Determining the Outcome of Laryngeal Manual Therapy in Female Subjects with Muscle Tension Dysphonia: An Experimental Study

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ABSTRACT

Introduction: Muscle tension dysphonia (MTD) is a voice disorder characterized by excessive muscular tension in the perilaryngeal areas (Roy and Leeper). Laryngeal manual therapy (LMT) is one of the direct approaches of voice therapy that involves kneading the laryngeal area without voicing to reduce hyperfunction of the muscles and improve the quality of voice.

Aims and objectives: The present study was conducted to determine the outcome of LMT in females with MTD by comparing assessment data between pre-therapy, immediate post-LMT, and 1 week after LMT.

Materials and methods: Ten females (20–40 years) with MTD were taken. Palpatory assessment, Dr Speech (Version 4), GRBAS scale, and voice handicap index (VHI) were used for voice evaluation. First, a pre-therapy assessment of all the voice parameters was collected. Second, LMT was carried out. Immediately after LMT, post-LMT data collection was done. No intervention was given following LMT. After 1 week of LMT, again data collection was done.

Results: A significant reduction in vocal parameters of jitter, shimmer, and NNE ($p < 0.05$) were found after LMT except for Mean Fo ($p > 0.05$). Hoarseness was reduced. A significant difference was found between VHI measures ($p < 0.05$), GRBAS scale ($p < 0.05$), and palpatory assessment ($p < 0.05$) in pre-LMT, immediate post-LMT, and 1-week post-LMT.

Conclusion: The present study would assist to determine the therapeutic efficacy of direct voice therapy and in predicting voice therapy outcomes in persons with MTD.

Keywords: Laryngeal manual therapy, Muscle tension dysphonia, Palpatory assessment, Voice handicap index.

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INTRODUCTION

Muscle tension dysphonia (MTD) is a voice disorder characterized by excessive muscular tension in the perilaryngeal areas.[1] "Perilaryngeal" tension means excess tension primarily in the extrinsic and intrinsic laryngeal muscles, but this tension may also extend to include the pharyngeal constrictor muscles and the deep muscles of the neck.[2] The excessive tension limits the normal movement of perilaryngeal muscles that interfere with normal vocal production. There are two categories of MTD: (1) primary and (2) secondary MTD. Primary MTD is diagnosed in the absence of vocal fold pathology, whereas secondary MTD coexists with an underlying laryngeal disturbance.[3] There are four basic patterns of muscle tension termed muscle tension patterns (MTPs) seen in MTD, i.e., type I, II, III, and IV. Type I is glottal, and types II to IV are supraglottal.[4] An unbalanced and/or excessive laryngeal or perilaryngeal muscle activity leading to vocal fold hyperadduction, constriction, or bowing is assumed to be the etiology of MTD.[5] Therefore, the initial cause of MTD with and without vocal fold lesions is excessive phonatory effort. Authors reported that 60–70% of patients in some voice clinics have been diagnosed as having MTD.[6] Muscle tension dysphonia usually affects young to middle-aged females using their voices extensively. Various abnormal psychological, medical, aerodynamic, perceptual-acoustic, and musculoskeletal characteristics have been seen in MTD.[7–9] Therefore, assessment and diagnosis of MTD depend on various key features which are assessed through case history of vocal misuse or abuse, psychological evaluations, perceptual

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acoustic voice assessment, observation of the larynx, and palpation. Management approaches of both primary and secondary MTD include hygiene programs, symptomatic modifications, attention to psychosocial issues, and direct physiologic manipulation and exercises.[10] There are various indirect and direct approaches to voice therapy. Indirect treatment involves hygienic voice therapy, symptomatic voice therapy, psychogenic voice therapy, physiologic

voice therapy, and eclectic voice therapy. Direct treatment approaches incorporate manipulation of the suprahyoid muscles for reducing hyperfunction of the muscles. Researchers have shown that MTD treatment includes laryngeal manual therapy (LMT),[11,12] manual circumlaryngeal therapy (MCT),[13] voice release,[14] voicing with abdominal breath support,[5] resonant tube phonation, phonation with vibrato,[15] and osteopathic myofascial rehabilitation of the larynx. Each of the above techniques had been proven to reduce hyperfunction in MTD and therefore improves the quality of voice. Aronson and Bless[16] first described manual treatment for the reduction of perilaryngeal musculoskeletal tension. They used manual treatments of stroking, kneading, and stretching of muscles around the larynx. Subsequently, several perilaryngeal manual therapies (PMTs) have arisen from multiple disciplines, including speech pathology, osteopathy, and physiotherapy. The two most prominent in the literature are MCT (Roy and Leeper) and LMT.[17] Manual circumlaryngeal therapy reduces tension in the extrinsic muscles of the larynx and improves phonatory skills. It does not use palpatory evaluation. Laryngeal manual therapy was given by Rubin, Lieberman, and Harris. Laryngeal manual therapy involves kneading the laryngeal area without voicing (Mathieson et al.). Laryngeal manual therapy consists of circular massages of the sternocleidomastoid muscles (SCMs) and supralaryngeal area and then massage is applied along the hyoid bone and can verify the tension of perilaryngeal muscles by lateral movement of the thyroid cartilage. There are many similarities between LMT and MCT; but LMT differs from MCT in that it includes a pre-treatment palpatory evaluation, is bimanual, and does not require phonation during treatment. The authors stated that LMTs may provide quick results in patients who are not receptive to traditional voice therapy. Palpatory evaluation is needed before LMT for determining the degree of muscular tension in the pharynx. Researches supported the LMT in the management of MTD. Van Lierde et al.[18] conducted a pilot study to determine the outcome of vocal quality after a well-defined LMT program in four Dutch professional voice users with a persistent moderate or severe MTD who have not responded to traditional voice therapy and supported the use of LMT. The perceptual impression of the vocal quality was somewhat better, the perceptual strain (S) of the voice was reduced, the produced highest frequency (F-high) was higher, the fundamental frequency (Fo) was closer to the normal and the acoustic parameters jitter and shimmer were improved (closer to the normal) in all subjects. Shimmer was closer to the normal in all four, the fourth being unchanged but within normal limits, and Jitter was closer to the normal in three subjects. Mathieson et al. conducted a study that was based on the hypotheses that if the vertical position of the larynx in the vocal tract would lower after LMT, then the quality of the voice would normalize, and a reduction in any vocal tract discomfort (VTD) would occur. A new treatment method called the criterion-based LMT (supported by classical LMT) can improve voice quality when used with manual maneuvers and phonatory tasks.[19]

MATERIALS AND METHODS

Multiple baseline design was used in this study. A total number of 10 females with MTD between the age ranges of 20 years and 40 years were considered for the study. The participants included in the study were diagnosed with MTD in a multidisciplinary voice clinic by a qualified otorhinolaryngologist and an experienced speech-language pathologist (SLP) using videostrobolaryngoscopy (Laryngeal Strobe, Model 9400, KayPENTAX), were not having any educations regarding the therapeutic procedures and were having minimum qualifications of high school. Participants falling outside the age range of 20–40 years, receiving voice therapy previously or taking other methods of intervention either before or concurrently with LMT, active or passive tobacco smoker, taking steroids for a longer period, having pulmonary disease, hearing impairment, upper respiratory tract infection, neurological disorder, hypothyroidism, other laryngeal pathology except for MTD, consuming oral contraceptive pills, and regularly consuming alcohol and having consumed alcohol since last 24 hours before the test were excluded from the study. Subjects were instructed to schedule the trial during days 7–12 from the start of menstruation (before ovulation) to avoid any effects that hormone levels may have on the data collection. Instruments were used that they were high fidelity video camera (Samsung SM-J500F), videostrobolaryngoscopy (Laryngeal Strobe, Model 9400, KayPENTAX), Dr Speech (VERSION 4, Tiger DRS, Inc., 1998),[20] an omnidirectional microphone (MAX CM-903 Electret Condensor Microphone). GRBAS[21] scale was used for subjective assessment of voice parameters. It is an auditory-perceptual evaluation method developed mainly used for assessing voice quality that gives scores of 0, 1, 2, or 3 for the grade of hoarseness, roughness, breathiness, asthenia, and strain, where 0 is normal, 1 is a slight degree, 2 is a medium degree, and 3 is a high degree. Voice handicap index (VHI)[22] was used. It is a self-reported rating scale that uses a questionnaire related to the quality of life items that are: "Functional" (F), "Emotional" (E), and "Physical" (P) impact of voice disorder patients. Palpatory assessment using criteria for extralaryngeal muscular tension grading system[23] was done. It is a grading system ranging from 0 to 3. Four muscle groups including the suprahyoid, the thyrohyoid, the cricothyroid, and the pharyngolaryngeal muscles are palpated at rest, phonation, and connected speech and then the severity of tension are graded using a four-point scale. The procedure of the study was first, detailed case history was taken. The participants were informed about the nature of the study and their written consent was obtained. Second, a pre-LMT assessment was done by doing first Dr Speech version 4.0 which is an objective analysis tool. By Dr Speech (version 4.0) Mean Fo, Jitter, Shimmer, NNE, and the parameters of voice quality estimates including hoarse, harsh, and breathy were measured by sustaining vowel/a/production with deep inspiration by the patient. Three trials were taken trials and the averages of the three trials were taken for analysis. Then, GRBAS scale, VHI, palpatory assessment using criteria for extralaryngeal muscular tension grading system (Angsuwarangsee and Morrison) were done. Third, LMT (Matheison et al.) application was done on those patients. During the procedure, the examining clinician stood behind the patient who was seated in a low-backed chair. The clinician ensured that the subject was seated well back on the seat of the chair, that the spine was straight, and that the head was in a neutral position so that the chin was not raised, depressed, retracted, or protruded. The patient was encouraged to relax his or her shoulders and ensured that the mandible was relaxed, thus avoiding teeth-clenching. The clinician asked the patient to ensure that his or her tongue was relaxed and not making strong contact, if any, with the hard palate. Laryngeal manual therapy consists of rotational massage, kneading, and stretching of the perilaryngeal muscles. The procedure of LMT was usually started on the SCMs, simultaneously. It was carried out by the clinician using the pads of the index, second, and third fingers of both hands. (The number of fingers used might vary according to the size of clinicians' hands and patients' neck sizes.) The site of the start of the massage was either the mastoid or sternal points of attachment of the SCMs or

the belly of the muscles, whichever are least tense on palpatory evaluation. Working from the area of less tension to that of greater tension is the most comfortable for the patient and achieves a reduction in overall muscle tension most rapidly. It is advisable to ensure that the movements of the massaging fingertips of each hand were not exactly synchronous; equal pressure on the SCMs simultaneously, on either side of the neck, might exert undesirable pressure on the carotid sinuses. Similarly, for that reason, the clinician ensured that the SCMs were accurately identified and that the massage does not waver from the course of the muscle. As the massage progressed along the length of the SCM and was repeated in the same area, the muscle was felt to change gradually from being tense and cord-like to a much softer structure with much less definition. When that point had been reached, attention was directed to the supralaryngeal area. The supralaryngeal area was kneaded using the clinician's dominant hand. The other hand cradled the patient's occiput so that the head did not move backward as pressure was applied to the supralaryngeal area. A kneading action was applied upward and backward from the midpoint of the mandible with the pads of the fingers of the index, second, and third fingers. (In practice, most of the pressure tends to be applied by the second finger because it is the longest.) It was helpful to remind the patient to relax the mandible, avoid teeth-clenching, and allow the tongue to rest on the floor of the mouth so that unnecessary tension is minimized. After working in the midline, kneading was also carried out from a more lateral position on the mandible, toward the larynx. As the tension of the supralaryngeal muscles was reduced, the area softened so that it was possible to increase pressure, without causing the patient discomfort, until the fingertips could be pressed beyond the border of the mandible. The first two stages were repeated until the clinician felt that maximum reduction in muscle tension has been achieved, without causing the patient undue discomfort. If the larynx was high-held on palpatory evaluation, it was at that stage that bilateral pressure could be applied to the superior edge of the thyroid cartilage so that the larynx is firmly, but gently depressed. Finally, when the perilaryngeal musculature was more relaxed than at the onset of LMT, bilateral digital pressure was applied to the thyroid lamina. Increased lateral movement of the larynx in response to this pressure, in comparison with pre-LMT status, was an indication of reduction of tension in the perilaryngeal musculature. The patient was asked to swallow and then to vocalize, frequently in response to the question, "How does that feel?" Vocalization was not requested from the patient during LMT until after the larynx responds easily to lateral digital pressure in the final stage of intervention. Counting days of the week, vocal glides, and spontaneous speech was then encouraged. The rationale was that the patient's phonatory patterns are hyperfunctional and the muscle postures associated with the dysphonia have become habituated. Waiting until maximum relaxation of the laryngeal musculature has been achieved allows phonation to be attempted with optimum muscle tone and reduced/eliminated discomfort. The clinical session for each patient will last for 45 minutes. The patient described her voice problem briefly to the SLP who carried out LMT. Explanations were given to the patient about the possible basis of the symptoms. The time taken for this process of LMT varied according to the patient's response to the procedure. It is not necessarily the case that higher levels of muscle tension require a longer period of treatment. The time was divided as follows: 5 minutes of massage on SCMs; 5 minutes of massage on the suprahyoid region; repetition of 3 minutes of massage on SCMs; repetition of 3 minutes of massage on the suprahyoid region; 2 minutes of sliding and lowering movements on the larynx region; 2 minutes of displacement movements on the thyroid region. Laryngeal manual therapy was conducted for 20 minutes. In fourth, immediately after the therapy, post-LMT data collection of all the parameters and measures as of the second step was done. No intervention was given following LMT. After 1 week of LMT, again data collection of all the parameters and measures as that of Step 2 was done. The data obtained for female participants with MTD across the three conditions were tabulated for processing in a Microsoft Word Excel datasheet. Statistical analysis such as mean, standard deviation, paired-samples T-test, Wilcoxon signed-ranks test, Cronbach's alpha, and intraclass correlation coefficient was done using Software Package for Social Sciences (SPSS) version 17.0 statistical software.

RESULTS

The results obtained for real voice analysis and voice quality estimates parameters of Dr Speech, VHI measures, palpatory assessment measures, and GRBAS scale measures from pre-therapy, immediate post-LMT, and 1 week after LMT assessment have been described under following;

In Figure 1, the mean Fo of immediate post-LMT was greater than that 1-week post-LMT and pre-LMT (immediate post-LMT > 1-week post-LMT > pre-LMT). There was an absence of significant difference for mean Fo between pre-LMT and immediate post-LMT and 1-week post-LMT. These findings were supported by Reimann et al. who found no differences in fundamental frequency (Fo) for both men and women between the pre- and post-LMT in both groups (dysphonic group with functional or organofunctional dysphonia, and the control group). They concluded the reason as less favorable results by 20-minute LMT. The mean value of the Jitter of immediate post-LMT was better than that 1-week post-LMT and pre-LMT (immediate post-LMT > 1-week post-LMT > pre-LMT). There was an existence of significant difference for Jitter between pre-LMT and immediate post-LMT and 1-week post-LMT. The mean value of Shimmer of immediate post-LMT was better than that 1-week post-LMT and pre-LMT (immediate post-LMT > 1-week post-LMT > pre-LMT). There was an existence of significant
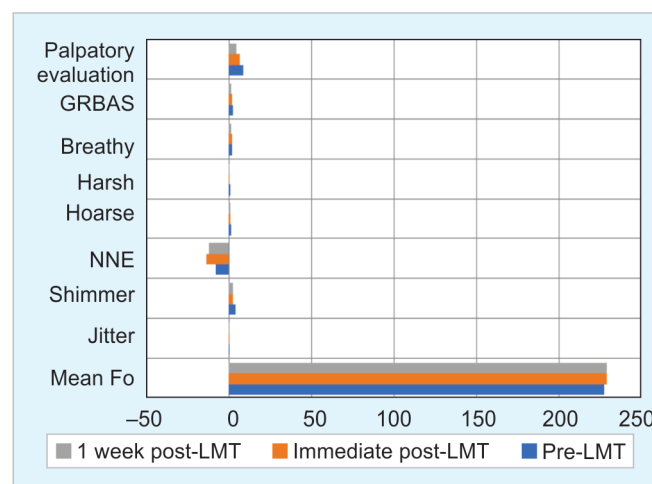

Fig. 1: Mean values of parameters of Dr Speech (Mean Fo, Jitter, Shimmer, NNE), voice quality (Harsh, Breathy, Harsh), GRBAS scale, palpatory evaluation

difference for Shimmer between pre-LMT and immediate post-LMT and 1-week post-LMT. The mean value of NNE of pre-LMT was greater than that 1-week post-LMT and immediate post-LMT (pre-LMT > 1-week post-LMT > immediate post-LMT). There was an existence of significant difference for NNE between pre-LMT and immediate post-LMT and 1-week post-LMT. The mean value of Harsh voice quality of pre-LMT was greater than 1-week post-LMT and immediate post-LMT. There was a significant difference in Harsh quality between pre-LMT and immediate post-LMT. But there was an absence of significance between pre-LMT and 1-week post-LMT and between immediate post-LMT and 1-week post-LMT. The mean value of hoarse quality of pre-LMT was greater than immediate post-LMT and 1-week post-LMT (pre-LMT > immediate post-LMT > 1-week post-LMT). There was a significant difference in hoarse quality between pre-LMT and immediate post-LMT and between pre-LMT and 1-week post-LMT. But there was an absence of significance between immediate post-LMT and 1-week post-LMT. The mean value of breathy voice quality of pre-LMT was greater than immediate post-LMT and 1-week post-LMT (pre-LMT > immediate post-LMT > 1-week post-LMT). A significant difference in breathy quality was found between pre-LMT and 1-week post-LMT. But there was an absence of significance between immediate post-LMT and 1-week post-LMT and between pre-LMT and immediate post-LMT. The mean value of the palpatory assessment of pre-LMT was greater than immediate post-LMT and 1-week post-LMT (pre-LMT > immediate post-LMT > 1-week post-LMT). There was an existence of significance for palpatory evaluation between pre-LMT, immediate post-LMT, and 1-week post-LMT. The mean value of the GRBAS scale of pre-LMT was greater than immediate post-LMT and 1-week post-LMT (pre-LMT > immediate post-LMT > 1-week post-LMT). There was an existence of significance for the GRBAS scale between pre-LMT and immediate post-LMT and between pre-LMT and 1-week post-LMT. But an absence of significance was found between immediate post-LMT and 1-week post-LMT.

In Figure 2, the mean value of VHI Functional (F), VHI Physical (P), VHI Emotional (E), and VHI Total (T) of pre-LMT was greater than immediate post-LMT and 1-week post-LMT (pre-LMT > immediate post-LMT > 1-week post-LMT) an all the three subscales measures and total VHI measures. A significant difference was found between pre-LMT and 1-week post-LMT and between immediate post-LMT and 1-week post-LMT for VHI (F) and VHI (E). But there was an

absence of significance between pre-LMT and immediate post-LMT for VHI (F) and VHI (E). A significant difference was found between pre-LMT, immediate post-LMT, and 1-week post-LMT for VHI (P) and VHI (T).

Discussion

Laryngeal manual therapy is relatively a new management strategy for the treatment of MTD to alter the state of tight vocal tract muscles and to improve the range of movement of the laryngeal joints. Laryngeal manual therapy reduces the intensity of pain on the temporal regions, larynx, posterior part of the neck, and lower and upper back. The muscles that are distal and proximal to the larynx are brought back to balance by LMT that improves blood irrigation in the applied region and makes it less resistant. Muscle tension dysphonia patients have increased muscle tension in the extrinsic neck muscles which occurs due to muscle imbalances, poor posture, and stress. The body movement and postural adaptation result from the action of muscle chains constituted by gravitational muscles working in synergy in the same chain. They are characterized as a set of muscles in the same direction, usually polyarticular with associated biomechanical function. The adequate balance control reflects on appropriate muscle synergies and produces an effective motor response, which minimizes and restores the displacement of the center of gravity. On the other hand, in the presence of postural changes, the body reorganizes itself in chains of compensation, searching for an adaptive response. Therefore, in case of imbalance, postural changes are established, and, in some cases, they lead to pain.[24] Laryngeal manual therapy includes rotational massage, kneading, and stretching of perilaryngeal muscles (Matheison et al.). As the muscles are rhythmically kneaded, rubbed, and stroked, circulation is stimulated. Blood flow delivers oxygen and nutrients and is key to helping muscles eliminate waste products, such as lactic acid, that may collect in muscles from spasms causing pain. Massage increases local blood and lymph flow facilitates muscle relaxation and reduces muscle stiffness, pain, and spasm. It improves circulation and reduces edema. Skillfully applied, systematic kneading of the extralaryngeal region is believed to stretch muscle tissue and fascia, promote local circulation with the removal of metabolic wastes, relax tense muscles, and relieve pain and discomfort associated with muscle spasms. The hypothesized physical effect of such circumlaryngeal massage is reduced laryngeal height and stiffness and increased mobility. Once the larynx is "released/lowered" and the range of motion is normalized, an improvement in the vocal effort, quality, and dynamic range should follow.[25] The skin is lifted up, pressed down and squeezed, pinched, and rolled. Alternate squeezing and relaxation of the tissues stimulates the local circulation and may have a pain-relieving effect with some muscular disorders. The present study aimed at determining the outcome of LMT in females with MTD by comparing the results obtained between pre-therapy assessment data, immediate post-LMT assessment data, and assessment data of 1 week after LMT. Several parameters and measures of voice have been involved in the present study for assessing the impact of extrinsic and intrinsic laryngeal muscles on vocal parameters for which discussion has been elaborated parameter-wise. In Figure 1, jitter findings were supported by Van Lierde et al. who studied the outcome of vocal quality after a well-defined LMT program by comparing results before (1 week before session 1 of the LMT) and after treatment (1 week after session 25
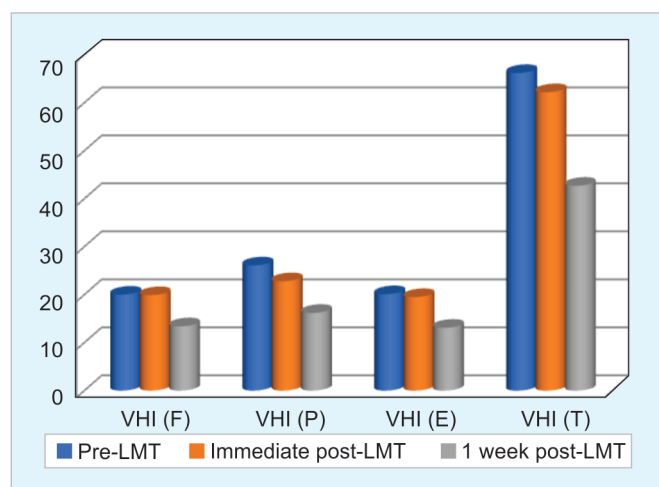

Fig. 2: Comparison of VHI measures of pre-LMT, immediate post-LMT, and 1-week post-LMT data

of the LMT). They found that Jitter was closer to the normal in three fourths, the fourth being unchanged but within normal limits. Reimann et al. studied the immediate effect of LMT in dysphonic individuals and found that jitter was not improved after therapy and concluded that 20-minute LMT may have contributed to less favorable results. These findings were found to be contradictory to the result of the present study. In the case of shimmer findings,[26] who found that Shimmer was significantly improved immediately following the MCT (manual laryngeal musculoskeletal tension reduction). NNE findings were supported by a study[27] who found significant improvement in NNE ($p = 0.000$) after vocal therapy in hyperkinetic dysphonia with prenodular lesions and soft nodules, harsh voice value findings were supported by this study that significant improvement in harsh voice scores ($p < 0.01$) after vocal therapy in hyperkinetic dysphonia with prenodular lesions and soft nodules, hoarse voice findings were supported by the study by showing significant improvement in showed a significant improvement in hoarse voice scores ($p < 0.01$) after vocal therapy in hyperkinetic dysphonia with prenodular lesions and soft nodules. Breathy voice findings were supported by Van Lierde et al. who studied the outcome of vocal quality after a well-defined LMT program by comparing results before (1 week before session 1 of the LMT) and after treatment (1 week after session 25 of the LMT). They found that breathiness was improved after therapy. The VHI findings were supported by a study[28] which compared the pre- and post-therapy (circumlaryngeal massage) outcome in MTD using VHI (quality of life measures) and found that voice improved a lot after voice therapy. Palpation is a non-instrumental technique that is used to observe any visible or palpable tensions around the larynx, especially in the extrinsic laryngeal muscles. In MTD, the tension of extrinsic musculature and thereby position of the larynx may be altered. Subsequently, the movement of cartilaginous structures of the larynx may be disturbed affecting the tension of intrinsic musculature. Therefore, laryngeal palpation is used to assess resting muscle tone, range of motion, and ease of mobility of the neck and laryngeal muscles in MTD. The majority of the palpatory methods describe muscle tension qualitatively and evaluate tension both at static and dynamic tasks. There are few studies on the validity and reliability of palpation methods.[29] The present study used palpatory assessment given by Angsuwarangsee and Morrison for which the results have been elaborated below. Palpatory assessment or evaluation findings have been supported by Mathieson et al. who found that the scores for the left SCMs, the right SCM, the supralaryngeal area, and for laryngeal resistance all show significant changes ($p < 0.001$) from pre- to post-LMT indicating that muscle resistance was reduced by the intervention. But the laryngeal position score was not significantly ($p = 0.279$) changed over the therapy session, although the trend indicated that it was relatively high held to neutral. The GRBAS scale findings aligned with Singh and Dutta who compared the pre- and post-therapy (circumlaryngeal massage) outcome in MTD using the GRBAS scale and found that voice improved a lot after voice therapy.

Conclusion

The present study was conducted to determine the outcome of LMT in females with MTD by comparing pre-therapy assessment data, immediate post-LMT assessment data, and assessment data of 1 week after LMT. It was concluded that after LMT, a significant ($p < 0.05$) reduction in vocal parameters (jitter, shimmer, and NNE)

except mean Fo ($p > 0.05$) was seen. Hoarseness was reduced. The subjective evaluation showed a significant improvement in VHI measures ($p < 0.05$). GRBAS scale showed a significant difference between pre-LMT and immediately after therapy ($p < 0.05$) and between pre-LMT and 1-week post-LMT. Palpatory evaluation showed significant improvement ($p < 0.05$).

Clinical Implications

The study will help the SLP to document the sensitivity of different assessment protocols in determining the efficacy of LMT as the therapeutic protocol as to whether a modification is needed or not. Laryngeal manual therapy could be used as an effective therapeutic tool for the management of MTD. This study would assist to determine the effective parameter for evaluating voice therapeutic outcomes.

Limitations

This study only documented the change in muscle tension around the larynx especially in the extrinsic laryngeal muscles qualitatively through palpation methods. Due to the lack of availability of instruments like laryngeal electromyography (LEMG), it was not possible to document the quantitative (objective) variations in muscle tension.

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