveness, additional research is warranted.

The purpose of the present study is to measure the effectiveness of two treatment techniques—vocalization with abdominal breath support and MCT—in 10 patients with MTD, using an objective multiparameter approach by means of the DSI. The treatment approach for respiration combined with vocalization was used, because respiration is one of the three major subsystems responsible for the production of voice, and a physiological balance of respiration, phonation, and resonance is the ultimate goal of voice therapy. Moreover, several authors concluded on the one hand that it is evident that some laryngeal pathologies certainly alter normal respiration, especially in MTD,\textsuperscript{12} and on the other hand that a better breathing pattern can lead to better phonation.\textsuperscript{13} In Europe, a lot of voice specialists use direct modification of breathing as a beginning of symptomatic voice therapy.\textsuperscript{14} Based on the results of previous reports, using MCT as the therapeutic technique, a significant improvement of the objective overall vocal quality can be expected.

**METHODS**

**Subjects**

Ten subjects, four females, six males, with a mean age of 58 years (range 18–65 years), with MTD and increased tension of the laryngeal muscles, were included in this study. The characteristics of the subjects, especially the initial complaints, the stroboscopic evaluation, the musculoskeletal evaluation during the diagnostic procedure of the ear, nose, throat (ENT) specialist, and the objective overall vocal quality by means of the DSI are mentioned in Table 2.

All subjects consulted the same multidisciplinary voice clinic in the university hospital of Gent. Each subject was clinically examined by the same ENT specialist, including mirror examination of the larynx, and videostroboscopic and musculoskeletal evaluation. A standard evaluation protocol\textsuperscript{15} was followed, and an evaluation form was completed. One ENT specialist and one voice therapist, with experience in the assessment of voice disorders, completed all evaluations. All subjects presented with MTD without evidence of laryngeal lesions or laryngeal neuropathology. The subjects were selected sequentially as they presented in the voice clinic. None of the subjects followed voice therapy.

**Objective Measurement Protocol: Aerodynamic, Vocal Range, Acoustic, and Dysphonia Severity Index Measurements**

The vocal quality before and after the two treatment techniques in these 10 subjects was measured by means of the DSI, which is designed to establish an objective and quantitative correlate of the perceived vocal quality. The DSI is based on the weighted combination of the following set of voice measurements: MPT, highest frequency ($F_{\text{high}}$), lowest intensity ($I_{\text{low}}$), and jitter.

MPT was measured on the basis of two test trials with the vowel /a/, sustained at the subject’s habitual pitch and loudness in free field and in sitting position. The length of sustained phonation was measured in seconds. The best trial was retained for further description. The highest frequency and the lowest intensity were measured with the Voice Range Profile from the Computerized Speech Lab (CSL).\textsuperscript{16} The procedure described by Heylen et al.\textsuperscript{17} was used. A “rough” contour was then generated by having the subject vocalize at his or her lowest and highest frequencies using the softest and greatest intensities at each frequency extreme.

The acoustic parameters $F_0$, jitter, and shimmer were obtained by the Multi Dimensional Voice Program (MDVP).\textsuperscript{18} A midvowel segment on a sustained /a/, at habitual loudness and pitch, was used. The DSI is constructed as $0.13 \times \text{MPT} + 0.0053 \times F_{\text{high}} - 0.26 \times I_{\text{low}} - 1.18 \times \text{jitter} (\%) + 12.4$. The DSI for perceptually normal voices equals +5 (or 100%) and for severely dysphonic voices equals −5 (or 0%). The more negative the patient’s index, the worse is his or her vocal quality.\textsuperscript{11}

The objective assessment procedure was carried out during the diagnostic procedure after the controlled comparison of alternative treatment technique (vocalization with abdominal breath support) and after the MCT.

**Experimental therapy design.** Before MCT, the treatment technique vocalization with abdominal breath support was performed for 45 minutes. The objective voice measurement protocol (as described earlier) was successively carried out
<table>
<thead>
<tr>
<th>Patients</th>
<th>Gender</th>
<th>Age (y)</th>
<th>Duration of MTD (m)</th>
<th>Complaints</th>
<th>Stroboscopic Evaluation</th>
<th>Musculoskeletal Evaluation</th>
<th>DSI Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP</td>
<td>F</td>
<td>64</td>
<td>6</td>
<td>Sometimes aphonie, Hoarseness, Pain, Increased tension</td>
<td>MTP IV</td>
<td>Laryngeal elevation, Difficulties to palpate the hyoid owing to high position, Hypertonicity with painful palpation of sternocleidomastoid muscle, High shoulder position with painful palpation of the trapezius muscle</td>
<td>+0.1</td>
</tr>
<tr>
<td>BK</td>
<td>F</td>
<td>36</td>
<td>18</td>
<td>Hoarseness, Vocal fatigue, Strained voice, Increased effort to phonate Globus pharyngeus</td>
<td>MTP I</td>
<td>Difficulties to palpate the hyoid owing to high position, Laryngeal pain during palpation of sternohyoid muscle</td>
<td>-4.0</td>
</tr>
<tr>
<td>VDVG</td>
<td>M</td>
<td>63</td>
<td>6</td>
<td>Hoarseness, Vocal fatigue, Strained voice, Increased effort to phonate Globus pharyngeus</td>
<td>MTP II</td>
<td>Laryngeal elevation, Pain in response to pressure on the thyrohyoid muscle, Reduced cricothyroid space</td>
<td>-15.8</td>
</tr>
<tr>
<td>MT</td>
<td>M</td>
<td>18</td>
<td>2</td>
<td>Hoarseness</td>
<td>MTP I</td>
<td>Laryngeal elevation, Hypertonicity with painful palpation of the sternocleidomastoid muscle, Very high shoulder position, Hypertonicity of sternohyoid muscle, High position of hyoid, Pain in the right aural region, Tension of the thyrohyoid muscle</td>
<td>-3.9</td>
</tr>
<tr>
<td>DWW</td>
<td>M</td>
<td>42</td>
<td>8</td>
<td>Hoarseness, Discomfort after performance of a vocal task, Inability to phonate with a higher intensity</td>
<td>MTP II</td>
<td>Hypertonicity with painful palpation of the sternocleidomastoid muscle, High position of hyoid, Pain in the temporomandibular joint in resting position</td>
<td>-2.8</td>
</tr>
<tr>
<td>KA</td>
<td>F</td>
<td>38</td>
<td>5</td>
<td>Aphonic, Hoarseness, Laryngeal pain, Globus pharyngeus</td>
<td>MTP IV</td>
<td>Hypertonicity with painful palpation of the sternocleidomastoid muscle, Very high shoulder position, Hypertonicity of sternohyoid muscle, High position of hyoid, Pain in the temporomandibular joint in resting position</td>
<td>-7.4</td>
</tr>
<tr>
<td>MA</td>
<td>F</td>
<td>39</td>
<td>12</td>
<td>Hoarseness, Laryngeal tension</td>
<td>MTP I</td>
<td>Laryngeal elevation, Reduced cricothyroid space</td>
<td>-5.1</td>
</tr>
<tr>
<td>DV</td>
<td>M</td>
<td>64</td>
<td>8</td>
<td>Vocal fatigue, Hoarseness, Difficulties to phonate with a higher intensity</td>
<td>MTP IV</td>
<td>Laryngeal elevation, Painful palpation of sternohyoid muscle, Painful palpation of trapezius muscle, Unable to palpate the hyoid muscle owing to high position, Painful palpation of thyrohyoid muscle</td>
<td>-6.4</td>
</tr>
</tbody>
</table>

(Continued)
before and after treatment approach 1 (vocalization with abdominal breath support) and before and after treatment approach 2 (MCT), as seen in the following diagram of the experimental therapy design.

The diagram of the experimental therapy design is as follows:

1. Diagnostic procedure with the use of the objective measurement protocol
2. Use of treatment approach 1: vocalization with abdominal breath support during a single treatment approach (45 minutes)
3. Evaluation procedure of treatment approach 1 with the use of the objective measurement protocol
4. Use of treatment approach 2: MCT during a single treatment approach (45 minutes)
5. Evaluation procedure of the MCT with the use of the objective measurement protocol.

Procedures 1–5 were successively performed. The objective measurement protocol was immediately performed before and after treatment approaches 1 (vocalization with abdominal breath support) and 2 (MCT) by a research assistant (ED) blinded to the purpose and the stages of the study.

**Procedure for the treatment approach 1: vocalization with abdominal breath support.**

1. Theoretical information about breathing patterns and limited breath support.
2. Identification of the breathing pattern of the subject.
3. Practicing abdominal/diaphragmatic breathing without phonation at rest while sitting.
4. Practicing abdominal/diaphragmatic breathing during phonation at rest while sitting with the use of tactile and visual feedback of the abdominal breathing pattern.
   4.1. During the production of /z//v/
   4.2. During the phonation of syllables starting with /z/ or /v/ (eg, za, zee, va, vee)
   4.3. During the phonation of short words (one syllable) starting with /z/ or /v/ (eg, zap, zop, vamp, viel)
   4.4. During the phonation of longer words (two syllables) (eg, vallen, vielen, zepen, and others)
   4.5. Counting from 1 to 10

**Procedure for treatment approach 2: manual circumlaryngeal therapy.**

The MCT or the manual laryngeal musculoskeletal tension reduction technique, as described by Aronson and Roy and Leeper, was used. The MCT for the laryngeal area involves a massage of the laryngeal musculature and does not involve laryngeal reposturing maneuvers.

**Hyoid bone.**

1. The hyoid bone was encircled with the thumb and index finger, which were worked posteriorly until the tips of the major horns were felt.
2. Circular movements with the fingers over the tips of the hyoid bone using light pressure.

**Thyroid cartilage.**

3. This circular movement procedure was repeated beginning from the thyroid notch and working posteriorly
4. The posterior borders of the thyroid cartilage just medial to the sternocleidomastoid muscles were located and the procedure was repeated.

**Total larynx.**

5. With the fingers over the superior borders of the thyroid cartilage, the total larynx was worked downward, and moved laterally at the same time.

During these procedures, facial expressions of the subjects were observed for signs of discomfort or pain. During the aforementioned procedures, the subjects were asked to sustain vowels, to produce syllables or very short words, while changes in vocal quality were observed. Improvement in vocal quality was immediately reinforced and subjects were reinforced to listen (auditory feedback) to the more optimal vocal quality and to feel (proprioceptive feedback) the more appropriate vocal quality. According to Aronson, improved vocal quality indicates relief of tension. The improved vocal quality was progressively shaped from vowels and words to short sentences.

**Statistical Analysis**

The SPSS V14 for Windows was used for the statistical analyses. Repeated-measures ANOVA was used to measure the differences regarding the objective vocal quality for the DSI before and after treatment approaches 1 and 2. Significance level was set at $P = 0.05$. Despite the small number of subjects, repeated-measures ANOVA was used, because the relevant measures consisted of the pair-wise differences. As a control, the nonparametric Friedman test was done, followed by the Wilcoxon paired signed rank test. This analysis revealed the same results regarding significant effects as the repeated-measures ANOVA.

**RESULTS**

The results of the voice assessment of the diagnostic DSI value (intake), after voicing with abdominal breath support (posttreatment 1) and after MCT (posttreatment 2) are provided in Table 3.

Figure 1 represents the changes of DSI from the intake, the posttreatment 1 condition (voicing with abdominal breath support) till the posttreatment 2 condition (MCT).

The repeated-measures ANOVA revealed a significant effect of therapy for the objective overall voice quality, represented by the DSI outcome measure. However, the effect situated itself for the DSI at the difference between the intake condition and the posttreatment 2 condition (after MCT) ($P < 0.001$) and between the posttreatment 1 (after voicing with abdominal breath support) and the posttreatment 2 conditions (after MCT) ($P = 0.003$).

No significant differences were measured between the objective overall vocal quality for the DSI value of the intake condition and the posttreatment 1 condition (after voicing with abdominal breath support) ($P = 0.2$).

**DISCUSSION**

The purpose of the present study was to measure the effectiveness of two treatment techniques—vocalization with abdominal breath support and MCT—in 10 patients with MTD. To the best of our knowledge, studies that document the objective improvement (based on a multiparameter approach) of vocal quality after these two treatment techniques, appear to be very limited. As hypothesized, the results of this study showed significant improvement of the objective vocal quality after MCT. As the DSI is a weighted variable including aerodynamic and acoustic measures, small improvements (closer to 5% or 100%) are very indicative for vocal quality improvement. The DSI value of the subjects improved from -5.9, corresponding to a DSI% of 9%, to -2, corresponding to a DSI% of 30% after MCT. Analysis of the components of the DSI show that the main responsible variables for this difference after MCT are MPT, lowest intensity, and jitter. Furthermore, in the studies of Roy et al., a significant improvement of the acoustic parameters was measured. Comparison of the DSI values of the current study with DSI data in the literature is only possible with the study of Van Lierde et al. Furthermore, in that study, the four selected subjects with moderate-to-severe MTD showed improvement of the DSI value after classic laryngeal manual therapy combined with facilitation techniques.

The significant improvement of the DSI data after MCT showed that one single treatment approach of 45 minutes using MCT is more effective than a similar time spent of abdominal breathing support associated with voice production. Because a controlled comparison of an alternative treatment approach is used, the data of this study support the superiority of MCT during a single treatment approach of 45 minutes over the alternative therapy technique of abdominal breathing support combined with voice production. Moreover, this study supports the suggestions of Roy and Leeper that, MCT should be considered early in the treatment-selection process. Aronson suggested that chronic posture of the larynx in an elevated position leads to cramping and stiffness of the hyoid-laryngeal musculature. Furthermore, in these 10 subjects, laryngeal elevation and increased tension of the extrinsic and intrinsic laryngeal muscles was observed, which contributes to the occurrence of MTD. As Aronson pointed out, MCT is a direct method to treat laryngeal hyperfunction. A direct decrease of laryngeal tension and an immediate voice improvement can be expected. The treatment technique abdominal breath support combined with voice production, can be considered as an indirect method to decrease the laryngeal tension.

Limitations of this study are that assessment of outcome is limited to objective measures using a multiparameter approach. A perceptual evaluation and a self-rating would have been a valuable information to obtain. To what extent there exists a cumulative therapy effect by combining the two therapy
<table>
<thead>
<tr>
<th>Type of Measurements</th>
<th>Intake Condition</th>
<th>Posttreatment Approach 1 (Voicing with Abdominal Breath Support)</th>
<th>Posttreatment Approach 2 (MCT)</th>
<th>P value of Intake Posttreatment 1</th>
<th>P value of Intake Posttreatment 2</th>
<th>P value of Intake Posttreatment 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerodynamic MPT (s)</td>
<td>10.8 ± 1.2</td>
<td>10.72 ± 1.3</td>
<td>16.39 ± 3.3</td>
<td>0.1</td>
<td>0.1</td>
<td>0.05*</td>
</tr>
<tr>
<td>Voice range profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity: low (dB)</td>
<td>67 ± 2.2</td>
<td>67.8 ± 2.5</td>
<td>63.9 ± 2.3</td>
<td>0.3</td>
<td>0.05*</td>
<td>0.007*</td>
</tr>
<tr>
<td></td>
<td>98 ± 1.1</td>
<td>97.5 ± 1.4</td>
<td>99.5 ± 1.5</td>
<td>0.6</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Frequency: low (Hz)</td>
<td>127 ± 11.6</td>
<td>125 ± 11.8</td>
<td>135.7 ± 16</td>
<td>0.1</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Frequency: high (Hz)</td>
<td>457 ± 48.1</td>
<td>453 ± 47</td>
<td>528 ± 41.3</td>
<td>0.7</td>
<td>0.8</td>
<td>0.05*</td>
</tr>
<tr>
<td>Acoustic analysis</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter (%)</td>
<td>3.9 ± 1.2</td>
<td>3.4 ± 1.2</td>
<td>2.5 ± 0.7</td>
<td>0.3</td>
<td>0.07</td>
<td>0.05*</td>
</tr>
<tr>
<td>Shimmer (%)</td>
<td>7 ± 2.4</td>
<td>7 ± 2.4</td>
<td>4.1 ± 1.4</td>
<td>0.1</td>
<td>0.05*</td>
<td>0.05*</td>
</tr>
<tr>
<td>DSI</td>
<td>-5.6 ± 1.4</td>
<td>-5.9 ± 1.4</td>
<td>-2 ± 1.2</td>
<td>0.2</td>
<td>0.003*</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

The posttreatment approach 1 = pretreatment approach 2.
P-value of intake posttreatment 1: level of significance (P < 0.05) between the results of the objective voice by means of the DSI between the intake condition and posttreatment condition 1 (after voicing with abdominal breath support).
P-value of intake posttreatment 2: level of significance (P < 0.05) between the results of the objective voice by means of the DSI between the intake condition and posttreatment condition 2 (after MCT).
P-value of intake posttreatment 1 and 2: level of significance (P < 0.05) between the results of the objective voice results by means of the DSI between posttreatment condition 1 (after voicing with abdominal breath support) and posttreatment condition 2 (after MCT).
* Significant difference.
Treatment of Muscle Tension Dysphonia

Kristiane M. Van Lierde, et al

approaches, and to what extent the improvement in vocal quality after MCT can be maintained, is a subject for future investigations. Focused on the question whether there exists a cumulative therapy effect by combining these two therapy approaches, there are some interesting trends to observe. A selection of the five subjects with the highest increase of DSI value after MCT (mean increase of 5.8 DSI values) shows a very slight increase (mean increase of 0.3 DSI values in three subjects) or even a decrease (mean decrease of 1.5 DSI values in two subjects) after the abdominal breath support with voicing approach. It seemed difficult to conclude that the increase of the DSI values after the second treatment technique (MCT) would be influenced by the first treatment approach. Moreover, when examining the aerodynamic parameter, MPT, no significant improvement was measured between the intake and the two treatment approaches. Again a selection of the same five subjects with the highest increase of DSI value after MCT showed that, after abdominal breath support, a mean decrease of 1.5 seconds in three subjects was observed. After MCT, the same three subjects showed a mean increase of 8.5 seconds of the MPT. To what extent there exists a late effect response of the first treatment technique—voicing with abdominal breath support—on the aerodynamic, vocal performance, and acoustic characteristics, is subject for future research using a matched control group.

This study showed evidence that MCT is an effective direct treatment technique for patients with elevated laryngeal position, increased laryngeal muscle tension, and MTD. The treatment effectiveness was measurable with a multiparameter approach by means of the DSI value, reflecting the objective overall vocal quality. The precise way in which MCT has an effect on vocal quality has not been addressed in this experiment, but merits study. The authors also suggest that further research into this topic could focus on EMG recordings in relation with vocal improvements to a larger sample of subjects.

REFERENCES