Manual Therapy with Neural Mobilization: Immediate Effect on the Vocal Quality of Women with Dysphonia

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Abstract: Objective. To evaluate the immediate effect of neural mobilization on the voice quality, self-perceived phonatory effort, and laryngeal muscles of women with behavioral dysphonia.

Method. This is an intrasubject comparative study. The research included 21 women aged 18 to 59 years with vocal complaints. Therefore, the selection of this sample excluded the lower limit of the voice change period and the upper limit of presbyphonia. The participants were assessed by voice acoustic and auditory-perceptual analysis, self-reported vocal effort, and laryngeal palpation performed at three moments: at baseline, after 10 minutes of vocal resting, and after manual therapy. The participants were divided into two groups: the group with 10 minutes of vocal resting (G1) and the group with intervention (G2). The patients in the intervention group underwent manual therapy using neural mobilization in the laryngeal region. For the statistical analysis, a descriptive analysis of the data was performed first with measures of central tendency and dispersion. Subsequently, the Anderson-Darling test was used to verify sample normality. To analyze the difference between three groups were used the parametric One-Way ANOVA or the non-parametric Friedman's test. The McNemar's or chi-squared tests were used to compare categorical variables and to compare an ordinal variable a non-parametric Wilcoxon test was used. The Gwet's AC1 test was used to assess intra-rater agreement in the auditory-perceptual analysis response.

Results. Neural mobilization in the laryngeal region showed no positive effects on the acoustic voice parameters and voice quality of women with dysphonia. Phonatory effort improved after neural mobilization in the laryngeal region ($p = 0.004$). There was no significant change in supralaryngeal resistance, lateral laryngeal resistance, and laryngeal position after neural mobilization in the laryngeal region.

Conclusion. Neural mobilization improved phonatory comfort but did have any effect on the voice quality and laryngeal musculature of women with dysphonia.

KeyWords: Manual therapy—Neural mobilization—Dysphonia—Voice—Osteopathy.

INTRODUCTION

The voice is an integral part of social communication, individual personality, and expression of emotions.[1] Communication supported by the use of the voice is a unique human ability that results from organic, emotional, and interactional aspects.[2] Under appropriate conditions, the voice improves speech intelligibility and communicative efficiency according to the professional and social demands of the speaker.[1]

Voice changes lead to dysphonia, which is conceptualized as a communication disorder that impairs the effective oral transmission of a message.[2]

Muscle tension dysphonia (MTD) is a functional voice disorder caused by unbalanced laryngeal or perilaryngeal muscle activity.[3] The etiological factors of MTD are inappropriate vocal behavior, gastroesophageal reflux, or psychological and personality factors that increase vocal fold tension.[3] Signs of larynx and hyoid bone elevation due to increased perilaryngeal muscle tension are predominant in patients with MTD.[3] MTD generally affects young and middle-aged women who use their voices extensively.[4,5]

Although the relationship between MTD and the presence of misalignment in the cervical muscles [3-5], the literature shows that behavioral dysphonia is also accompanied by hyperfunctional disorders of the cervical muscles, and they can benefit from laryngeal massage techniques for proper functional adjustment of the voice. [2,6,7]

Treatment options for behavioral dysphonia consist of voice therapy, psychotherapy, laryngeal manual therapy, and treatment of associated disorders.[8] Voice therapy is the main behavioral voice disorders treatment, and, if properly performed, laryngeal massage techniques can improve vocal condition faster.[8]

Osteopathy is defined by the American Osteopathic Association as complete healthcare with a philosophy that combines patient needs with current medicine practices, surgery, and obstetrics, emphasizing the relationship between structure and function as well as considering the body's ability to heal itself.[9] Manual therapy is a type of therapeutic approach used by osteopathic physiotherapists to improve physiological functions and homeostasis changed by the dysfunction in the patient.[10] One example of a manual therapy techniques is the manipulation of fascial tissue. This technique is therapeutic due to its capacity to change the afference arising from this tissue and, consequently, its efference.[11]

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Neural tissue manual therapy aims to improve function, reduce mechanosensitivity, and activate analgesic mechanisms via mechanical stimulation of nerves through palpation, stretching, and neurodynamic slider.[12]

Neural mobilization improves the movement between neural structures and their surroundings (interface) through manual techniques, which also reduces thermal and mechanical hyperalgesia.[13] Research has shown that neural mobilization therapy (NMT) improves neural function, strength levels [14], and decreases disability and pain.[13-15]

The research question that motivated this study was: Understanding the relationship between dysphonia and the presence of hyperfunction of the cervical muscles, would dysphonic individuals benefit from NMT, as a new therapeutic procedure, considering its effect on improving muscle function and strength?

Given that behavioral dysphonia presents with clinical signs of increased tension in the laryngeal and perilaryngeal muscles, which are associated with dysphonia and phonatory discomfort, NMT may be beneficial for patients with behavioral voice disorders.

This study aimed to understand the immediate effect of neural mobilization on voice quality, self-perceived phonatory effort, and laryngeal muscles in women with behavioral dysphonia.

MATERIALS AND METHODS

This was a comparative intrasubject study (repeated measures design) approved by the Research Ethics Committee of the Federal University of Minas Gerais (UFMG) under study number 3,021,805. All participants signed the Informed Consent Form (ICF).

Women diagnosed with behavioral dysphonia by otorhinolaryngologists, and speech language pathologist (SLP) were included in the study. The exclusion criteria were smokers, neurological voice disorders, a history of surgery in the cervical region, and presence of tattoos, scars, or fractures in the cervical region.

The SLP diagnosis considered the presence of changed voice quality to a mild degree or higher analyzed by auditory-perceptual voice assessment [16] and a total score >16 on the validation of the Brazilian version of the Voice Symptom Scale (VoiSS).[17]

The Otorhinolaryngological evaluation considered the presence of glottic chink and/or benign vocal fold lesions in the laryngeal evaluation.

Initially, the study consisted of a sample of 24 participants aged 18−59 years with vocal complaints. The reason for choosing this age range was to exclude the lower limit of the voice change period at the upper limit of presbyphonia. Three participants were excluded from the sample due to incomplete assessment data. Thus, the study finally included 21 participants: 13 (62%) with a mild overall degree of dysphonia, and 8 (38%) with a moderate overall degree of dysphonia.

The mean age of the 21 participants was 38.76 years (range: 24−56; SD = 10.70). Data collection occurred at the Functional Health Speech Therapy Observatory of the UFMG School of Medicine in the period of April 2019 to March 2020.

The patients underwent laryngeal examination by videolaryngoscopy, and the medical diagnoses of the 21 participants evaluated were vocal fold nodules in 9 (43%), glottic chink in 6 (29%), vocal fold cysts in 4 (19%), vascular dysgenesis in 1 (4.5%), and Reinke's edema in 1 (4.5%). The mean total VoiSS protocol score was 37.14 points (range: 16−59; SD = 13.57).

The participants' voice quality was evaluated by three SLP who specialized in voice and had more than 5 years of experience in the area. The degrees of intra-rater agreement were 100%, 89%, and 80% for each SLP, respectively, and as defined by AC1 statistics. The evaluators analyzed the auditory-perceptual parameters of the general degree of dysphonia (G) of the GRBAS scale.[16]

Patient demographics are outlined in Table 1.

Evaluations

Each of the participants underwent three evaluations. The first evaluation moment (baseline - M1) was considered as the beginning of the period, which was the baseline measurement. The second evaluation (post rest - M2) took place after the participants remained 10 minutes in silence. Finally, the third evaluation (post treatment - M3) occurred after the intervention period to analyze the immediate effect of the technique.

The participants were organized into two groups. The data included 21 women aged between 24 and 56 years with SLP and otorhinolaryngological diagnoses of behavioral dysphonia. All participants were evaluated at baseline (M1) and at M2, which was 10 minutes of vocal resting (G1). The second group received intervention (G2) and included the same participants as G1, in which all participants were evaluated at M2 and at M3, which was after 10 minutes of intervention by neural mobilization (Figure 1).

The evaluations consisted of laryngeal muscle assessment, use of the Visual Analog Scale (VAS) for self-perceived phonatory effort, acoustic and auditory-perceptive analysis of the voice. The assessment of laryngeal muscles consists of an analysis of the tone performed by the physical therapist who conducted the research.

Acoustic voice analysis

Acoustic voice analysis was performed using the Computerized Speech Lab (CSL) software of Kay Pentax, model 6103, MDVP module and PRAAT software version 6.1.16. Both programs were installed in a Dell OptiPlex GX260 computer with a professional Direct Sound card and a Shure unidirectional condenser microphone model SM81 positioned 10 cm from the labial commissure, in a diagonal position and at a directional pickup angle of 45 degrees. The participants were instructed to produce the vowel /a/ in

TABLE 1.
Summary of Patients Demographic Information

Patient	Age	Laryngeal evaluation	VOiSS Scor	General degree of dysphonia (G)
1	25	glottic chink	42	mild
2	55	vocal fold cysts	21	moderate
3	49	vocal fold cysts	39	mild
4	41	glottic chink	58	moderate
5	53	glottic chink	41	mild
6	31	vocal fold nodules	32	moderate
7	37	vocal fold nodules	18	moderate
8	26	glottic chink	16	mild
9	47	Reinke's edema	59	moderate
10	25	vocal fold cysts	32	moderate
11	29	vascular dysgenesis	45	mild
12	33	vocal fold nodules	41	mild
13	42	glottic chink	50	mild
14	56	glottic chink	16	mild
15	28	vocal fold cysts	33	moderate
16	48	vocal fold nodules	43	mild
17	46	vocal fold nodules	33	mild
18	24	vocal fold nodules	19	moderate
19	49	vocal fold nodules	41	mild
20	36	vocal fold nodules	59	mild
21	34	vocal fold nodules	42	mild

a sustained manner at their maximum phonation time with normal frequency and intensity. Similarly, the speech material was also recorded with the emission of the days of the week.

The acoustic parameters analyzed in the Kay Pentax CSL software were fundamental frequency (F0 Hz), jitter (%), period perturbation quotient (PPQ %), shimmer (%), amplitude perturbation quotient (APQ %), and harmonic-noise ratio (HNR dB). The fundamental frequency value used was the mean of all extracted frequency periods. The parameters measuring the short-term period perturbation chosen were jitter, which is the relative mean of frequency variation in the period; and PPQ, which is the relative mean of the period perturbation every five periods (five-point mean). The parameters measuring short-term amplitude perturbation were shimmer, in percentage, which is the relative mean of the amplitude variation in the periods; and APQ, also in percentage, which is the relative mean of the amplitude variability every 11 periods (11-point mean). The noise measurement used was phonemic restoration, which relates the harmonic and noise components of the acoustic wave.

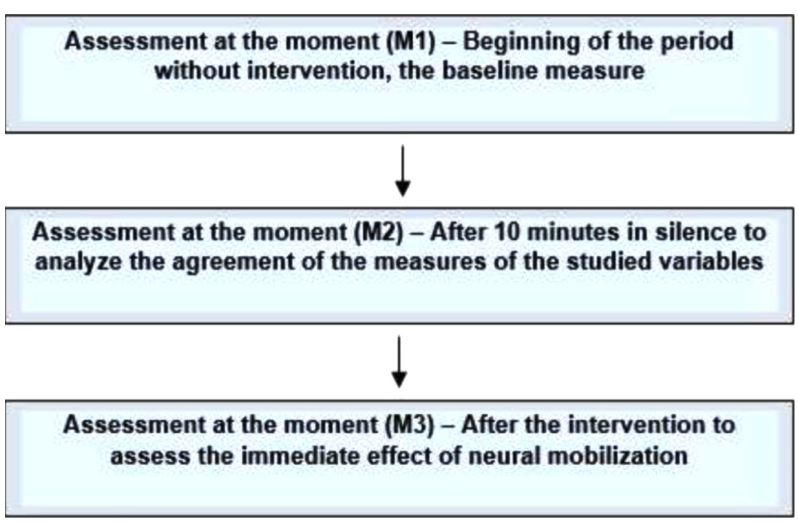

FIGURE 1. Flowchart of the steps involved in the study
Source: Elaborated by the author.

PRAAT software version 6.1.16 was used to extract the cepstral measurements. Sustained vowel and continuous speech productions were transferred to the PRAAT software. Then, Cepstral Peak Prominence (CPP) and Cepstral Peak Prominence-Smoothed (CPPS) parameters were extracted for vowel and speech. The parameters proposed in the literature were selected for measurement extraction.[18] The start and end of the productions were excluded from recordings and the analyzed emission time was standardized at 4 seconds.

Auditory-perceptual voice analysis

The recorded voices (sustained vowel and continuous) were randomized for the recording moments (M1, M2, and M3) and groups (G1 and G2). The evaluators did not know beforehand whether the voices analyzed were recorded before or after neural mobilization intervention.

Auditory-perceptual analysis evaluated the general degree of dysphonia (G) of the GRBAS protocol on a scale of 0-3 (0 = normal, 1 = mild degree, 2 = moderate degree, and 3 = high degree) and considered productions before and after the moment with 10 minutes of vocal resting (baseline and post rest) and before and after the moment with intervention (post rest and post treatment), which were arranged in pairs and randomly positioned according to a draw.

Afterwards, the productions were independently analyzed by six SLP with experience in the voice area, evaluating if there was any improvement, worsening, or unchanged voice quality of the second voice compared to the first.

The answers of the three raters with higher intra-rater agreement were selected. The intra-rater agreement values were 1, 0.89, 0.80, 0.54, and 0.40. The responses of the three raters with substantial or near-perfect agreement were analyzed.[19] Intra-rater agreement was determined by randomly repeating 20% of the sample. The Gwet's AC1 test was used to assess intra-rater agreement values.

Self-perceived phonatory effort analysis

Self-reported vocal effort was analyzed using the VAS, a visual analog scale graded from 0 to 10, which 0 represented absence of effort and 10 very intense phonatory effort. Vocal effort was considered as the presence of symptoms of tension, burning sensation, and/or pain during vocal emission. All participants were instructed to mark their degrees of phonatory effort before and after the experiment.

Palpatory evaluation of the larynx

This assessment followed a protocol created by Mathieson et. al. (2007).[20] The purpose of the palpatory evaluation was to define the degree of muscle tension and the height of the larynx in the vocal tract. The following parameters were analyzed through palpation: supralaryngeal tension, rated from 1 (minimum resistance) to 5 (maximum resistance); lateral laryngeal tension, also rated from 1 to 5; and laryngeal height, evaluated as high, neutral, or low.

This evaluation was performed at the three moments by the same physical therapist, who had 17 years of experience in manual therapy. There was no grade 5 classification for supralaryngeal tension and lateral laryngeal tension nor any low position in the evaluation of laryngeal position that was noted.

Physiotherapeutic intervention

The intervention utilized three techniques. The first technique aimed to reduce tension in the jugular foramen, while the second and third mobilized the superior and inferior laryngeal nerves, respectively. The intervention followed the steps recommended by the American Osteopathic Association. In all techniques, the therapist used pressure that corresponds to the whitening of the nails, with the targeted muscles being those extrinsic to the larynx.

Initially, the patients were placed in a dorsal decubitus position, and the therapist was positioned at the head of the stretcher close to the patient's head. The initial technique aimed to facilitate the exit of the vagus nerve through the jugular foramen, placing the middle finger on the patient's external acoustic meatus and the other hand supporting the skull base. Then, through the palpation of the neck region close to the larynx with one hand and the feeling the pulsation of the carotid artery that descends through the carotid sheath along with the jugular vein and the superior laryngeal nerve with the other, a stretch was made in the skin and subsequently a slight head rotation movement was requested to the patient. This action aimed to reach the superior laryngeal nerve. This procedure was repeated on the left side, inverting the hands, and was performed for 1 minute on each side (Figure 2).

Subsequently, the therapist rotated the patient's head in the contralateral direction to the side to be treated. The epidermis near the larynx and superior laryngeal nerve on that side were palpated. To palpate the epidermis next to the nerve, the therapist felt the carotid artery pulsation on the

FIGURE 2. Technique for the jugular foramen
Source: Elaborated by the author.

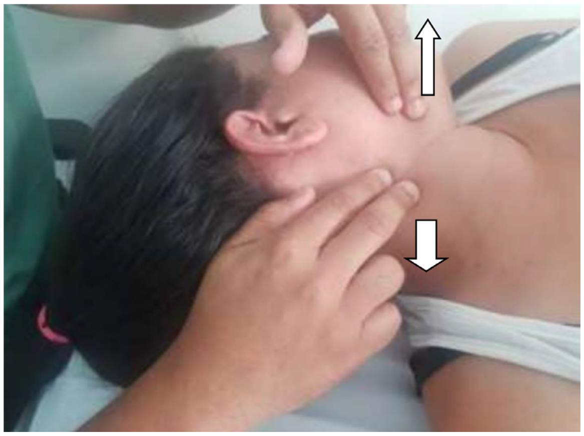

FIGURE 3. Technique of neural mobilization for the superior laryngeal nerve
Source: Elaborated by the author.

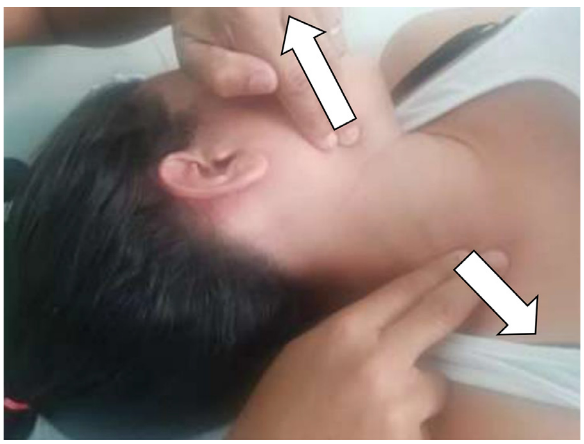

FIGURE 4. Neural mobilization technique for the lower laryngeal nerve
Source: Elaborated by the author.

carotid sheath. During this time, neural mobilization was again performed by slight stretching of the skin and small rotational movements of the patient's head to release tension. The procedure lasted 2 minutes on each side (Figure 3).

Next, the fingers were kept in the region close to the larynx and the other hand's fingers close to the clavicle, in the passage region of the recurrent laryngeal nerve, a technique aiming at neurodynamic of the two nerves. The epidermis near the larynx and on the clavicle region were palpated and the carotid artery pulsation was felt on the carotid sheath. Neural mobilization was performed again to stretch and release tension for 2 minutes on each side (Figure 4).

This entire procedure lasted 10 minutes and was performed bilaterally for 5 minutes on each side.

Statistical analysis

MINITAB statistical software version 17 was used for statistical analysis. First, a descriptive analysis was performed with central tendency and dispersion measurements and absolute and relative frequency calculations. Subsequently, the Anderson-Darling test was used to verify the normality of the sample for numerical variables.

The parametric One-Way ANOVA test with repeated measures was used to compare F0 acoustic measurements and vowel CPP, speech CPP, and vowel CPPS cepstral measurements between the three evaluation moments (M1, M2 and M3). The non-parametric Friedman's test was used for the other acoustic measurements, that the residuals did not follow a normal distribution.

The McNemar's or chi-squared tests were used to compare categorical variables (auditory-perceptual analysis, supralaryngeal tension, lateral laryngeal tension, and laryngeal position) between the three moments (M1, M2 and M3).

To compare an ordinal variable and two dependent groups (M1 and M3) for VAS scale a non-parametric Wilcoxon test was used.

The Gwet's AC1 test was used in the R software version 3.5.1 to assess intra-rater agreement. The result considered the auditory-perceptual analysis response to be the mode value of the three raters with higher intra-rater agreement. There was no agreement between the three raters for four of the 42 voice pairs evaluated. Thus, a SLPt and voice specialist both with over 20 years of experience evaluated the four pairs blindly to arrive at a final result.

A significance level of 5% was considered in all analyses.

RESULTS

Table 2 presents the acoustic voice analysis results at the three moments evaluated: baseline (M1); post rest (M2) and post treatment (M3). The results showed no significant acoustic measurement changes between the evaluated moments.

Table 3 shows the results of the auditory-perceptual analysis with 10 minutes of vocal resting (M1 and M2) and with NMT intervention (M2 and M3). NMT had no effects on the voice quality of the participants with dysphonia.

Table 4 shows the assessment of self-perceived phonatory effort using VAS before and after neural mobilization intervention. Significant results were observed, indicating improvement in phonatory effort after the use of the techniques and 10 minutes of vocal resting.

Table 5 shows the palpatory evaluation performed at the three moments. There was no significant supralaryngeal tension, lateral laryngeal tension, or laryngeal position changes between the three moments.

DISCUSSION

The results of this research found that neural mobilization improves self-perceived phonatory effort, although it has no effect on the voice quality as well as the tension and position of the larynx in women with behavioral dysphonia.

Within the vast array of therapies available, NMT is an important manual therapy in the treatment of somatic

TABLE 2.
Acoustic Parameters of the Vowel / a / Comparing the Three Evaluated Moments

	Baseline (M1)			Post vocal rest (M2)			Post NMT (M3)			p-value
	Median	Average	SD	Median	Average	SD	Median	Average	SD	
F0 (Hz)*	200.65	197.79	36.5	194.96	192.48	26.17	193.93	194.52	30.77	0.943
Jitter (%)**	0.71	1.27	1.23	1.27	1.58	1.43	1.33	1.51	0.9	0.229
PPQ (%)**	0.56	0.7	0.61	0.69	0.9	0.79	0.77	0.89	0.53	0.131
Shimmer (%)**	3.91	4.35	2.38	4.1	4.54	2.73	4.18	4.28	1.61	0.717
APQ (%)**	2.87	3.13	1.66	2.73	3.17	1.72	2.85	3.01	1.09	0.827
NHR**	0.13	0.13	0.02	0.13	0.13	0.04	0.13	0.13	0.02	0.322
CPP vowel*	25.36	25.67	2.82	25.18	25.3	2.93	24.72	25.04	3.21	0.748
CPP speech*	18.63	18.5	0.97	18.58	18.45	1.12	18.4	18.46	1.04	0.984
CPPs vowel*	15.09	15.46	2.27	14.93	14.98	2.43	14.43	14.68	2.61	0.506
CPPs speech**	9.05	8.76	1.05	9.08	8.79	1.19	9.04	8.76	1.2	0.962

* Anova test; F0 (F-value=0.06); CPP vowel (F-value=0.29); CPP speech (F-value=0.02); CPPs vowel (F-value=0.69).
** Friedman test; DF=2; Jitter (S=2.95); PPQ (S=4.07); Shimmer (S=0.67); APQ (S=0.38); NHR (S=2.27); CPPS speech (S=0.08).Legend: APQ = amplitude perturbation quotient; CPP= Cepstral peak prominence; CPPs = Smoothed cepstral peak prominence; F0 = fundamental frequency; M1 = Starting moment; M2 = Moment after vocal rest; M3 = Moment after neural mobilization therapy; NHR = noise harmonic ratio; PPQ = period perturbation quotient; SD = standard deviation; DF= degrees of freedom.

TABLE 3.
Comparison of the Auditory-Perceptual Analysis of the Voice Before and After the Neural Mobilization Technique

Auditory-perceptual assessment	With 10 minutes of vocal resting (G1) N = 21		With intervention (G2) N = 21		p-value*
	N	%	N	%	
Improved	0	0	1	4.8	0,283
Worsened	3	14.3	0	0	
Unchanged	18	85.7	20	95.2	

* Chi-square test.

TABLE 4.
Analysis of Self-Perceived Vocal Effort Without (M1) and with Intervention (M3) of the Neural Mobilization Technique

Self perception	Baseline (M1)			Post NMT (M3)			p-value*
	Median	Average	SD	Median	Average	SD	
Visual Analog Scale	3	4.01	3.53	1	1.66	2.02	0.004

* Wilcoxon test.Legend: SD = standard deviation; NMT = neural mobilization therapy.

dysfunction present in several clinical conditions. Pain patterns in people with nonspecific cervical pain or low back pain improve as the amplitude and quality of fascial sliding movement increase after NMT.[21]

Neural mobilization may change the descending inhibitory mechanisms of pain by modifying blood flow to brain regions associated with pain, besides reducing the activation of supraspinal pain centers.[22] A study [23] showed that four series of 10 tensioning mobilizations directed to the median nerve were enough to induce hypoalgesia in the forearm, which was maintained 30 minutes after the end of the NMT intervention. These results suggest that NMT induces hypoalgesia through a centrally mediated mechanism, activating both the descending inhibitory pain pathway and the pain modulatory systems mediated by endogenous opioids.[23]

The role of manual laryngeal therapies in the treatment of vocal disorders that present with phonatory hyperfunction requires further investigation.[24] Some studies [24-26] have considered the positive effect of perilaryngeal manual therapies in the treatment of MTD and behavioral voice disorders.[6]

Understanding the importance of laryngeal massage techniques in behavioral dysphonia that are accompanied with muscle tension[2,6,7], and as NMT is a manual therapy, which aims at a functional balance of muscles, the hypothesis of this research was that NMT, when applied in cervical region, could bring functional benefits to dysphonic women, such as improved voice quality, self-perceived phonatory effort and decreased muscle tension.

Some studies on manual therapy with manipulation of the perilaryngeal and cervical muscles showed improved

TABLE 5.
Evaluation of the resistance of the laryngeal musculature

Palpation	Degree of Resistance / Level	Baseline (M1)		Post vocal rest (M2)		Post NMT (M3)		p-value
		N	%	N	%	N	%	
Supralaryngeal resistance*	1	1	5%	1	2.40%	2	9.50%	
	2	6	28.50%	5	25%	6	28.50%	M1 x M2 = 0.615
	3	6	28.50%	10	47.60%	9	42.80%	M2 x M3 = 0.898
	4	8	38%	5	25%	4	19.20%	
Larynx Lateral Resistance *	1	4	19.10%	4	19.10%	7	33.30%	
	2	8	38.10%	9	42.90%	10	47.60%	M1 x M2 = 0.987
	3	7	33.30%	6	28.50%	3	14.30%	M2 x M3 = 0.524
	4	2	9.50%	2	9.50%	1	4.80%	
Larynx Position**	Neutral	13	61.90%	14	66.60%	16	76.20%	M1 x M2 = 0.286
	Elevated	8	38.10%	7	33.40%	5	23.80%	M2 x M3 = 0.093

* Chi-square test; DF=3.
** McNemar test.
Legend: M1 = Starting moment; M2 = Moment after rest; M3 = Moment after neural mobilization therapy; DF= degrees of freedom.

acoustic parameters of the voice and voice quality, as analyzed using a auditory-perceptual approach.[27] These findings suggest that manual laryngeal therapy with muscle manipulation can improve phonatory function balance owing to better adjustment of the laryngeal and perilaryngeal muscles, thus improving vocal production as evidenced by acoustic measurements and voice quality results.[6]

In this research, we did not observe changes in voice quality evaluated in a perceptual-auditory and acoustic way. These results suggest that the immediate effect of NMT on the function of the cervical muscles was not enough to develop a greater balance in the laryngeal muscles, and consequently in the quality of voice.

A study analyzing the use of NMT in the lumbosacral region of 56 patients with leprosy showed improved electromyographic muscle strength levels and neural function as well as decreased disability and pain after 6 weeks of treatment.[15]

Further studies on cervical NMT conducted for a longer period of time and with follow-ups ≥6 months may be able to better evaluate if the effect of NMT on laryngeal and perilaryngeal muscle strength balance would positively impact vocal emission, which may then lead to improved voice quality and acoustic voice measurements.

The evaluation of self-perceived phonatory effort indicated that NMT improves phonatory effort in women with behavioral dysphonia. Vocal effort is reported to be associated with pain in patients with behavioral voice disorders.[7] Since NMT can lead to pain relief [13,28-31] by activating analgesic mechanisms [23], the results of the present study may be justified by the inhibitory action of descending pain mechanisms, which may have reduced activation of the supraspinal pain centers.[22]

Some studies analyzing NMT interventions alone or associated with other treatments reported decreased pain and disability levels in people with low back pain as well as increased muscle flexibility in healthy adults.[31] Such results suggest that NMT can be an important therapeutic tool in relieving vocal effort symptoms in women with behavioral dysphonia. The subjective nature of self-perceived phonatory effort should be considered, and a research design in which participants are blind is important to assess the real effects of NMT in women with behavioral dysphonia.

In this study, NMT had no effect on palpatory evaluation and did not change larynx tension and position. These results may be justified by the fact that NMT was only assessed for its immediate effect on the laryngeal and perilaryngeal muscles.

The palpatory evaluation of the perilaryngeal musculature is described in the literature.[20,25] Palpation of extrinsic laryngeal muscles provides important information regarding internal laryngeal posture and is important in the diagnosis of vocal disorders due to muscle misuse. However, this evaluation is inevitably subjective.[24] Palpation is an easy, direct, and useful clinical method to measure muscle tension that uses no equipment. Thus, it is a safe technique with no known adverse effects.[32] Research shows the positive results of manual therapy with manipulation of perilaryngeal and cervical muscles, which result from improved laryngeal position and muscle resistance to horizontal displacement.[20] Such results can be justified by the fact that manipulating the tissues directly related to the larynx reduces excessive muscle tension.[10]

The subjective nature of palpatory evaluation should be considered, showing the need to refine this evaluative process. Palpatory evaluation protocols need improvement, and further studies with blinded evaluations are necessary to investigate intra-examiner reliability as well as whether the interpretation of tension will be influenced by the therapist's strength, among others. In this study, palpatory evaluation was performed by one of the researchers, which can be considered a bias in the evaluative process. However, the results corroborate the impartiality of the data.

The limitations of this research were the small sample size and the different clinical laryngeal condition. The COVID-19 pandemic also prevented the researchers from involving a large number of participants.

It is important to emphasize that the results of the self-perception assessment compared moment 1 (M1 - baseline) and moment 3 (after NMT intervention). In this case, the 10 minutes of vocal rest at moment 2 (M2) may have influenced the results observed. It is also reasonable to assume that, as self-perceived phonatory effort is a subjective assessment, dependent on the patient's analysis, these results may be influenced by the type of assessment.

Future studies evaluating the effects of NMT with longitudinal follow-up are important to understand the real effects of this therapeutic technique in patients with dysphonia.

Laryngeal manual therapy may be effective in treating people with dysphonia due to muscle tension. However, its role still needs further investigation[24], especially considering clinical procedures such as NMT. Our findings suggest that NMT should not be used as an isolated treatment for behavioral voice disorders but should be performed in conjunction with other treatments. Nevertheless, NMT was effective in improving phonatory effort. Thus, it can be initially used to improve the condition of patients with phonatory discomfort, with other techniques that will be effective for other aspects, such as improving voice quality, and can be subsequently added to the patient's treatment regimen. In addition, it is a mild technique that requires no extra resources and only needs a trained and skilled therapist.

The interest of SLP in laryngeal manual therapy has grown in the last three decades. In this sense, several behavioral vocal disorders associated with excessive muscle tension can improve with manual laryngeal therapy. However, it is necessary to carry out more randomized and blind clinical trials with laryngeal manual therapy (laryngeal massage and NMT), which make evidence-based practice in voice sciences possible.[33]

CONCLUSION

The use of NMT in women with behavioral dysphonia improved their phonatory effort. NMT did not improve voice quality, analyzed acoustically and perceptually, as well as lateral resistance and laryngeal position.

DATA STATEMENT

We state the availability of the data.

DECLARATIONS OF INTEREST

None.

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