



Efficacy of Manual Circumlaryngeal Therapy in Patients with Muscle Tension Dysphonia

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Abstract

Objectives: The aim of this study was to evaluate the effects of manual circumlaryngeal therapy after one session of treatment on the voice of patients with muscle tension dysphonia.

Methods: A total of 20 patients with muscle tension dysphonia were evaluated by recording vowel /a/ phonation and extracting fundamental frequency (F0), first formant frequency (F1), jitter, shimmer, and harmonics-to-noise ratio (HNR). One session of manual circumlaryngeal therapy was held for these patients. Immediately after treatment, acoustic assessments were replicated.

Results: Following manual circumlaryngeal therapy, jitter and shimmer showed a significant reduction ($P < 0.009$), while HNR improved significantly versus pretreatment ($P < 0.001$). The mean changes in F0 were not significant, whereas a significant reduction was observed in F1 parameter ($P < 0.009$).

Conclusions: The reduction in jitter and shimmer and increase in HNR after therapy resulted in the patients' vocal improvement. Reduction of F1 after treatment suggests elongation of vocal tube and elimination of vocal tract shortness in response to the descent of larynx from its high-tension status. The insignificant change of F0 was attributed to the lack of change in vibrational characteristics, as well as stretching of vocal cords.

Keywords: Therapy, Dysphonia, Acoustic, Voice

1. Background

Muscular dysphonia or muscle tension dysphonia (MTD) is a functional voice disorder, which arises from the imbalanced activity of laryngeal or extralaryngeal muscles and leads to extreme collision, vocal cord squeezing or bowing, as well as pain and stiffness in extralaryngeal muscles (1). The excessive pressure and tension of extralaryngeal muscles is considered a major clinical indicator of MTD (2).

Patients with MTD usually experience pain and stiffness in front of the neck and shoulders, along with vocal struggle and rapid vocal fatigue (3). The pressure and tension around the larynx is related to tension in the internal and external muscles of the larynx in particular. However, this pressure and tension may propagate to pharyngeal constrictor muscles and deep muscles of the neck. The effects of extra tension include shrinkage and stiffness of muscles, which play direct and indirect roles in producing dysphonia (4).

As the pressure and tension around the larynx tend to limit voice flexibility, most patients experience locked pitch and loudness and have a significantly limited dynamic range of voice when singing and speaking. Voice fatigue is also an accompanying factor. The qualitative symptoms of voice can change with respect to the intensity and type of MTD, ranging from extremely pressed to extra-breathy; a combination of several symptoms may also occur considering the involved muscle groups. Overall, different types of voice disorders include cramped voice, pressed voice, vocal fry, breathiness, high-pitch voice, diplophonia, voice breaks, and pitch breaks, which differ in stability and intensity (3, 4).

In speech therapy methods for MTD, different manual instructions are used for extralaryngeal muscles. Manual therapy methods are applied with the aim of mitigating the tension and facilitating extralaryngeal muscle activity, laryngeal joint movement, and improved and convenient voice production (3, 5, 6). One of the newest manual ther-

apy methods for MTD is circumlaryngeal manual therapy (CMT). In this method, circular massage, active and passive kneading of extralaryngeal and articular muscles, muscle stretching, lowering of the larynx, and removal of trigger points are applied (3). The efficiency of CMT has been examined by different methods, including acoustic analysis, self-assessment, and palpation assessment (5-9).

In a number of studies on the acoustic properties of voice, acoustic parameters of fundamental frequency (F0), first formant frequency (F1), jitter, shimmer, and harmonics-to-noise ratio (HNR) have been used (6, 8, 10, 11). F0 is the fundamental frequency of voice produced by the human vocal cords. F1 is the mean first acoustic resonance of the human vocal tract, which increases when the height of the larynx increases in the neck and pharyngeal constriction occurs (12). CMT is expected to decrease the larynx height and increase the pharyngeal opening, as a result of which F1 decreases. Moreover, jitter is the voice frequency turbulence, while shimmer is the turbulence of voice intensity. The percentage of these turbulences is higher in the voice of individuals with MTD. Finally, HNR is the harmonic-to-noise ratio of voice produced by the vocal system, which seems to increase by improving the quality of voice (13).

With this background in mind, the aim of this study was to evaluate the efficacy of CMT after one session of treatment on the voice of patients with MTD. For this purpose, the mean F0, F1, jitter, shimmer, and HNR were compared before and after treatment.

2. Methods

Twenty patients with primary MTD participated in this quasi experimental study. Twelve women in the age range of 23 - 42 years (mean, 34.1 years), as well as eight men in the age range of 34 - 41 years (mean, 37.6 years), were recruited. The patients had no history of surgery, temporomandibular joint (TMJ) problems, short neck, or neurological/behavioral problems. All patients were evaluated by a laryngologist and a speech-language pathologist with ten years of experience in voice therapy. The study was carried out at the musculoskeletal rehabilitation research center of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran from April to September 2017.

All patients with MTD were diagnosed by an ear, nose, and throat (ENT) consultant and a speech language pathologist, using video laryngoscopy. Patients with primary MTD had no evidence of laryngeal lesions or neuropathology affecting the laryngeal area. Dysphonia was rated as moderate to severe by the ENT consultant and speech language pathologist. The criteria for grading extralaryngeal muscular tension were used in the palpation test (14). All

patients were diagnosed with moderate to severe MTD according to the criteria. The minimum MTD history was six months, and maximum history was four years (average, two years and eight months).

In this study, similar to some previous research, the vocal tract discomfort (VTD) scale was used to examine the severity of vocal tract discomfort (6, 15). In both subscales of VTD scale (frequency of sensation and severity of sensation), the scores ranged from four to six (range, 0 - 6), indicating the severity of discomfort and pain. This study was approved by the ethics committee of Ahvaz Jundishapur University (code, IR.AJUMS.REC.1395.661).

Similar to previous studies, to analyze the acoustic data, PRAAT version 5.4.12 was employed (16, 17). Analyses were performed for extracting F0, F1, jitter, shimmer, and HNR from the middle part of each signal after removing the first and last half seconds from each sound. The middle part was selected, as it showed fewer changes and less instability in comparison with other parts; the observations were based on the waveform and spectrogram (17, 18).

Voice recording was carried out using a microphone (Behringer C-1 Studio Condenser), placed ten centimeters away from the patient's mouth at a 45° angle off the patient's mouth, using an external soundcard (Steinberg UR12) at a sampling rate of 44.1 kHz. Voice recording was conducted in a soundproof room with maximum noise of 19 db (16). Considering the objectives of this study, the patient's voice was recorded when producing vowel/a/with normal loudness and habitual pitch (minimum duration, 3 seconds) before and after manual therapy; thereafter, F0, F1, jitter, shimmer, and HNR were extracted.

In this study, CMT was applied. The original format of CMT, based on the manual therapy methods by Aronson and Bless (19) and Roy and Leeper (9), was used. The therapeutic procedure for MTD involved the following techniques considering the patient's problems:

1) Palpation assessment of the larynx region to evaluate muscle tone at rest, range of motion, and facilitation and convenience of motion.

2) Reposturing maneuvers with the aim of removing muscle patterns and improper use of muscles. The first kneading involves compression of the larynx by applying anteroposterior pressure on superficial regions and below the hyoid bone ("hyoid pushback"). Another maneuver involves downward pressure on the upper angle of laryngeal cartilage ("pull-down").

3) Rotational massage, which involves systematic kneading of the extralaryngeal region. It is believed that this type of massage causes stretching of muscles and fascia, resulting in increased local blood circulation, removal of waste due to metabolism, diminished muscle tension, and reduced pain and discomfort because of

muscle cramps (20).

Once the assessments were carried out, manual tension reduction techniques were initiated according to Aronson's principles. The hyoid bone was surrounded by thumbs and index fingers, and we proceeded back up towards the posterior horn of the hyoid bone. Pressure was applied using circular movements on the horn of the hyoid bone. Pressure was also applied for the thyrohyoid space, starting from the thyroid notch and moving backwards.

The same procedure was applied for the posterior margins of thyroid cartilage, which are located in the middle of sternocleidomastoid muscles. The larynx was pulled down by the fingers on the upper edge of thyroid notch; at the same time, it was moved towards the surrounding parts. More attention was paid to sites with superficial sensitivity, nodularity, or stiffness; slow or continual massage could also involve these regions.

Massage was initiated superficially, and then, its depth increased with respect to areas surrounding the region with severe sensitivity or pain; then, the region of interest was approached (19). In the event of severe tension, the practitioner applied techniques for the middle or lateral regions of suprahyoid muscles. The immediate effects of massage were noticeable on the skin; friction and rotational movements caused increased blood circulation, redness, and skin warmth.

During treatment, the patients were asked to prolong the vowels or murmur sound /m/, while both the therapist and patient paid attention to the changes in sound quality. The patient, as an active participant, was asked to self-review the type and manner of sound production. Some discomfort was inevitable when implementing the methods. Improved voice, mitigation of pain, and reduced height of the larynx were the signs of diminished tension. An improved voice should be extended from vowels to words (usually automatic serial speech, e.g. counting or weekdays), followed by short phrases, sentences, paragraphs, storytelling, and conversational speech. The patients were encouraged to use their improved voice in conversations with family and phone calls to family members and friends.

Normal distribution of data was evaluated using Kolmogorov-Smirnov test. Data were not normally distributed; therefore, Wilcoxon test was used for before-after comparisons. All statistical analyses were performed in SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).

3. Results

Since F0 and F1 are different in the voice of men and women, comparison of these parameters was performed in terms of gender (21-24). However, since jitter, shimmer,

and HNR are expressed in percentages in the literature, gender analysis was not performed in this study for statistical assessment (6, 8). After treatment, the mean F1 in the voice of men and women decreased in vowel/a/, which was statistically significant ($P \leq 0.009$). The mean F0 also decreased after treatment in the voice of women and men, although the difference was not significant ($P \geq 0.21$) (Table 1).

Table 1. The Mean, Standard Deviation, and Significance Level of Formant Measures (Vowel /a/) Before and After Treatment, Separated by Gender^a

Formants	Before Treatment	After Treatment	Significance Level (P Value)
F0			
Male	134.3 (21.4)	129.4 (18.7)	0.21
Female	221.7 (32.2)	219.6 (27.4)	0.24
F1			
Male	474.3 (24.8)	375.2 (40.2)	0.002
Female	654.2 (39.2)	542.6 (52.9)	0.009

^aValues are expressed as mean (SD).

During sustained/a/phonation analysis, jitter reduced based on the comparison of mean values before (0.37) and after (0.74) treatment; the difference was statistically significant ($P = 0.009$) (Table 2). Moreover, shimmer significantly decreased following the management session ($P = 0.006$). Table 2 shows that the mean shimmer before treatment (4.19%) reduced to 2.11% (Table 2). On the other hand, a significant increase was observed in HNR after treatment ($P < 0.001$); in fact, HNR increased from pretreatment (20.63) to posttreatment (25.49) (Table 2).

Table 2. The Mean, Standard Deviation, and Significance Level of Acoustic Measures (Vowel/a/) Before and After Treatment^a

Acoustic Parameters	Before Treatment	After Treatment	Significance Level (P Value)
Jitter	0.74 (0.48)	0.37 (0.46)	0.009
Shimmer	4.19 (2.11)	2.11 (0.59)	0.006
HNR	20.63 (3.48)	25.49 (2.60)	< 0.001

^aValues are expressed as mean (SD).

4. Discussion

In this study, we examined 20 patients with primary MTD (12 females and 8 males; mean age, 36.2 ± 3 years). The patient's voice during vowel/a/phonation was recorded before and after one session of CMT with normal loudness and habitual pitch (minimum duration, three seconds). Afterwards, F0, F1, jitter, shimmer, and HNR were extracted,

and the mean values were compared. In the first part, the mean F0 and F1 were compared before and after treatment. Comparisons were separately made in women and men, as the frequency of voice is highly gender-dependent (21, 23).

The mean F1 in the voice of men and women significantly decreased after treatment ($P \leq 0.009$); this indicates the increased pharyngeal opening and reduced laryngeal height. Changes in F1 in this study are consistent with a report by Roy and Ferguson (2001) (25). On the other hand, the mean F0 did not show any significant changes after treatment in both men and women ($P \geq 0.21$). F0 is generally related to the amount of elasticity and stiffness of vocal cords (26). There was no massage for laryngeal manual therapy in the cricothyroid area, related to F0 changes; therefore, no significant changes were observed in the mean F0 before and after treatment. This conclusion was also made in a study by Mathieson et al. (2009) (6). It should be noted that Roy et al. (2001) (25) did not examine the F0 parameter. Generally, study of F0 is important, as its change is associated with voice alterations, which cannot be pleasant for the patient.

Significant acoustic changes in the voice of patients (F1) occurred even with one session of treatment, as laryngeal muscles could alter their rigid and fixed motion pattern owing to the effects of treatment and could produce vowel/a/with a lower F1. The results of this study are in line with the findings of previous research (9). Moreover, the results reported by Mathieson et al. are in accordance with the results of this study regarding the significant reduction in acoustic parameters (6). In addition, improved extralaryngeal muscle coordination affects the improvement of intralaryngeal muscle function, leading to voice production with less noise and greater harmony. These effects of treatment have been also observed in previous studies, using other acoustic assessment methods (3, 9, 25).

The second part of this study focused on the turbulence of frequency (jitter) and voice amplitude (shimmer). Improvement of jitter and shimmer parameters can indicate the adjustment of phonatory subsystems, which leads to the regulation of phonatory muscular balance and consequently better voice and extrinsic muscle coordination. The coordinated function of extrinsic laryngeal muscles also affects the performance of intrinsic laryngeal muscles, helping them produce voice with less noise and more harmony (3, 8, 25). These therapeutic effects have been also reported in previous studies, using other laryngeal manual therapies and acoustic methods (9, 25).

HNR presents the ratio of total harmonic energy to noise in the voice waveform. The significant increase in HNR indicates the reduction and regulation of voice hoarseness. The increase in this acoustic parameter has been also reported by Roy et al. (1993) (9). In their study,

the participants were mostly women (16 females and one male), and the age range of patients was 20 - 70 years (average, 46.9 years). On the other hand, in this study, patients from a younger age group (23 - 42 years) were evaluated to prevent the aging effect of voice in elderly people. In this regard, Salehi et al. (2013) (8) applied a treatment approach, called voice-based laryngeal manual therapy and showed a significant increase in HNR. Their study aimed at examining the long-term effects of treatment, while the aim of our study was to investigate the immediate effects of treatment.

Although it is assumed that MCT leads to reduced height, reduced rigidity, and increased mobility of the larynx, experimental evidence is sparse to support this assumption. As the efficiency of MCT method has not been examined in Iran, and a suitable sample of primary MTD was recruited in our study, the findings can help voice therapists understand the effects of treatment. It is recommended to conduct similar studies using secondary MTD samples with pathological problems of vocal cords. Also, other acoustic and muscle activity parameters can be used to measure treatment efficacy. It should be noted that in this study, only one treatment session was held, and in principle, the immediate effects of CMT treatment were measured. Therefore, the long-term effects of treatment and complete patient recovery should be considered in future research.

4.1. Conclusions

In this study, reduced jitter and shimmer and increased HNR after therapy resulted in the vocal improvement of patients. Reduction of F1 after treatment suggests elongation of the vocal tube and resolution of vocal tract shortness in response to the descent of larynx from its high-tension status. The insignificant change of F0 may be attributed to lack of change in vibrational characteristics, as well as stretching of vocal cords.

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Footnotes

Conflict of Interests: The authors declare that they have no conflicts of interest related to the publication of this article. The local ethics committee approved this study.

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