Positive Effects of Manual Circumlaryngeal Therapy in the Treatment of Muscle Tension Dysphonia (MTD): Long Term Treatment Outcomes

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Abstract: Introduction. Manual circumlaryngeal therapy (MCT) aims to correct laryngeal position and relax (para) laryngeal and cervical muscles resulting in improved voice quality. The goal of the current study was to further verify long-term effects of MCT in the treatment of Muscle Tension Dysphonia (MTD) patients based on acoustic findings and perceptual judgments.

Method. Twenty-eight adult female patients who had been referred to the speech therapy clinic of Khatam Hospital, Zahedan city, participated in this study. Manual circumlaryngeal therapy was undertaken. There were 15 therapy sessions, three sessions per week, each with duration of 30 minutes. Pre- and post-treatment audio recordings of sustained vowels, selected sentences, and connected speech samples were submitted to auditory-perceptual and acoustical analysis to assess the long-term (6-months) effects of the 15 treatment program.

Results. Acoustically, Harmonic to Noise Ratio (HNR) increased and perturbation (Jitter and Shimmer) measures decreased, and perceptually, the subjective CAPE-V ratings improved in all patients.

Conclusion. These results suggest that MCT can be an effective method for voice rehabilitation in patients with MTD and the changes due to the therapy were persistent over a 6-month duration following the termination of treatment sessions.

Keywords: Voice–MTD–Voice Therapy–Manual Circumlaryngeal Therapy

INTRODUCTION

Muscle tension dysphonia (MTD) occurs when laryngeal muscle tension is imbalanced due to excessive or dysregulated activation of the (para) laryngeal muscles.[1,2] Features often associated with this dysregulated muscle activity include deviations in head and neck posture with hyperextension, short and compressed respiration, a relatively high position of the larynx, and tension of the muscles of the face. MTD has the following classification: primary (i.e., MTD-1), related to the absence of structural alteration in the larynx; and secondary (MTD-2), with the presence of tissue reactions.[1–3] Commonly reported laryngoscopic signs of MTD-1 include, but are not limited to, hyperadduction of the true vocal and vestibular folds, the presence of triangular glottal chinks of different lengths, and reduced vocal fold opening angle.[1-3] These features are often associated with complaints of tightness and pain in the throat, throat irritation, increased effort, and fatigue when speaking.[3,4] Vocal fatigue is defined by its symptoms. Specifically, the voice user perceives an increase in phonatory effort over time that may be accompanied by decreased phonatory function.[5] This symptom frequently results in an increase in speaking fundamental frequency, an anterior glottal chink, and a reduced maximum phonation time.[6,7] Changes in phonation may or may not be audible or otherwise detectable by a listener or by acoustic or physical measures. Vocal fatigue can occur in the absence of dysphonia or pathologic tissue changes like that seen in MTD-1, but tissue changes may occur if vocal demands continue unabated or if the speaker engages in maladaptive compensatory strategies.[5]

The literature describes the beneficial use of indirect and direct therapy techniques.[8] Indirect methods include raising awareness of healthy vocal habits and their importance. Direct therapy is comprised of voice therapy techniques.[9,10] The direct approach aims to correct laryngeal position; relax (para)laryngeal and cervical musculature; promote respiratory control, efficient glottal closure, and resonance equilibrium; reduce voice symptoms; improve articulation; and reduce tension in the laryngeal musculature.[1,11] An often used method is Manual Circumlaryngeal Therapy (MCT). Aronson described and advocated manual circumlaryngeal therapy as a primary approach for patients with musculoskeletal tension disorders.[12] Roy and Leeper evaluated the short-term effects of the manual laryngeal muscle tension reduction approach (as described by Aronson) with 17 patients with functional dysphonia. Using acoustic and perceptual measures to assess the immediate effects of the procedure, the authors reported that 93% of the patients obtained an approximation of normal voice following a single treatment session.[13] In another study, Roy et al. (2009) documented significant changes in formant transitions associated with successful MCT with muscle tension dysphonia (MTD-1) patients, suggesting improvement in speech and vowel articulation. Roy et al. (2009) stated that "The results indicate that the manual circumlaryngeal treatment may have desirable effects on both the phonatory and articulatory systems. Clearly, additional acoustic, perceptual, and

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physiologic studies are needed to assess the nature of MTD-1 and the oral and laryngeal mechanisms underlying the changes associated with its successful management."[14] An important question that arises from the literature review is: what are the effects of MCT on vocal quality, especially long term? Therefore, the goal of the current study was to extend and test for long-term effects of Manual Circumlaryngeal Therapy in the treatment of MTD-1 patients based on acoustic findings and perceptual judgments.

METHODS

Participants

Twenty-eight adult female patients who had been referred to the speech therapy clinic of Khatam Hospital, Zahedan city, participated in this quasi experimental study. Adult females were chosen instead of men due to the higher percentage of voice problems for this population.[15] A convenient sampling method was used. Patients who came to the Speech Therapy clinic and were diagnosed with MTD were referred to the Ear, Nose and Throat (ENT) ward.

Participants were between 18 and 40 years old (mean age 32.1 ± 5.93 years), and all had a diagnosis of Primary MTD. Diagnostic inclusion criteria for MTD-1 were: (a) a voice disturbance, tension, fatigue, and pain in the absence of any visible mucosal disease or structural pathology; (b) no neurological pathology, specifically vocal fold paresis, paralysis, or motor speech disturbance; (c) no previous laryngeal surgery; and (d) no co-existing upper respiratory infection symptoms at the time of examination. Two laryngologists in the ENT ward of Khatam Hospital performed routine laryngological examinations, and examined the larynx using both indirect laryngoscopy and laryngostroboscopy. The patients were asked to sustain the vowel /i/ for better visualization of the larynx.

All patients were treated by one speech pathologist who used the same management protocol for all patients. The minimum duration of dysphonia was 6 months prior to the diagnostic session (mean 9.35 ± 4.69 months)

Treatment protocol

Manual circumlaryngeal therapy (the manual laryngeal musculoskeletal tension reduction technique) was undertaken according to the description of Aronson[12]: (a) the hyoid bone was encircled with the thumb and index finger, which were worked posteriorly until the tips of the major horns were felt; (b) light pressure was exerted with the fingers in a circular motion over the horns of the hyoid bone; (c) the procedure was repeated beginning from the thyroid notch and working posteriorly; (d) the posterior borders of the thyroid cartilage just medial to the sternocleidomastoid muscles were located and the procedure was repeated; (e) with the fingers over the superior borders of the thyroid cartilage, the larynx was worked downward, and moved laterally at times; and (f) the patient was asked to hum or prolong vowels during the above procedures, while changes in vocal quality were noted. Improvement in the voice production of the patients was immediately reinforced by repositioning the larynx by the clinician. The improved voice was progressively shaped from vowels and words (usually automatic serial speech, i.e., counting, stating the days of the week) to short phrases to sentences, and finally conversation. There were 15 therapy sessions, three sessions per week, each with duration of 30 minutes. The MCT technique was the exclusive therapy for all 15 sessions.[16]

Assessment of outcome variables

Using tokens of sustained vowels may be preferred over regular speech in vocal acoustic assessment[17] and thus they were used here. After instruction and several test trials, the subjects were instructed to phonate 10 stable /â/ vowels[18] continuously for as long as possible, using habitual vocal pitch and loudness and constant quality, with about 5 seconds between tokens. Patients were audio-recorded using a microphone (*ECM-717 electret condenser microphone*; Sony Corporation, Minato, Tokyo, Japan; frequency response 100−15,000 Hz) positioned approximately 10 cm from the mouth. All recordings were made in a quiet, acoustically treated room. The room noise level was determined by a sound level meter (model: *CEL-450*, product of Casella CEL, Regent House, Kempston, Bedford, UK) with room noise measured as Min LA: 28.0 dB and Min LC: 40.8 dB.

Recordings and analyses were carried out using *PRAAT software version* 5.3.1330 (Phonetic Sciences, University of Amsterdam, Amsterdam, The Netherlands) installed on a laptop (*ASUSK43SJ; ASUSTeK* Computer Inc., Taipei, Taiwan). The measures acquired from *PRAAT* included the F_0 (Hz), F_1 (Hz), jitter (%), shimmer (%), and HNR (dB). A mid-3-second segment of each vowel prolongation was subjected to the acoustic analyses. Auditory perceptual evaluation of the patients' voices overall severity was performed using the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V). The CAPE-V is a subjective measurement tool of perceived voice qualities. Voice roughness, breathiness, strain, pitch, loudness, and severity are rated during several tasks, including general conversation, vowel prolongation, and sentence reading. A score of 0 represents a normal voice and 100 a severely deviant voice. Ratings are recorded on a 100 mm line as a visual analog scale for each parameter. The scores were judged together as a whole and rated as severely deviant, moderately deviant, mildly deviant, and normal.[19] The blind ratings were performed on recorded vowels and 1-minute samples of recorded sentences and spontaneous speech, by two speech language pathologists with more than 10 years' experience performing voice therapy. The first recording was made before starting treatment during the first session of therapy as a pre-treatment sample, recordings of the post therapy voice samples were obtained both immediately after the last therapy session and 6 months after termination of the therapy. For all of the cases, the patients tried to use their voices normally during the 6 months after the termination of the treatment

TABLE 1.
Mean (M) and Standard Deviations (SD) of F0, F1, Jitter, Shimmer, and HNR Before and After Completion of the MCT at Two Time Points (Immediately and 6 Months after Termination of the Therapy)

	Pre-treatment		Post-treatment			
	Parameter		Immediately		6 months later	
Time	M	SD	M	SD	M	SD
F0	216.7	10.06	219.04	9.09	218.78	9.13
F1 for /â/ vowel	638.56	39.1	605.10	50.7	607.98	50.1
Jitter	1.36	0.64	1.22	0.67	1.22	0.67
Shimmer	5.38	2.16	5.30	2.16	5.31	2.2
HNR	17.15	2.11	18.09	1.42	18.05	1.41

but without any vocal behaviors that couldresult in hard glotal attacks.

Statistical analysis

Data were analyzed with the statistics software *IBM SPSS* 22.0 for windows (SPSS Corp, Chicago, IL). The Kolmogorov-Smirnov test was used to assess normality of distributions. Acoustic data were found to be normally distributed. A one way repeated measures ANOVA was conducted to compare the effects of MCT on acoustical parameters at three time points (before starting of the therapy, immediately after termination of therapy, and 6 months after that). Intra-rater reliability was calculated by Kappa coefficient agreement for the six CAPE-V features. The correlation between the raters in the CAPE-V scores was calculated by a Spearman correlation coefficient.

RESULTS

Mean (M) and standard deviations (SD) of F_0, F_1 for the /â/ vowel, jitter, shimmer, and HNR before therapy and then at the two time points after completion of the MCT (immediately after and then 6-months after termination of the therapy) (see Table 1. There was not a significant effect of MCT on fundamental frequency of the patients: Wilks' Lambda = 0.81, $F(2, 26) = 3.03$, $p = 0.06$. As shown in Figure 1, for F_1, there was a significant effect of MCT: Wilks' Lambda = 0.66, $F(2, 26) = 6.17$, $p = 0.007$. Since Mauchley's test of sphericity was violated, the Greenhouse-Geisser correction was used. For the adjusted values, F (1,25) = 8.19, $p = 0.008$. Effect size or partial $\eta^2 = 0.24$. The eta^2 effect size ($\eta^2 = 0.24$) indicated that the effect of MCT on F_1 was relatively substantial. Bonferroni post-hoc tests comparing adjacent MCT conditions revealed a significant difference in F_1 between before and immediately after the completion of the therapy ($p = 0.02$), and between before and 6 month after completion of the therapy ($p = 0.02$). Also, there was no any significant differences between immediate completion of the therapy and 6 months later after the termination of the therapy ($p = 0.32$). There was a significant effect of MCT on jitter values, Wilks' Lambda = 0.58, $F(2,26) = 9.36$, $p = 0.001$. Since Mauchley's test of sphericity was violated, the Greenhouse-Geisser correction was used. The adjusted values: F(1,27) = 13.09, $p = 0.001$. Effect size or partial $\eta^2 = 0.33$. The eta^2 effect size ($\eta^2 = 0.33$) indicated that the effect of MCT on jitter was large. Bonferroni post-hoc tests comparing adjacent MCT conditions revealed a significant difference in jitter between before and immediately after the completion of the therapy ($p = 0.003$), and 6 month after completion of the therapy ($p = 0.004$). Also, there was no significant difference between immediate completion of the therapy and 6 months later after the termination of the therapy ($p = 0.31$) (see Figure 2). On the other hand, as seen in Figure 3, for shimmer values, there was a significant effect of the therapy:, Wilks' Lambda = 0.63, F(2,26) = 7.47, $p = 0.001$. Since Mauchley's test of sphericity was violated, the Greenhouse-Geisser correction was used. The adjusted values were: F (1.08,29) = 11.96, $p = 0.008$. Effect size or partial $\eta^2 = 0.36$. The eta^2 effect size ($\eta^2 = 0.36$) indicated that the effect of MCT on shimmer was substantial. Bonferroni post-hoc tests comparing adjacent MCT conditions revealed a significant difference in shimmer between before and immediately after the completion of the therapy ($p = 0.003$), and

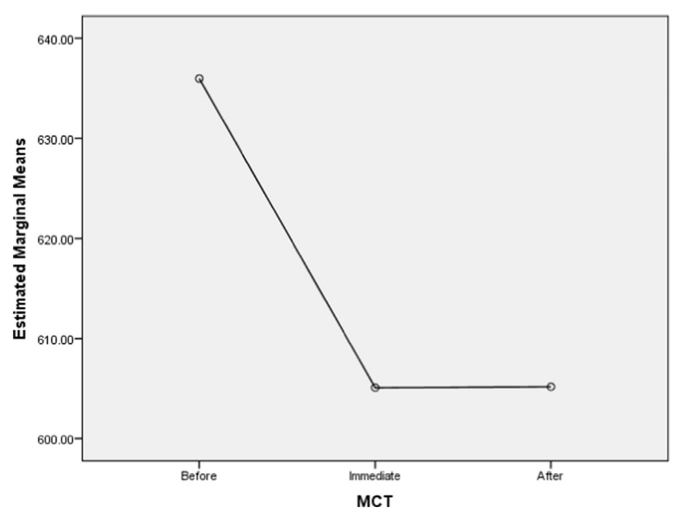

FIGURE 1. Comparison of F1 (Hz) means among pre- and post-treatment (Immediate and 6 months. later)

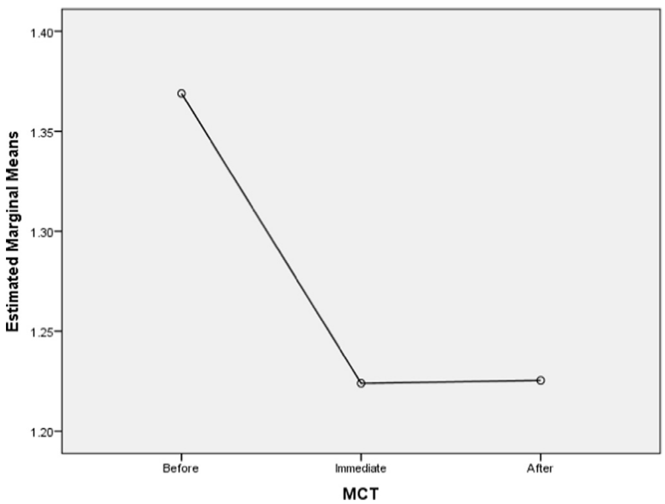

FIGURE 2. Comparison of Jitter (%) means among pre- and post-treatment (Immediate and 6 months. later)

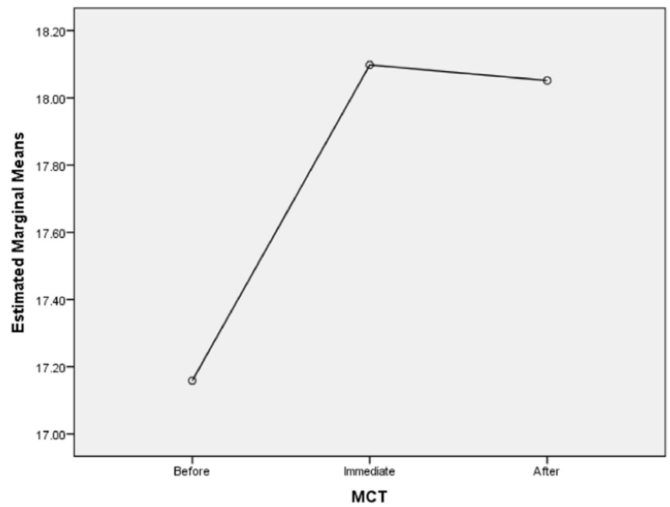

FIGURE 4. Comparison of HNR (dB) means among pre- and post-treatment (Immediate and 6 mons. later)

6 months after completion of the therapy (p = 0.009). Also, there was no significant difference between immediate completion of the therapy and 6 months later after the termination of the therapy (p = 0.22). Finally, there was a significant effect of MCT on HNR values: Wilks' Lambda = 0.72, F(2,26)= 5.08, p = 0.01. Since Mauchley's test of sphericity was violated,; the Greenhouse-Geisser correction was used. The djusted values were: F(1.02, 27) = 8.91, p = 0.006. Effect size or partial $\eta^2 = 0.25$. The eta^2 effect size ($\eta^2 = 0.25$) indicated that the effect of MCT on jitter was relatively large. Bonferroni post-hoc tests comparing adjacent MCT conditions revealed a significant difference in jitter between before and immediately after the completion of the therapy (p = 0.01), and 6 months after completion of the therapy (p = 0.02). Also, there was no significant difference between immediate completion of the therapy and 6 months later after the termination of the therapy (p = 0.61) (see Figure 4).

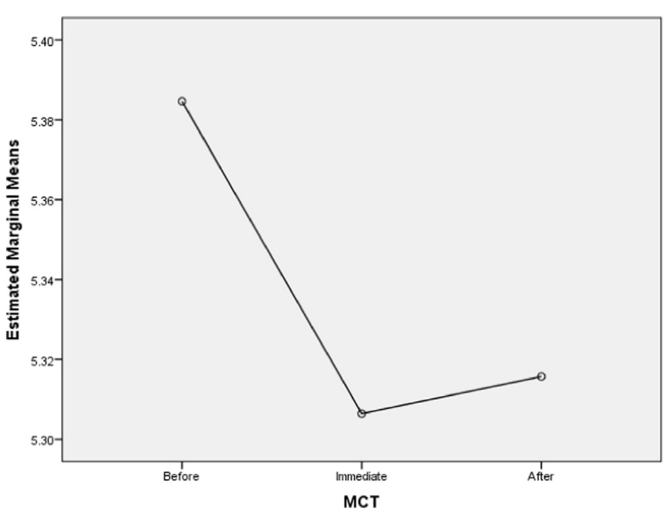

FIGURE 3. Comparison of Shimmer (%) means among pre- and post-treatment (Immediate and 6 months. later)

Intra-rater reliability was relatively high, with a Kappa coefficient agreement ranging from 0.78 to 92 across the six CAPE-V features. The subjective CAPE-V ratings changed in all patients ($p < 0.001$). In overall severity before treatment, 8 patients had severe deviation ($r = 0.88$, $p < 0.001$). After completion of the treatment (6 months later), Spearman correlations between two ratters showed that of those patients, 1 changed to moderate ($r = 0.85$, $p < 0.001$), 3 to mild ($r = 0.78$, $p < 0.001$), and 4 to normal ($r = 0.89$, $p < 0.001$). The other 20 patients were moderately deviant pre-treatment ($r = 0.83$, $p < 0.001$), of which 9 changed to mild ($r = 0.81$, $p < 0.001$) and 11 to normal ($r = 0.90$, $p < 0.001$).

DISCUSSION

Except for F_0, all of the acoustic parameters were significantly improved immediately and 6 months after termination of the therapy. This study suggests that manual circumlaryngeal therapy has positive effects immediately after termination of therapy and also has stable effects after 6 months for patients with MTD relative to both objective and subjective measures.

Altman et al.[20] mentioned that the main voice symptoms in patients with MTD were hoarseness, fatigue, and voice strain, which are caused by excessive muscle action of the laryngeal region. The present study showed that voice therapy can create positive changes in the vibration regularity and suggests that there can be a decrease in excessive action of para laryngeal muscles and hoarseness.[21,22]

The percentage of jitter and shimmer is related to roughness and lack of glottal closure control.[20] As mentioned above, perturbation measures decreased after the therapy, and in this study, the subjective overall severity of the voice quality was consistent with the objective lower perturbation values after therapy (and higher HNR values). These findings match the study by Roy et al.,[23] who found a reduction in jitter and shimmer values in functional dysphonia after the manual laryngeal technique was applied to reduce musculoskeletal tension. Also, de Oliveira Lemos et al.[24] demonstratd that manual therapy can reduce the jitter and shimmer in MTD patients.

Studies have reported that jitter may reflect the overall deviation level of the voice, a sensible measure to detect voice quality deviation, which justifies higher values in most deviated voices considering all perceptual features.[25,26] Studies combining the number of acoustic features and data from laryngeal examinations suggest that jitter and shimmer can be reasonable predictors of voice disorders, being able to detect mild changes that would normally go unnoticed in perceptual analysis.[27-30]

Studies have compared patients before and after voice therapy and reported a moderate correlation between acoustic features (jitter, shimmer, and harmony-noise ratio) and perceptual analysis. The strongest correlation was found between overall deviation level and jitter and shimmer.[25,26] The findings of the current study show a decrease in vocal stability measures (jitter and shimmer) and HNR, consistent with the literature,[13,23] and the greatest effect sizes belong to these measures.

Formant frequencies are spectral peaks that correspond to resonances of the human vocal tract. The formants have distinctive values depending on the shape and length of the vocal tract and they are particularly sensitive to changes in tongue height and advancement during production of vowels.[31] The decrease of the first formant frequency value post therapy in the current study is consistent with the Roy and Ferguson (2001) study. They concluded that the lowering of formants is due to the decrease in the laryngeal height and the lengthening of the vocal tract.[32] Also, Boone and McFarlane (1997) reported lowered formants in subjects who were treated with the yawn-sigh voice therapy technique.[33]

Findings of the perceptual-auditory assessment showed positive changes in voice following the therapy. In general, it was observed in overall severity, the severe and moderate grades significantly being reduced. Thus, it is possible to infer that this change could be attributed to the therapy approach applied in the current study. The therapy led to stability in sound production and better voice presentation[34]. Van Lierde et al. [35] also reported relevant improvement in the GRBASI parameters after a long-term therapy program was applied to patients with hyperfunctional dysphonia.

In summary, this study suggests that the manual circumlaryngeal therapy approach provides clinicians with an effective method for voice rehabilitation in the patient with MTD with long term (at least 6-months) positive effects. The therapy used in the study resulted in a positive change in acoustic and perceptual-auditory aspects of voice production. However, several caveats are worth considering. First, because there was no controlled comparison with the use of an alternative or no-treatment technique, a randomized clinical trial providing such comparison would be of interest. Second, because laryngeal muscle tension (and laryngeal positioning) was in no way objectively evaluated here, and the reactive psychological effects of clinical interaction could not be controlled, we cannot wholly substantiate that laryngeal repositioning alone was responsible for the observed improvements. Third, assessment and treatment was administered by a voice clinician who was experienced in manual laryngeal techniques, and therefore the results are confined to the clinician's level of experience, confidence, and expectations. Regardless of these factors, it is premature to give unqualified endorsement of manual laryngeal reposturing as a primary approach for MTD.

CONCLUSION

The results of the current study showed that Manual Circumlaryngeal Therapy can lead to positive changes in the treatment of primary MTD. The findings provide an important basis for clinical practice and the development of new protocols for using MCT in the management of MTD.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jvoice.2018.07.010.

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