Myofascial Release Effects in Teachers' Posture, Muscle Tension and Voice Quality: A Randomized Controlled Trial

[*,†]Ricardo Cardoso, [*,†,∥]Rute F. Meneses, [*,‡,§]José Lumini-Oliveira, and [*,¶]Pedro Pestana, *†‡∥Porto, and ¶Esposende, Portugal, and §Porto

Summary: Objective. Myofascial release (MFR) comprises a set of manual therapeutic techniques applied to many conditions, but specific evidence concerning its effects on body posture, muscle tension and voice has been lacking. Thus, the aim of this study was to verify the effects of MFR in teachers' posture, muscular tension and voice quality.

Study Design. Randomized controlled trial − crossover.

Methods. Twenty-four teachers, after completing a Sociodemographic and Clinical Questionnaire and providing written informed consent, were randomly distributed into two groups designated Group 1 (G1; n = 12; received MFR first) and Group 2 (G2; n = 12; belong to control group first). All participants received treatment and were into control group, since, after a 14 day period, procedures were switched between groups. Photogrammetry, muscle tension assessed through palpation, algometry, aerodynamic assessment of voice, acoustic and auditory-perceptual analysis of voice were performed before and after interventions.

Results. Regarding voice, statistically significant differences were found when intervention was applied to both groups for maximum phonation time (MPT) (G1 $P = 0.019$; G2 $P = 0.004$). The acoustic variables did not differ. Concerning the auditory-perceptual analysis of voice statistically significant differences were found when intervention was applied in both groups for Grade in G2 ($P = 0.046$) and for Roughness in G1 ($P = 0.025$). Regarding the photogrammetry assessment statistically significant differences were found when intervention was applied to both groups in many parameters while as control group they did not. Concerning the algometry and muscle tension assessed through palpation statistically significant differences were found when intervention was applied in all muscles.

Conclusions. Findings indicated that MFR seems to be an effective therapy in improving MPT, two subscales (Grade and Roughness) of the GRABASH scale, muscle tension assessed through palpation and algometry. Regarding photogrammetry, MFR had an immediately effect in improvement of the posture, especially related with head.

Key Words: Voice−Posture−Muscle tension−Myofascial release−Teachers.

INTRODUCTION

The prevalence of voice disorders among the general population is 6% to 15%. However, when teachers are considered, these values increase to 20% to 50%, reaching up to 80%.[1,2] Subjects using their voice as a professional instrument are more prone to voice disorders, those which are induced by professional use are more likely to be chronic and may increase work absence.[3,4] Factors correlated with voice disorders in teachers are the gender (women are more frequently affected), the age between 40 and 59 years, to have a family history of voice disorders[5] and to have job stress where highly stressed teachers more often present voice disorders.[6]

With rare exceptions, teachers do professional vocal use without any previous preparation, ignoring healthy vocal habits and acting under unfavorable environmental conditions, which causes an intense effort. Teachers often work in large rooms, under excessive internal and external environmental noises, and have to constantly speak with strong vocal intensity.[7] Also, they have to deal with variables that are beyond their control, such as improper environmental conditions, lack of educational resources, and the constant risk of developing voice disorders due to exposure or close contact with children who frequently develop upper respiratory infections.[8]

Optimal postural alignment is necessary because it can help to harmonize muscle tension, which itself can cause postural changes. Also, muscle tension and dysphonia may influence each other. Muscle tension may cause dysphonia and, on the contrary, to be a result of dysphonia as subjects increasingly add muscle effort trying to make their voices work.[9,10]

Hyperfunctional dysphonia is related to excessive tension of the muscles not only of the pharynx, larynx, face and neck but often of the thorax and abdominal walls. In this way, the subjects with hyperfunctional dysphonia are prone to affect the muscular-fascial-ligamentous system and can change the posture of the whole body. In patients with muscle tension dysphonia, an altered tension of the extrinsic laryngeal musculature results in a changed position of the larynx in the neck (a mostly higher position) and a disturbed inclination of the cartilaginous structures of the larynx (hyoid, thyroid,

Accepted for publication March 23, 2021.

From the *Fernando Pessoa University, Porto, Portugal; †Transdisciplinary Center of Consciousness Studies of Fernando Pessoa University, Porto, Portugal; ‡CIAFEL - Research Centre in Physical Activity, Health and Leisure, Porto University, Porto, Portugal; §LABIOMEP - Porto Biomechanics Laboratory, Porto University, Porto; ∥Longevity and Development Observatory of Fernando Pessoa University, Porto, Portugal; and the ¶PMP terapia, Esposende, Portugal.

Address correspondence and reprint requests to Fernando Pessoa University, CIAFEL - Research Centre in Physical Activity, Health and Leisure, Porto University, Rua Delfim Maia, 3344200-253 Porto, Portugal E-mail: rcardoso@ufp.edu.pt

Journal of Voice, Vol. 37, No. 4, pp. 635.e15−635.e27
0892-1997

https://doi.org/10.1016/j.jvoice.2021.03.029

cricoid, and arytenoid) that immediately affects the intrinsic laryngeal musculature. Tension of the vocal folds is altered, and the voice becomes disturbed. [9,11,12]

Myofascial dysfunction can be described as an anomaly or lack of a correct stabilizing response of the fascial system which can overload all segments of the fascial system and alter the functioning of the body structure. In addition, a lack of coordination (temporary or definitive) of movements at all levels and body segments is created.[13] Fascia is a sheet of connective tissue, beneath the skin that attaches, encloses, stabilizes and separates muscles and other internal organs, and has a key role to play in musculoskeletal dynamics: its ability to spontaneously adapt and adjust to strain or stretch makes it as an active contributor to stability and mobility.[14] In fact some authors suggest the existence of a fasciotome that includes the portion of deep fascia supplied by the same nerve root as the corresponding dermatome but organized according to force lines to emphasize the main directions of movement and with a crucial role in proprioception.[15]

Myofascial release (MFR) comprises a set of manual therapeutic techniques that promotes the release of fascial restraints to restore maximal functionality to the body.[16-19] The MFR is different from circumlaryngeal manual therapy and manual laryngeal reposturing. Usually, it involves sustained and slow pressure of about 120 to 300 seconds in the fascia layers either directly or indirectly. In direct techniques fingers or knuckles, elbow or other instruments are used to slowly sink into the fascia, applying tension, or stretch the fascia, to release a restricted fascial tissue, while the indirect techniques include stretching until the motion becomes less limited, with the hands being placed in the direction of restriction and held in the same position until the fascia is released.[16,17,20] These techniques promote vasodilation and muscle relaxation, with the main results being an increased range of motion, decreased pain and restored tensegrity, tissue length, resulting in optimization of tissue function.[16,19] The fascia is located immediately before the motor barrier and as soon as it is reached, light pressure is applied to lengthen the restriction area.[21] This concept initially had more attention through manual therapies and there are currently several methods of fascial release.[22] This release of the restriction takes place due to the viscoelastic properties (the continuous technique individually requests the collagen strands), plastic (if the elongation is maintained in time the collagen that is in the tissues deforms) and piezoelectric, that is, the continuous movement of the liquid element that travels in the fascia maintains the proper electrical charge to maintain the adjacent tissue homeostasis.[23] Since fascia is a continuous tissue in our body, a restriction of it in one area can cause stress and dysfunction in other regions. The MFR can then decrease or eliminate the restrictions being reported as effective in relieving pain and relaxing tissues.[24,25]

However, specific evidence concerning the MFR effects on body posture, muscle tension and voice has been lacking. Thus, the aim of this study was to verify the effects of MFR in teachers' posture, muscular tension and voice quality.

MATERIALS AND METHODS

Ethics statement

Initially the project protocol was submitted to the approval of the Ethics Committee of the UFP's University Hospital. During the first face-to-face contact with each participant, signed informed consent was obtained following the World Medical Association Declaration of Helsinki (Ethical Principles for Medical Research Involving Human Subjects), ensuring the anonymity and confidentiality of the data and that it would not be used for purposes other than this research. Participants were also informed that, if they wished, they could cease their participation in the study at any time without any consequences for themselves.

Sample selection

After obtaining the necessary authorizations to carry out the study in the UFP's University Hospital, the directors of the school groups of São Pedro da Cova and Rio Tinto were contacted by telephone to inform them about the nature, objectives, procedures and period of the study.

Subsequently, an email was sent to those directors with a cover letter and information about the study and to all teachers to recruit volunteers. Teachers who were on leave or had retired were excluded. After each teacher confirmed his/her participation via email, the day of the assessment in the Physical Medicine and Rehabilitation Service of the UFP's University Hospital was scheduled.

After the data collection period, a new email was sent to thank the interest of the teachers and their participation in the study. The final results of the study were also disclosed to teachers this way. The collected data was archived separately and, following the Ethics Committee instruction will be deleted when no longer serves for any research purpose.

Subjects

The convenience sample consisted of 24 teachers of both genders, between 27 and 60 years of age who signed an informed consent form. To standardize the sample regarding the vocal load, only participants who were teaching full-time were included.[25] The participants had no knowledge of how MFR would be conducted.

The exclusion criteria were: to have hearing loss[26]; to have undergone voice therapy or lessons for voice enhancement in the last six months[26]; to have neurological diseases; to have been under pharmacological treatment for the last purpose; to have history of oncological pathology; to have dermatological lesions; to be tracheostomized or laryngectomized; to have extensive scar of any origin (surgery, radiotherapy, trauma) in the anterior region of the cervical and soft tissues surrounding the larynx.[12]

Experimental procedure

Participants completed a Sociodemographic and Clinical Questionnaire, to characterize the sample and identify possible exclusion criteria. The Sociodemographic and Clinical

Questionnaire included: personal data (10 items), vocal habits (7 items), personal habits (5 items) and clinical background (2 items). The data collection was done in a room of the Physical Medicine and Rehabilitation Service of the UFP's University Hospital, in a calm environment, illuminated with soft white light and at a temperature between 20°C and 23°C. All the assessments were done within three months and took place in the afternoon, between 15:00 and 19:00 hours, to standardize their schedules.

After completing the Sociodemographic and Clinical Questionnaire, the subjects were randomly assigned into two groups designated Group 1 (G1; n = 12) (received MFR first) and Group 2 (G2; n = 12) (belong to control group first) using the softwarewww.graphpad.com/quickcals. All participants received treatment, since, after a 14-day period[27], procedures were switched between groups: participants who underwent MFR on the first day were subjected to control and vice versa. Each participant was assigned an odd number (who started in G1) or even (who started in G2).

After the randomization, participants were assessed to establish a baseline [Time 0 (T0)] in 6 separate main outcome variables: Photogrammetry, muscle tension assessed through palpation, algometry, aerodynamic assessment of voice, acoustic and auditory-perceptual analysis of voice. After the intervention or control, was carried out the second evaluation [Time 1 (T1)], which consisted in the same outcome measures. In this phase, a 14-day wash-out period was performed where procedures were switched between groups and, after that, was performed the third assessment [Time 2 (T2)]. After the intervention or control, was carried out the fourth assessment [Time 3 (T3)]. The outcome measures used in T2 and T3 were the same as in T0 (Figure 1).

Initially, each individual was evaluated for their anthropometric composition, using a stadiometer (Seca Medical Scales and Measuring Systems, UK) to record their height and a scale (Seca Medical Scales and Measuring Systems, UK) to measure their weight.

The following evaluation parameters were collected by an experienced physiotherapist investigator, using a blinded approach and trained for the purpose. The average time to assess each participant was 60 minutes.

Voice assessment

The voice assessments were performed in an acoustically isolated room in the hospital, respecting the maximum threshold of 45dB ambient noise that was measured by the application of an Android smartphone, Sound Meter 3.5.0.[28,29].

The participants produced the sustained vowel /a/. They were asked to stand with their backs straight, and with their head forming perpendicular to the line of the shoulders. This allowed better control under the respiratory system, better postural control, approximation to the habitual use of the voice and defined aerodynamic characteristics ideal for voice production.[30-33]

The microphone was held by the participant́s hand, positioned at an angle of 90 cm and 20 cm away from the mouth.[30,34-37]

The vowel / a / was recorded in the habitual pitch and loudness. The vowel was sustained as long as participants were able – the task was then repeated three times.[32,38] The recording of sustained vowels is very useful since it allows the sound to be analyzed without alterations derived from the articulation of the words, thus remaining in its most stable and clear form.

The vowel / a / was chosen because when acoustic analysis of vowels is performed, it tends to be the most affected among all vowels[39] and, as described by Behlau (2001),[30] is the best vowel for verifying variations in frequency and intensity.

The maximum phonation time, an aerodynamic variable that indicates the voice's efficiency, was also assessed. This evaluation consisted in measuring, in seconds, the maximum phonation time of the vowel /a/ during exhalation. The assessment was repeated three times and the average was considered.[40,41]

The acquisition and analysis of the acoustic signal was done with the opensource software PRAAT version 6.0.35 with a single channel, 16 bits resolution and a sampling rate of 44,100 Hz.[33,36,42] The recording was done with the dynamic microphone Shure SM58, through the digital interface Behringer FCA 1616 connected to the HP Pavilion beatsaudio computer.[43]

The studied variables for acoustic analysis were: fundamental frequency (F_0), standard deviation fundamental

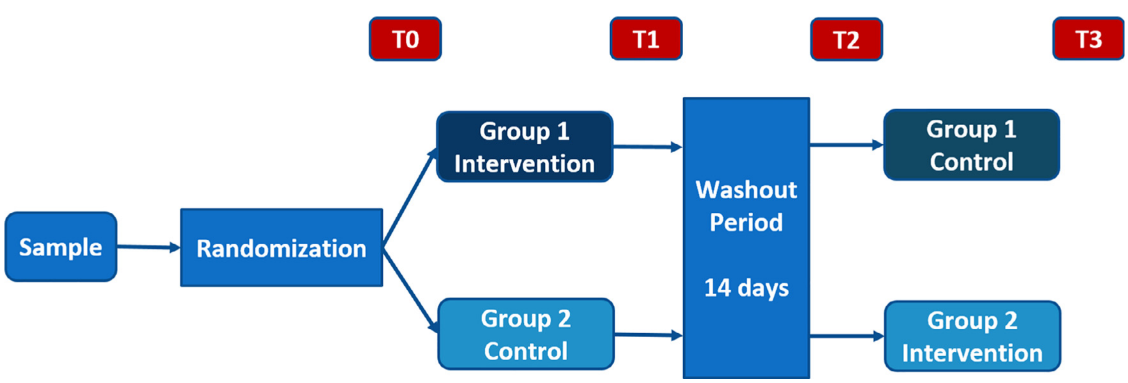

FIGURE 1. Experiment flow-chart.

frequency (F_0SD), Jitter, Shimmer and Harmonic-to-Noise Ratio (HNR).[32,33,41,44,45] These variables were chosen because they provide information on vocal signal modifications that reflect physiological changes in the vocal folds.[32] The F_0 was chosen because it is "the natural result of vocal fold length" and its aerodynamic characteristics in the interaction with subglottic pressure.[30] The Jitter indicates "the variability of F_0 in the short term by measuring the differences between neighboring glottic cycles".[30] The Shimmer indicates "the variability of the amplitude of the sound wave in the short term".[30] As for HNR, it is an indicator capable of expressing the "vocal fold signal contrast with the irregular signal of the folds and vocal tract, offering an index that relates the harmonic component versus the noise component of the acoustic wave".[30] The auditory-perceptual analysis of the voice was performed by three experienced voice therapists (over five years of experience) who listened to the voice recordings in a blind and random manner.[27,33] The three clinicians were asked to listen carefully to all the voice samples successively. Each voice sample was played, and the clinicians were asked to complete perceptual evaluation of the subjects' vocal quality on the Grade, Roughness, Breathiness, Astheny, Strain, Harshness (GRBASH) subscales using a four-point scale: (1) 0 = normal, (2) 1 = mild deviance, (3) 2 = moderate deviance, and (4) 3 = severe deviance. Afterwards the mean values of each subscale of GRBASH was calculated based on the three clinicians' perceptual evaluation.[41,44,46] In order to adapt the GRBAS, Nemr and Lehn (2010).[47]included the term harshness -H to the original scale, giving rise to the GRBASH scale, with the aim of adapting the perceptive assessment of voice to the voices concomitant to a partial laryngectomy, with harshness being a perceptual parameter evident in these cases. The GRBASH scale maintains the remaining parameters originally proposed by the GRBAS scale.

Photogrammetry

The photogrammetry was assessed by following the recommendations of the postural evaluation software (SAPO). A plumb line (Rubi) attached to the ceiling was used, with two strips of neuromuscular bands (Sportex) spaced 50 cm from each other, glued on the wire for later calibration of the image. The participant was positioned in such a way that the plumb line would lie in the same plane perpendicular to the axis of the digital camera (CANON -S40, with a resolution of 4.1 megapixels, 3.0 x zoom)[32,48,49] that was placed on a support camera tripod (Cullmann primax 350) leveled to 1 meter from the ground, and the participant was at a distance of 3 meters, so as to allow their correct visualization from head to toe.[32,48,49]

In a first phase, the points were marked, using the surface anatomy and palpation, according to the SAPO protocol. The following points were referenced with orange colored stickers[49]:

Anterior view: Tragus of the right ear[2] and tragus of the left ear[3]; right acromion[5] and left acromion[6]; right anterosuperior iliac spine[12] and left iliac spine[13]; greater trochanter of the right[14] and left[15] femur; joint line of right[16] and left knee[19]; medial point of the right[17] and left[20] kneecap; tuberosity of the right[18] and left[21] tibia; right[22] and left[25] lateral malleolus and right[23] and left[26] medial malleolus.

Side view: Ear tragus[2]; acromion[5]; spinous process C7[8]; anterosuperior iliac spine[21]; posterior superior iliac spine[22]; greater trochanter of the femur[23]; medial articular line of the knee[24]; lateral malleolus[30]; and the point between the head of the second and third metatarsals.[31]

Subsequently, the participants were instructed to stand in orthostatic position on the green card (Staples). Four photographs were taken for each participant: anterior view, right lateral view, left lateral view and posterior view, after the anatomical points marking[32,48,49] In an attempt to minimize the error, the photographs were carried out by the same investigator.[49]

Muscle tension assessment through palpation

For muscle tension through palpation, the Lieberman method, which consists of a graduation system of four muscle groups surrounding the larynx,[50] was used. Graduation varies from 0 to 3, with 0 indicating normal tonus, 1 for mild muscle tension, 2 for moderate tension and 3 for severe muscular tension.[12] The palpated muscle groups were the suprahyoids, thyrohyoids, cricothyroid and pharyngolaryngeal muscles. The evaluation was performed with the participants lying in the supine position.

Algometry

In algometry, the pressure pain threshold was evaluated using an algometer (Wagner Fdix, USA) at the same points of the muscle tension assessment through palpation and in the same position. Trapezius, diaphragm, suboccipital muscles[51] and scalenes were also assessed in algometry, in supine position.[52] The average of 3 measurements was collected. Participants were instructed to say "yes" when the pressure became uncomfortable in each assessment, averaging three measurements.[51]

Intervention

After the baseline assessment, the participants received the treatment according to the group to which they belong. The participants of the G2 kept resting for 20 minutes on a massage table (Posturarte Olympic), in supine, without inclination; during that period their breathing was controlled by a digital metronome - an Android smartphone application (Metronome Beats 4.5.0) to maintain 15 cycles per minute (2: 2).[53]

At G1, participants received MFR treatment in four distinct body areas according to the procedures described by Pilat (2003)[14]:

Diaphragm - participants remained seated while the therapist stood behind the patient and leaned against the patient with a cushion between them. The patient should be relaxed and slightly flexed in order to relax the abdominals while the therapist placed both hands under the rib cage, lateral to the xiphoid process of the sternum. The therapist then performed a slide from the center outward using the pulp of the fingers. At the end of the movement, the patient breathed deeply and took a more upright position. Three replicates were performed.

Induction of the suprahyoid and infrahyoid fascia

Infrahyoid fascia - with the patient in the supine position, the therapist crossed the hands, one on the upper part of the thorax and other above the clavicle and below the hyoid bone, holding it between the thumb and indicator. The first hand exerted a gentle caudal traction and the second performed a cephalic traction. The pressure was three-dimensional and was applied for 3 to 5 minutes, until release occurred.

Supra-hyoid fascia - The therapist placed the lower hand below the hyoid bone, holding it between the thumb and forefinger. The index, middle and ring fingertips of the upper hand were placed in the inframandibular area. The lower hand exerted caudal traction and superior cephalic traction. The pressure was gentle and applied for 3 to 5 minutes until liberation was achieved.

Oblique elongation of the cervical fascia - With the patient in the supine position, the therapist supported the patient's head with one hand in a position of flexion, inclination and external rotation. The second hand was placed firmly on the patient's shoulder, making a caudal pressure.

Suboccipital induction - With the patient lying in the supine position, the therapist placed the hands together (palm of the hand facing the patient's head and with flexion of the fingers in order to press with the index, middle and annular fingers of each hand over the base of the skull) under the patient's head. This pressure was maintained (without reducing pressure and causing pain to the patient) for a few minutes until fascia release.

Depending on the direction and degree of restriction, the release movement may occur in either direction. The therapist was aware of changes in the location, direction, range and speed of movements.

The intervention was performed by a professional specialized in physiotherapy and osteopathy with seven years of experience. After the intervention, all participants were assessed again in the same way and with the same baseline parameters.

Statistical analyses

The data was analyzed with IBM SPSS Statistics 25. The Shapiro-Wilks test was used for assessment of normality and the Levene's test for the homogeneity of variance. The independent Student's t-test was applied to characterize the sample. As both normality and variance homogeneity of variances were not secured for all variables, therefore non-parametric tests were used. For intragroup comparison were used Friedman test and Wilcoxon's T-test while to intergroup comparison MannWhitney's *U*-test was used. The Intraclass Correlation Coefficients was applied to evaluate the inter-rater reliability between the three raters of auditory-perceptual analysis of voice through GRBASH scale and the intra-rater reliability in photogrammetry. A *P* value equal or lower than 0.05 was considered significant.

RESULTS

The biometric characteristics of the sample variables are summarized in Table 1, for both groups. No difference was found between both study groups considering age, weight, height, and body mass index.

At baseline there were no statistically significant differences for the aerodynamic voice assessment, acoustic and auditory-perceptual analysis of voice, photogrammetry, muscle tension through palpation and algometry, with p values above 0.05 meaning there was homogeneity between the groups at T0.

For the aerodynamic assessment of voice statistically significant differences were found when intervention was applied in both groups for MPT (G1 $P = 0.019$; G2 $P = 0.004$). In a group by group analysis in the different moments were not found significant differences between groups at any moment. The acoustic analysis of voice parameters did not differ (Table 2).

Concerning the auditory-perceptual analysis of voice statistically significant differences were found when intervention was applied in both groups for Grade in G2 ($P = 0.046$) and for Roughness in G1 ($P = 0.025$). In a group by group

TABLE 1.
Comparison Between the Groups in Terms of Biometric Characteristics

Variables	Group 1	Group 2	*P* Between Groups
n	12	12	
Gender (F)	9	9	
Age (years)	42.50 ± 10.08	38.67 ± 8.01	0.314
Weight (kg)	67.42 ± 13.81	69.08 ± 12.50	0.760
Height (cm)	164.50 ± 7.63	165.83 ± 7.98	0.680
Body mass index (kg/m^2)	24.81 ± 4.24	25.04 ± 3.66	0.888

TABLE 2.

Differences Within and Between the Groups in the Different Moments in Aerodynamic, Acoustic and Auditory-Perceptual Analysis of Voice

	Variables		T0		T1		$P^{\#}$	T2		T3		$P^{\#}$
			Median	Interquartile Range	Median	Interquartile Range		Median	Interquartile Range	Median	Interquartile Range	
Aerodynamic assessment	MPT (s)	G1	16.40	5.65	17.22	5.20	0.019*	16.40	5.48	16.56	5.42	1.000
		G2	15.25	8.20	15.13	8.00	0.937	15.24	8.25	16.84	7.74	0.004*
	$P^{\dagger}$		$P < 0.488$		$P < 0.204$			$P < 0.564$		$P < 0.854$		
Acoustic assessment	F_0 (Hz)	G1	188.86	72.94	189.69	72.75	0.239	188.68	72.62	191.09	73.83	0.060
		G2	178.84	81.07	179.29	82.33	0.158	177.74	79.25	179.44	81.85	0.308
	$P^{\dagger}$		$P < 0.686$		$P < 0.686$			$P < 0.603$		$P < 0.686$		
	F_0SD (Hz)	G1	1.57	0.69	1.57	0.75	0.480	1.58	0.65	1.59	0.71	0.814
		G2	1.41	0.85	1.40	0.89	0.272	1.39	0.85	1.36	0.89	0.875
	$P^{\dagger}$		$P < 0.686$		$P < 0.453$			$P < 0.488$		$P < 0.488$		
	Jitter (%)	G1	0.33	0.10	0.32	0.09	0.189	0.33	0.10	0.33	0.10	0.222
		G2	0.39	0.21	0.39	0.21	0.388	0.39	0.20	0.39	0.20	0.356
	$P^{\dagger}$		$P < 0.419$		$P < 0.166$			$P < 0.341$		$P < 0.644$		
	Shimmer (%)	G1	2.66	0.81	2.64	0.81	0.152	2.64	0.80	2.70	0.78	0.327
		G2	3.28	1.60	3.31	1.60	0.195	3.27	1.52	3.26	1.50	0.273
	$P^{\dagger}$		$P < 0.184$		$P < 0.119$			$P < 0.184$		$P < 0.248$		
	HNR (dB)	G1	22.12	2.55	22.17	2.57	0.146	22.07	2.47	22.12	2.65	0.388
		G2	21.52	3.01	21.50	3.06	0.346	21.51	3.01	21.52	3.02	0.282
	$P^{\dagger}$		$P < 0.862$		$P < 0.149$			$P < 0.862$		$P < 0.624$		
Auditory-perceptual assessment	Grade	G1	0.50	1.00	0.00	1.00	0.157	0.50	1.00	1.00	1.00	0.317
		G2	1.00	1.75	1.00	1.75	1.000	1.00	1.75	1.00	1.00	0.046*
	$P^{\dagger}$		$P < 0.342$		$P < 0.122$			$P < 0.183$		$P < 1.000$		
	Roughness	G1	1.00	0.00	1.00	1.00	0.025*	1.00	0.00	1.00	0.75	0.317
		G2	1.00	1.00	1.00	1.75	0.317	1.00	1.75	1.00	1.00	0.102
	$P^{\dagger}$		$P < 0.558$		$P < 0.294$			$P < 0.799$		$P < 0.350$		
	Breathiness	G1	0.00	0.75	0.00	0.75	1.000	0.00	0.75	0.00	0.75	1.000
		G2	0.00	0.00	0.00	0.75	0.317	0.00	0.75	0.00	0.00	0.317
	$P^{\dagger}$		$P < 0.623$		$P < 1.000$			$P < 1.000$		$P < 0.623$		
	Astheny	G1	0.00	0.00	0.00	0.00	1.000	0.00	0.00	0.00	0.00	1.000
		G2	0.00	0.75	0.00	0.75	1.000	0.00	0.75	0.00	0.75	0.317
	$P^{\dagger}$		$P < 0.623$		$P < 0.623$			$P < 0.568$		$P < 0.623$		
	Strain	G1	0.00	1.00	0.00	0.75	0.317	0.00	1.00	0.00	0.00	0.083
		G2	0.00	0.00	0.00	0.00	0.317	0.00	0.75	0.00	0.00	0.317
	$P^{\dagger}$		$P < 0.356$		$P < 0.284$			$P < 0.660$		$P < 0.546$		
	Harshness	G1	0.00	0.00	0.00	0.00	1.000	0.00	0.00	0.00	0.75	0.317
		G2	0.00	0.75	0.00	0.75	1.000	0.00	0.00	0.00	0.75	0.317
	$P^{\dagger}$		$P < 0.623$		$P < 0.623$			$P < 1.000$		$P < 1.000$		

* Significant values ($P \leq 0.05$);

\# For intragroup significance - Wilcoxon test;

† For post-intervention inter-group significance – Mann-Whitney *U*-testAbbreviations: F_0, fundamental frequency; F_0SD, fundamental frequency standard deviation; HNR, Harmonic-to-Noise Ratio; MPT, maximum phonation time.

analysis in the different moments were not found significant differences between groups at any moment. Reliability analysis was carried out on the three raters of auditory-perceptual analysis of voice through the GRBASH scale. The Intraclass Correlation Coefficients was superior than 0.92 in all GRBASH subscales.

For the photogrammetry assessment statistically significant differences were found when intervention was applied in both groups for vertical alignment of the head with the acromion in G2 (P = 0.046), horizontal alignment of the pelvis in G1 (P = 0.028), left vertical alignment of the head with the acromion (G1 P = 0.036; G2 P = 0.046), left horizontal alignment of the pelvis in G1 (P = 0.017) and horizontal asymmetry of the scapula in relation to T3 in G1 (P = 0 049). When participants belonged to control, there were not significant differences (Table 3). The Intraclass Correlation Coefficients was superior than 0,86 in all photogrammetry variables.

In a group by group analysis in the different moments significant differences were not found between groups at any moment, with exception of horizontal alignment of the head and vertical alignment of the head with the acromion in T1, respectively (P < 0.040; P < 0 021) and left vertical alignment of the head with the acromion in T3 (P < 0.015).

About the muscle tension assessment through palpation were found statistically significant differences when intervention was applied in both groups for suprahyoids (G1 P = 0.046; G2 P = 0.008), thyrohyoids in G2 (P = 0.002), cricothyroids (G1 P = 0.046; G2 P = 0.046) and pharyngolaryngeal muscles (G1 P = 0.025; G2 P = 0.046). When participants belonged to control, there were not significant differences (Table 4).

In a group by group analysis in the different moments significant differences were not found between groups at any moment, with exception of suprahyoids and thyrohyoids in T1 (P < 0.015 in both).

For the algometry assessment were found statistically significant differences when intervention was applied in both groups for all muscles. When participants belonged to control, there were not significant differences (Table 5).

In a group by group analysis in the different moments significant differences were found between groups in T1 in all muscles, with exception of the right diaphragm point.

DISCUSSION

Voice disorders are a common problem that occurs more frequently in teachers than in other professionals that use the voice frequently.[13,54,55] In a systematic review[10] teachers were the most prevalent professionals in the included studies, with the predominance of female participants (225 out of 286 participants). The sample of this study corroborates the systematic review and the international literature, as the female gender is predominant in the teaching profession and has a higher prevalence of voice disorders, due to the demand of the profession.[56-58]

Individuals with functional or organofunctional dysphonia may have an increase in muscle tension in cervical and perilaryngeal muscles,[59,60] muscle pain at rest or during function,[12,60] reduced range of motion in cervical spine,[12,60] hyperactivity of extrinsic laryngeal muscles,[12] and postural changes.[60] Because of that, it is important to find therapeutic alternatives for the patients, such as MFR. The purpose of this study was to verify the effects of MFR in teachers' posture, muscular tension and voice quality.

In this investigation, the MFR showed a statistically significant improvement in MPT, which is an objective aerodynamic parameter that indicates voice efficiency. No differences were found among the acoustic parameters. Analogue results were found in the study of Marszałek et al. (2012),[40] where statistically significant post-therapy improvement was observed in the phoniatric examination, including Voice Handicap Index scores, MPT results and parameters of videostroboscopic examination. In this investigation, when the intervention was performed, the MPT median of G1 improved from 16.40s to 17.22s (P = 0.019), while in G2 MPT improved from 15.24s to 16.84s (P = 0.004). Marszałek et al (2012)[40] found a bigger improvement on average by 3.7s for MPT. Although no studies were found to corroborate these results with MFR in the other voice assessment parameters, it is known that massage has some effects on voice, as demonstrated in the study of Aghadoost et al. (2019),[61] manual circumlaryngeal therapy (MCT) improved the Voice Handicap Index and Dysphonia Severity Index in teachers with muscle tension dysphonia. In another study, D'haeseleer, Claeys and Van Lierde (2013),[62] where 16 vocal performers received a single treatment approach of MCT for 20 min, whereas the control group (CG) was instructed to have complete vocal rest for 20 min. In the experimental group, a significant difference in Dysphonia Severity Index was found before and after MCT. No differences in Dysphonia Severity Index were found in the CG between the two measurements. In line with this study, in the MCT group, improvements in MPT, Jitter, Shimmer and HNR were found, but not significant. In this investigation, F_0 did not show differences intra or inter groups; however, in the investigation of Ternström, Andersson and Bergman (2000),[63] 31 amateur choir singers performed a 30 min massage. They found that massage improved F_0 and sound pressure level. In another paper, Kennard, Lieberman, Saaid and Rolfe (2015)[64] conducted a crossover randomized controlled trial where 12 asymptomatic singers received specific laryngeal manipulation (30 min) or postural manual therapy (30 min). Both groups showed a significant improvement of F_0 (P = 0.018; P = 0.0143, respectively). No differences were verified in glottal closing time. The study of Leppänen, Laukkanen, Ilomäki and Vilkman (2009)[65] was performed in 60 teachers that received a 3 hours long voice hygiene lecture (VHL). After that, they were divided into two groups: Voice Massage (VM) group (five times in 1 hour sessions; the first three sessions were performed at intervals of 1 week, while the last two sessions were conducted at intervals of 1 month) and a

TABLE 3.
Differences Within and Between the Groups in the Different Moments in Photogrammetry

Variables (°)		T0		T1		$P^{\#}$	T2		T3		$P^{\#}$
		Median	*Interquartile Range*	*Median*	*Interquartile Range*		*Median*	*Interquartile Range*	*Median*	*Interquartile Range*	
HAH	G1	1.23	3.10	1.17	1.51	0.715	1.33	3.10	1.32	3.10	0.655
	G2	2.13	2.27	2.10	2.25	0.678	2.15	2.29	1.80	1.64	0.225
$P^{\dagger}$		$P < 0.119$		$P < 0.040$*			$P < 0.126$		$P < 0.298$		
HAA	G1	1.24	3.02	1.16	1.60	0.686	1.32	2.99	1.31	2.31	0.344
	G2	2.09	1.66	2.08	1.64	0.416	2.17	1.57	1.88	0.90	0.345
$P^{\dagger}$		$P < 0.125$		$P < 0.099$			$P < 0.149$		$P < 0.272$		
HAASIS	G1	1.22	3.04	1.16	1.60	0.686	1.26	2.99	1.28	3.00	0.715
	G2	2.12	1.08	2.11	0.91	0.674	2.12	0.94	1.99	0.88	0.123
$P^{\dagger}$		$P < 0.223$		$P < 0.140$			$P < 0.272$		$P < 0.506$		
VAHA	G1	2.24	2.98	1.23	1.23	0.063	2.14	2.99	2.17	2.97	0.173
	G2	2.85	4.36	2.84	4.27	0.066	2.84	4.38	2.11	2.16	0.046*
$P^{\dagger}$		$P < 0.419$		$P < 0.021$*			$P < 0.355$		$P < 0.977$		
HAP	G1	-3.67	5.58	-3.11	5.40	0.028*	-3.67	5.39	-3.65	5.67	0.892
	G2	-1.84	-9.21	-1.73	-9.18	0.528	-1.94	-9.21	-1.67	-8.35	0.116
$P^{\dagger}$		$P < 0.603$		$P < 0.707$			$P < 0.603$		$P < 0.470$		
VAB	G1	1.17	2.31	1.10	1.52	0.686	1.18	2.33	1.17	2.31	0.197
	G2	1.34	1.74	1.29	1.72	0.500	1.39	1.73	1.28	1.68	0.893
$P^{\dagger}$		$P < 0.258$		$P < 0.247$			$P < 0.402$		$P < 0.338$		
Left VAHA	G1	2.14	2.98	1.23	3.03	0.036*	2.24	2.99	2.34	1.24	0.609
	G2	3.51	3.61	3.50	3.52	0.066	3.50	3.64	2.78	1.91	0.046*
$P^{\dagger}$		$P < 0.157$		$P < 0.236$			$P < 0.119$		$P < 0.015$*		
Left HAP	G1	-4.22	5.55	-3.89	5.40	0.017*	-4.23	5.39	-4.26	5.67	0.336
	G2	-3.97	9.21	-3.96	9.18	0.528	-3.94	9.22	-3.95	8.35	0.225
$P^{\dagger}$		$P < 0.840$		$P < 0.977$			$P < 0.862$		$P < 0.603$		
Left VAB	G1	1.23	2.71	1.11	1.66	0.753	1.25	2.72	1.24	2.71	0.285
	G2	1.34	1.69	1.28	1.70	0.786	1.39	1.71	1.23	1.48	0.176
$P^{\dagger}$		$P < 0.310$		$P < 0.259$			$P < 0.506$		$P < 0.877$		
HAST3	G1	-3.51	6.22	-2.61	5.28	0.049*	-3.50	5.97	-3.66	6.51	0.102
	G2	0.33	7.16	0.44	7.00	0.581	0.23	7.15	0.45	6.94	0.735
$P^{\dagger}$		$P < 0.248$		$P < 0.285$			$P < 0.260$		$P < 0.119$		

* Significant values ($P \leq 0.05$);
\# For intragroup significance - Wilcoxon test;
† For post-intervention inter-group significance – Mann-Whitney *U*-testAbbreviations: G, Group; HAA, horizontal alignment of acromion; HAASIS, horizontal alignment of anterior superior iliac spine; HAH, horizontal alignment of the head; HAP, horizontal alignment of the pelvis; HAST3, horizontal asymmetry of the scapula in relation to T3; VAB, vertical alignment of the body; VAHA, vertical alignment of the head with the acromion.

TABLE 4.
Differences within and Between the Groups in the Different Moments in Muscle Tension Through Palpation According to Lieberman Method

Muscles		T0		T1		$P^{\#}$	T2		T3		$P^{\#}$
		Median	*Interquartile Range*	*Median*	*Interquartile Range*		*Median*	*Interquartile Range*	*Median*	*Interquartile Range*	
Suprahyoids	G1	1.00	1.00	0.50	1.00	0.046*	1.00	1.00	1.00	1.00	0.317
	G2	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.00	0.008*
$P^{\dagger}$		$P < 0.172$		$P < 0.015$*			$P < 0.258$		$P < 0.527$		
Thyrohyoids	G1	1.00	1.75	1.00	1.00	0.059	1.00	1.75	1.00	1.75	1.000
	G2	1.50	1.00	1.50	1.00	1.000	1.50	1.00	1.00	1.00	0.008*
$P^{\dagger}$		$P < 0.272$		$P < 0.015$*			$P < 0.272$		$P < 0.592$		
Cricothyroids	G1	1.00	1.00	0.00	1.00	0.046*	1.00	0.75	1.00	1.00	0.157
	G2	0.50	0.50	0.00	1.00	0.317	1.00	0.00	0.00	0.75	0.046*
$P^{\dagger}$		$P < 0.724$		$P < 0.680$			$P < 0.292$		$P < 0.089$		
Pharyngolaryngeal	G1	1.00	0.75	0.00	1.00	0.025*	1.00	1.00	1.00	1.00	0.317
	G2	0.00	1.00	0.00	1.00	1.000	1.00	1.00	0.00	1.00	0.046*
$P^{\dagger}$		$P < 0.096$		$P < 0.889$			$P < 0.894$		$P < 0.229$		

* Significant values ($P \leq 0.05$);
\# For intragroup significance - Wilcoxon test;
† For post-intervention inter-group significance – Mann-Whitney *U*-testAbbreviations: G, Group

VHL group that received the previous 3 hours long VHL. Measurements were performed at the beginning and end of the autumn school term, before and after a working day. The mean F_0 (in reading samples) was higher and more difficult phonation was reported in the VHL group. Perceived pitch in loud reading increased in the VHL group and decreased in the VM group. In the VM group, the perceived firmness of loud reading decreased ($P = 0.026$). The results suggest that VM may help in sustaining vocal well-being during a school term.

Concerning the auditory-perceptual analysis of voice for the GRABASH scale, in this investigation statistically significant differences were found for Grade in G2 and Roughness in G1 both after the intervention. In another study,[26] 42 teachers were divided into two groups: perilaryngeal manual massage or vocal training. Participants performed eight sessions (30 min), once a week. The authors concluded that both groups had an improvement in vocal symptoms, no difference was verified in Vocal Activity and Participation Profile protocol between groups and perilaryngeal manual massage provided a slight improvement in teachers' global dysphonia level and reduced cervical tension, which was significantly reflected in the self-perceived pain score. In the same paper, concerning the GRBASI scale and before the vocal intervention, 80% of the subjects that performed perilaryngeal manual massage had light dysphonia, while only 5% had moderate dysphonia and 15% were non-dysphonic. After the intervention, the number of subjects with moderate dysphonia in this group remained the same, but the number of those with light dysphonia decreased to 70% and those with no dysphonia increased to 25%.

In this study MFR had an immediate effect on the posture, as it was confirmed in the results of the photogrammetry: improvement of vertical alignment of the head with the acromion in G2, horizontal alignment of the pelvis in G1, left vertical alignment of the head with the acromion in G1 and G2, left horizontal alignment of the pelvis in G1 and horizontal asymmetry of the scapula in relation to T3 in G1. When participants belonged to control, there were no significant differences. When the groups were compared in different moments, was verified that in T1, horizontal alignment of the head and vertical alignment of the head with the acromion got a significant improvement. The same results were found for the left vertical alignment of the head with the acromion in T3.

Regarding muscle tension assessment through palpation, MFR improved muscle tension in all four muscles when the intervention was applied. When the groups were compared, suprahyoids and thyrohyoids muscles in T1 improved muscle tension in a significant way. Concerning algometry assessment, MFR showed a statistically significant improvement in all muscles when pre and post-intervention were compared while in groups that belonged to control, they did not show any significant differences. In a group by group comparison, MFR significantly improved all muscles in T1, with the exception of right diaphragm point.

TABLE 5.
Differences Within and Between the Groups in the Different Moments in Algometry

Muscles (Kgf/m²)		T0		T1		$P^{\#}$	T2		T3		$P^{\#}$
		Median	*Interquartile Range*	*Median*	*Interquartile Range*		*Median*	*Interquartile Range*	*Median*	*Interquartile Range*	
Right SUB	G1	2.52	0.98	3.39	0.91	0.002*	2.55	0.91	2.56	0.90	0.395
	G2	2.27	1.60	2.29	1.57	0.141	2.26	1.50	2.99	1.78	0.002*
$P^{\dagger}$			$P < 0.225$		$P < 0.009$*			$P < 0.184$		$P < 0.564$	
Left SUB	G1	2.46	0.52	3.39	0.88	0.002*	2.58	0.92	2.70	0.95	0.933
	G2	2.24	1.60	2.26	1.55	0.132	2.26	1.43	3.23	1.77	0.002*
$P^{\dagger}$			$P < 0.525$		$P < 0.009$*			$P < 0.165$		$P < 0.326$	
Right TA	G1	2.52	0.98	3.39	0.78	0.002*	2.55	0.91	2.76	0.87	0.108
	G2	2.50	1.90	2.58	1.86	0.092	2.45	1.91	3.12	1.72	0.002*
$P^{\dagger}$			$P < 0.419$		$P < 0.019$*			$P < 0.371$		$P < 0.312$	
Left TA	G1	2.56	0.93	3.39	0.78	0.003*	2.53	0.89	2.58	0.85	0.128
	G2	2.27	1.53	2.39	1.44	0.753	2.45	1.24	2.99	1.56	0.003*
$P^{\dagger}$			$P < 0.356$		$P < 0.013$*			$P < 0.386$		$P < 0.470$	
Right DIAPH point	G1	2.52	1.14	3.39	1.28	0.003*	2.50	1.01	2.52	0.97	0.134
	G2	2.57	1.26	2.56	1.56	0.479	2.50	1.62	3.01	1.31	0.004*
$P^{\dagger}$			$P < 0.908$		$P < 0.065$			$P < 0.564$		$P < 0.225$	
Left DIAPH point	G1	2.54	1.13	3.40	0.98	0.002*	2.55	1.08	2.65	1.00	0.112
	G2	2.58	1.26	2.56	1.56	0.636	2.51	1.62	3.08	1.31	0.002*
$P^{\dagger}$			$P < 0.977$		$P < 0.038$*			$P < 0.525$		$P < 0.149$	
Right SCAL	G1	2.52	0.70	3.39	0.86	0.002*	2.56	0.75	2.51	0.76	0.397
	G2	2.50	2.02	2.54	1.80	0.135	2.45	1.96	3.12	1.72	0.002*
$P^{\dagger}$			$P < 0.507$		$P < 0.018$*			$P < 0.453$		$P < 0.106$	
Left SCAL	G1	2.58	0.70	3.21	0.87	0.005*	2.51	0.82	2.58	0.72	0.098
	G2	2.40	1.92	2.48	1.79	0.135	2.45	1.90	3.12	1.72	0.002*
$P^{\dagger}$			$P < 0.507$		$P < 0.018$*			$P < 0.386$		$P < 0.174$	
Right SUP	G1	2.49	0.87	3.29	0.95	0.002*	2.43	0.98	2.51	0.95	0.077
	G2	1.94	1.51	1.97	1.46	0.365	1.99	1.41	2.87	1.36	0.003*
$P^{\dagger}$			$P < 0.112$		$P < 0.001$*			$P < 0.083$		$P < 0.248$	
Left SUP	G1	2.53	0.87	3.29	0.95	0.002*	2.54	0.99	2.53	0.96	0.063
	G2	1.95	1.41	1.97	1.44	0.168	1.97	1.33	2.93	1.35	0.002*
$P^{\dagger}$			$P < 0.094$		$P < 0.001$*			$P < 0.080$		$P < 0.225$	
Right THY	G1	2.41	1.35	3.22	0.88	0.004*	2.43	1.49	2.42	1.27	0.093
	G2	1.74	1.24	1.73	1.19	0.085	1.77	1.19	2.83	1.36	0.003*
$P^{\dagger}$		$P < 0.069$			$P < 0.001$*			$P < 0.083$		$P < 0.119$	
Left THY	G1	242	1.35	3.22	0.88	0.006*	2.42	1.46	2.42	1.30	0.103
	G2	1.70	1.25	1.74	1.21	0.094	1.68	1.17	2.76	1.33	0.002*
$P^{\dagger}$			$P < 0.073$		$P < 0.001$*			$P < 0.078$		$P < 0.184$	
Right CRICO	G1	2.52	0.99	3.29	1.06	0.005*	2.53	0.98	2.57	0.95	0.183
	G2	1.94	1.50	1.97	1.45	0.156	1.97	1.43	2.93	1.28	0.004*
$P^{\dagger}$			$P < 0.106$		$P < 0.001$*			$P < 0.073$		$P < 0.248$	
Left CRICO	G1	2.51	1.01	3.28	1.04	0.002*	2.54	0.97	2.59	0.93	0.083
	G2	1.94	1.51	1.97	1.48	0.107	1.98	1.43	2.92	1.30	0.002*
$P^{\dagger}$			$P < 0.119$		$P < 0.001$*			$P < 0.060$		$P < 0.248$	
Right PHARY	G1	2.52	1.00	3.29	0.98	0.002*	2.54	1.01	2.53	0.86	0.109
	G2	1.94	1.34	1.97	1.40	0.181	1.97	1.29	2.93	1.31	0.003*
$P^{\dagger}$			$P < 0.126$		$P < 0.001$*			$P < 0.088$		$P < 0.260$	
Left PHARY	G1	2.52	0.97	3.29	0.95	0.002*	2.53	1.03	2.59	0.93	0.108
	G2	1.92	1.38	1.95	1.41	0.082	1.97	1.33	2.93	1.28	0.002*
$P^{\dagger}$			$P < 0.112$		$P < 0.001$*			$P < 0.069$		$P < 0.204$	

* Significant values ($P \leq 0.05$);
\# For intragroup significance - Wilcoxon test;
† For post-intervention inter-group significance – Mann-Whitney *U*-testAbbreviations: CRICO, cricothyroids; DIAPH, diaphragm; G, Group; PHARY, pharyngolaryngeal muscles; SCAL, scalenes; SUP, Supra-hyoids; SUB, suboccipital muscles; TA, trapezius; THY, thyrohyoids.

The MFR seems to be an interesting therapy to include in the rehabilitation of occupational dysphonia or in cases such as those of teachers where they have an increased risk of developing voice disorders, such as increased muscle tension. According to Kooijman et al. (2006),[66] excessive muscular tension is a sign of problems with voice in teachers. Angsuwarangsee and Morrison (2002)[12] verified that moving the chin forward increases the vocal effort and, consequently, increases the tension of muscles around the larynx during phonation. If this posture is not improved, it can lead to chronic overloading of "perilaryngeal muscles" during phonation and increased tension of the larynx. Rubin, Lieberman and Harris (2000)[67] also concluded that incorrectly arranged head, excessive lordosis or kyphosis and center of gravity displaced forwards or backwards would be pathologically compensated in the form of excessive tension at the neck level and the laryngeal area.

An investigation with similar results to this study was performed by Marszałek et al. (2012),[40] where the tension of the thyrohyoid muscle was not checked, but its function was investigated. This disorder was observed in the preliminary examination during glissando (in 37.5% of patients) and during yawning (in 27.5% of patients), while in the follow-up after the applied therapy a decrease in observed dysfunctions in 12.5 and 7.5% of patients, respectively, was noted. The authors found that voice therapy supplemented with MFR of the larynx resulted in a statistically significant decrease in tenderness of muscles raising the larynx (cricothyroid ligament, sternocleidomastoid muscles, and pharyngeal constrictor muscles) and in lowering the tonus (geniohyoid muscles, pharyngeal constrictor muscles and sternocleidomastoid muscles). A significant improvement was also observed in the case of dysfunction of the cricothyroid joint examined during glissando and yawning, as well as in asymmetry of the thyrohyoid apparatus. Moreover, the therapy resulted in significantly better normalization of the head position and better control of the center of gravity of the body.

Compensations tend to be asymmetrical and therefore generate discomfort, where the body remains under gravity action while it loses progressively the vertical alignment of its three-dimensional organization. In an attempt to avoid discomfort, new compensations are developed, progressively affecting the functionality of the whole organism, which can cause non-apparent retractions at the level of fascia and muscle. This is explained by the reciprocity between the systems, which remain connected by the connective tissue, being possible pathological implications on the health of the individual as a whole.[68] When performing MFR, regions of the body are released from retractions, increasing flexibility, and, on the other hand, other regions retract in favor of a structural and biomechanical reorganization favorable to the posture and the accomplishment of the functional activities.[68]

The effects of MRF may be due to the alpha motoneurons' afferent excitability reduction, which can be monitored with the Hoffman (H-) reflex. According to Behm and Wilke (2019),[69] the local effects of MRF may be explained by thixotropic effects on muscle or myofascial. The often observed global or non-local changes in pain provide strong evidence that mechanical alterations of a non-treated muscle or myofascia do not seem to be consistently present in healthy individuals and, thus, increased stretch tolerance effects on ROM due to activation of global pain modulatory responses such as Diffuse noxious inhibitory control and gate control theory as well as increased parasympathetic nervous system relaxation of muscle would be likely mechanisms.[69]

This research has the limitation of having a small sample and only investigates the immediate effects of the MFR.

We suggest further research with more similar assessment methods in order to better compare the studies and systematize knowledge about MFR in posture, muscle tension and voice. We also suggest longitudinal studies, investigations with larger samples and that relate gold standard measurements of voice, like aerodynamic, acoustic and auditory-perceptual assessments, with objective measurements of posture, like photogrammetry or imaging exams such as magnetic resonance imaging, as well as an evaluation of muscle tension through electromyography, algometry or muscle tension through palpation by validated scales. The posture assessment should be analyzed both in a fixed position and during a specific action or task. We suggest studies with two groups: (1) healthy individuals and individuals with voice disorders, and (2) using experienced blinded examiners. Samples with professionals who are frequently affected with voice disorders, like teachers and singers, are suggested as well as samples with more males. We suggest also studies that verify the long-term effects of MFR in posture, muscle tension and voice to understand how long do the muscle release, vocal benefits, and postural improvements of MFR last. These studies will may have different treatment frequencies per week (eg, once, twice or three) to know how often MFR treatments may be applied as well as how cost effective is MFR as a therapeutic tool.

CONCLUSION

The findings of this study indicate that MFR seems to be an effective therapy in improving MPT, but not in the acoustic parameters of voice. It was also found that MFR improved two subscales (Grade and Roughness) of the GRABASH scale, in two groups, but not in both.

About muscle tension through palpation and algometry, MFR improved the results in all muscles when the intervention was applied, but when the groups were compared, the differences between groups were only significant in some parameters. Concerning photogrammetry, MFR had an immediate effect in improving posture, especially related to the head.

The presented study confirms the necessity for the cooperation of the physiotherapist or osteopath with a phoniatrician and voice therapist in the treatment of voice disorders. This is in accordance with the current trend of a transdisciplinary approach to the therapy of these disorders. These observations will allow us to increase the effectiveness of rehabilitation of patients with occupational disorders of the voice organ.

REFERENCES

1. Roy N, Merrill RM, Thibeault S, et al. Prevalence of voice disorders in teachers and the general population. *J Speech Lang Hear Res*. 2004;47:281–293.
2. Simberg S, Laine A, Sala E, et al. Prevalence of voice disorders among future teachers. *J Voice*. 2000;14:231–235. https://doi.org/10.1016/S0892-1997(00)80030-2.
3. Da Costa V, Prada E, Roberts A, et al. Voice disorders in primary school teachers and barriers to care. *J Voice*. 2012;26:69–76. https://doi.org/10.1016/j.jvoice.2010.09.001.
4. de Medeiros AM, Assunção AÁ, Barreto SM. Absenteeism due to voice disorders in female teachers: a public health problem. *Int Arch Occup Environ Health*. 2012;85:853–864. https://doi.org/10.1007/s00420-011-0729-1.
5. Lauriello M, Angelone AM, Businco DLR, et al. Correlation between female sex and allergy was significant in patients presenting with dysphonia. *Acta Otorhinolaryngol Ital*. 2011;31:161.
6. Roy N, Bless DM. Personality traits and psychological factors in voice pathology: a foundation for future research. *J Speech Lang Hear Res*. 2000;43:737–748.
7. Chan RWK. Does the voice improve with vocal hygiene education? A study of some instrumental voice measures in a group of kindergarten teachers. *J Voice*. 1994;8:279–291. https://doi.org/10.1016/S0892-1997(05)80300-5.
8. Smith E, Gray SD, Dove H. Frequency and effects of teachers' voice problems. *J Voice*. 1997;11:81–87. https://doi.org/10.1016/S0892-1997(97)80027-6.
9. Cardoso R, Lumini-Oliveira J, Meneses RF. Associations between posture, voice, and dysphonia: a systematic review. *J Voice*. 2019;33:124e1–12412. https://doi.org/10.1016/j.jvoice.2017.08.030.
10. Van Houtte E, Van Lierde K, Claeys S. Pathophysiology and treatment of muscle tension dysphonia: a review of the current knowledge. *J Voice*. 2011;25:202–207. https://doi.org/10.1016/j.jvoice.2009.10.009.
11. Angsuwarangsee T, Morrison M. Extrinsic laryngeal muscular tension in patients with voice disorders. *J Voice*. 2002;16:333–343. https://doi.org/10.1016/S0892-1997(02)00105-4.
12. Kooijman PG, De Jong FICRS, Oudes MJ, et al. Muscular tension and body posture in relation to voice handicap and voice quality in teachers with persistent voice complaints. *Folia Phoniatr Logop*. 2005;57:134–147. https://doi.org/10.1159/000084134.
13. Pilat A. *Terapias Miofasciales: Inducción Miofascial*. McGraw-Hill Interamericana de España; 2003.
14. Schleip R, Duerselen L, Vleeming A, et al. Strain hardening of fascia: static stretching of dense fibrous connective tissues can induce a temporary stiffness increase accompanied by enhanced matrix hydration. *J Bodywork Mov Ther*. 2012;16:94–100. https://doi.org/10.1016/j.jbmt.2011.09.003.
15. Stecco C, Pirri C, Fede C, et al. Dermatome and fasciatome. *Clin Anat*. 2019;32:896–902. https://doi.org/10.1002/ca.23408.
16. Ajimsha MS, Al-Mudahka NR, Al-Madzhar JA. Effectiveness of myofascial release: systematic review of randomized controlled trials. *J Bodywork Mov Ther*. 2015;19:102–112. https://doi.org/10.1016/j.jbmt.2014.06.001.
17. Ajimsha MS, Shenoy PD. Improving the quality of myofascial release research−A critical appraisal of systematic reviews. *J Bodywork Mov Ther*. 2019;23:561–567. https://doi.org/10.1016/j.jbmt.2019.03.011.
18. Laimi K, Mäkilä A, Bärlund E, et al. Effectiveness of myofascial release in treatment of chronic musculoskeletal pain: a systematic review. *Clin Rehabil*. 2018;32:440–450. https://doi.org/10.1177/0269215517732820.
19. Simmonds N, Miller P, Gemmell H. A theoretical framework for the role of fascia in manual therapy. *J Bodywork Mov Ther*. 2012;16:83–93. https://doi.org/10.1016/j.jbmt.2010.08.001.
20. Ajimsha MS, Daniel B, Chithra S. Effectiveness of myofascial release in the management of chronic low back pain in nursing professionals. *J Bodywork Mov Ther*. 2014;18:273–281. https://doi.org/10.1016/j.jbmt.2013.05.007.
21. Saratchandran R, Desai S. Myofascial release as an adjunct to conventional occupational therapy in mechanical low back pain. *Indian J Occup Ther*. 2013;45:3–7.
22. Day JA, Copetti L, Rucli G. From clinical experience to a model for the human fascial system. *J Bodywork Mov Ther*. 2012;16:372–380. https://doi.org/10.1016/j.jbmt.2012.01.003.
23. Day JA, Stecco C, Stecco A. Application of fascial manipulation© technique in chronic shoulder pain—Anatomical basis and clinical implications. *J Bodywork Mov Ther*. 2009;13:128–135. https://doi.org/10.1016/j.jbmt.2008.04.044.
24. Hou CR, Tsai LC, Cheng KF, et al. Immediate effects of various physical therapeutic modalities on cervical myofascial pain and trigger-point sensitivity. *Archives of physical medicine and rehabilitation*. 2002; 83:1406-1414. doi: 10.1053/apmr.2002.34834.
25. McKenney K, Elder AS, Elder C, et al. Myofascial release as a treatment for orthopaedic conditions: a systematic review. *J Athletic tTaining*. 2013;48:522–527. https://doi.org/10.4085/1062-6050-48.3.17.
26. Anhaia TC, Klahr PDS, Ourique AAB, et al. Effects of two interventions in teachers with voice complaints. *Audiology-Communication Research*. 2014;9:186–193. https://doi.org/10.1590/S2317-64312014000200014.
27. Fachinatto APA, de Campos Duprat A, Silva MA, et al. Effect of spinal manipulative therapy on the singing voice. *J Voice*. 2015;29:645–e33. https://doi.org/10.1016/j.jvoice.2014.10.005.
28. Na Y, Joo HS, Yang H, et al. Smartphone-based hearing screening in noisy environments. *Sensors*. 2014;14:10346–10360. https://doi.org/10.3390/s140610346.
29. Remacle M, Eckel HE. *Surgery of Larynx and Trachea*. Berlin: Springer; 2010:12.. (Eds.).
30. Behlau M. *Voz: o livro do especialista*. 2001;1:139–147.
31. Cardoso R, Meneses RF, Lumini-Oliveira J, et al. Associations between teachers' autonomic dysfunction and voice complaints. *J Voice*. 2020. https://doi.org/10.1016/j.jvoice.2020.03.013.
32. Carneiro PR, Teles LCDS. Influência de alterações posturais, acompanhadas por fotogrametria computadorizada, na produção da voz. *Fisioterapia em Movimento*. 2012;25:13–20. https://doi.org/10.1590/S0103-51502012000100002.
33. Teixeira LC, Behlau M. Comparison between vocal function exercises and voice amplification. *J Voice*. 2015;29:718–726. https://doi.org/10.1016/j.jvoice.2014.12.012.
34. Cardoso R, Meneses RF, Lumini-Oliveira J, et al. Associations between teachers' posture, muscle tension and voice complaints. *J Voice*. 2020. https://doi.org/10.1016/j.jvoice.2020.02.011.
35. Camargo ZA, Madureira S. Dimensões perceptivas das alterações de qualidade vocal e suas correlações aos planos da acústica e da fisiologia. *DELTA: Documentação e Estudos em Linguística Teórica e Aplicada*. 2009;25:285–317. https://doi.org/10.1590/S0102-44502009000200004.
36. Choi SH, Lee J, Sprecher AJ, et al. The effect of segment selection on acoustic analysis. *J Voice*. 2012;26:1–7. https://doi.org/10.1016/j.jvoice.2010.10.009.
37. Uloza V, Verikas A, Bacauskiene M, et al. Categorizing normal and pathological voices: automated and perceptual categorization. *J Voice*. 2011;25:700–708. https://doi.org/10.1016/j.jvoice.2010.04.009.
38. Watts CR, Diviney SS, Hamilton A, et al. The effect of stretch-and-flow voice therapy on measures of vocal function and handicap. *J Voice*. 2015;29:191–199. https://doi.org/10.1016/j.jvoice.2014.05.008.
39. Guimarães I. *A ciência e a arte da voz humana*. Alcoitão: Escola Superior de Saúde do Alcoitão; 2007.
40. Marszałek S, Niebudek-Bogusz E, Woźnicka E, et al. Assessment of the influence of osteopathic myofascial techniques on normalization of the vocal tract functions in patients with occupational dysphonia. *Int J Occup Med Environ Health*. 2012;25:225–235. https://doi.org/10.2478/S13382-012-0041-7.
41. Zielińska-Bliźniewska H, Pietkiewicz P, Miłoński J, et al. Acoustic and capacity analysis of voice academic teachers with diagnosed

hyperfunctional dysphonia by using diagno scope specialist software. *Otolaryngol Pol*. 2013;67:144–148. https://doi.org/10.1016/j.otpol.2013.02.001.
42. Smits I, Ceuppens P, De Bodt MS. A comparative study of acoustic voice measurements by means of Dr. speech and computerized speech lab. *J Voice*. 2005;19:187–196. https://doi.org/10.1016/j.jvoice.2004.03.004.
43. Vogel AP, Morgan AT. Factors affecting the quality of sound recording for speech and voice analysis. *Int J Speech Lang Pathol*. 2009;11:431–437. https://doi.org/10.3109/17549500902822189.
44. Cho SW, Yin CS, Park YB, et al. Differences in self-rated, perceived, and acoustic voice qualities between high-and low-fatigue groups. *J Voice*. 2011;25:544–552. https://doi.org/10.1016/j.jvoice.2010.07.006.
45. Halawa WE, Freire ARF, Muñoz IV, et al. Assessment of effectiveness of acoustic analysis of voice for monitoring the evolution of vocal nodules after vocal treatment. *Eur Arch Otorhinolaryngol*. 2014;271:749–756. https://doi.org/10.1007/s00405-013-2685-8.
46. Santos MED. *GRBASH−Scale for Evaluating the Hoarse Voice*. Universidade Fernando Pessoa; 2013. (Master dissertation, [sn]).
47. Nemr K, Lehn C. Voz em câncer de cabeça e pescoço. In: Fernandes FDM, Mendes BCA, Navas ALPGP, eds. *Tratado de Fonoaudiologia*. 2ª Ed São Paulo: Editora Roca Ltda.; 2010:787–802.
48. Marques RM. Avaliação fisioterapêutica da postura natural da cabeça e pescoço em portadores de disfunções da articulação temporomandibular por meio da fotometria e radiografia *(Doctoral dissertation)*. Bauru: Faculdade de Odontologia da Universidade do Sagrado Coração, Brazil; 2003.
49. Santos ARRD. *Avaliação postural por biofotogrametria em crianças e adolescentes num agrupamento de escolas do concelho de Bragança*. Portugal: Instituto Politécnico de Bragança; 2014. (Doctoral dissertation).
50. Lieberman J. Principles and techniques of manual therapy: application in the management of dysphonia. *Voice clin Handbook*. 1998:91–138.
51. Wytrążek M, Huber J, Lipiec J, et al. Evaluation of palpation, pressure algometry, and electromyography for monitoring trigger points in young participants. *J Manipulative Physiol Ther*. 2015;38:232–243. https://doi.org/10.1016/j.jmpt.2014.12.005.
52. Tixa S. *Atlas De Anatomía Palpatoria Tomo 1. Cuello, Tronco Y Extremidad Superior*. Elsevier Masson; 2006.
53. Pomeranz B, Macaulay R, Caudill MA, et al. Assessment of autonomic function in humans by heart rate spectral analysis. *Am J Physiol Heart Circ Physiol*. 1985;248:H151–H153.
54. Sala E, Laine A, Simberg S, et al. The prevalence of voice disorders among day care center teachers compared with nurses: a questionnaire and clinical study. *J Voice*. 2001;15:413–423. https://doi.org/10.1016/S0892-1997(01)00042-X.
55. Sliwinska-Kowalska M, Niebudek-Bogusz E, Fiszer M, et al. The prevalence and risk factors for occupational voice disorders in teachers. *Folia Phoniatr Logop*. 2006;58:85–101. https://doi.org/10.1159/000089610.
56. Behlau M, Zambon F, Guerrieri AC, et al. Epidemiology of voice disorders in teachers and nonteachers in Brazil: prevalence and adverse effects. *J Voice*. 2012;26:665–6e9. https://doi.org/10.1016/j.jvoice.2011.09.010.
57. Bovo R, Galceran M, Petruccelli J, et al. Vocal problems among teachers: evaluation of a preventive voice program. *J Voice*. 2007;21:705–722. https://doi.org/10.1016/j.jvoice.2006.07.002.
58. Munier C, Kinsella R. The prevalence and impact of voice problems in primary school teachers. *Occup Med*. 2008;58:74–76. https://doi.org/10.1093/occmed/kqm104.
59. Bigaton DR, Silvério KCA, dos Santos Berni KC, et al. Postura crânio-cervical em mulheres disfônicas Craniocervical posture in dysphonic women. *Revista da Sociedade Brasileira de Fonoaudiologia*. 2010;15:329–334. https://doi.org/10.1590/S1516-80342010000300004.
60. Menoncin LCM, Jurkiewicz AL, Silvério KCA, et al. Alterações musculares e esqueléticas cervicais em mulheres disfônicas. *Arquivos Internacionais de Otorrinolaringologia*. 2010;14:461–466. https://doi.org/10.1590/S1809-48722010000400014.
61. Aghadoost S, Jalaie S, Khatoonabadi AR, et al. A study of vocal facilitating techniques compared to manual circumlaryngeal therapy in teachers with muscle tension dysphonia. *J Voice*. 2019. https://doi.org/10.1016/j.jvoice.2019.06.002. In press.
62. D'haeseleer E, Claeys S, Van Lierde K. The effectiveness of manual circumlaryngeal therapy in future elite vocal performers: a pilot study. *Laryngoscope*. 2013;123:1937–1941. https://doi.org/10.1002/lary.24050.
63. Ternström S, Andersson M, Bergman U. An effect of body massage on voice loudness and phonation frequency in reading. *Logoped Phoniatr Vocol*. 2000;25:146–150. https://doi.org/10.1080/140154300750067520.
64. Kennard EJ, Lieberman J, Saaid A, et al. A preliminary comparison of laryngeal manipulation and postural treatment on voice quality in a prospective randomized crossover study. *J Voice*. 2015;29:751–754. https://doi.org/10.1016/j.jvoice.2014.09.026.
65. Leppänen K, Laukkanen AM, Ilomäki I, et al. A comparison of the effects of voice massage™ and voice hygiene lecture on self-reported vocal well-being and acoustic and perceptual speech parameters in female teachers. *Folia Phoniatr Logop*. 2009;61:227–238. https://doi.org/10.1159/000228000.
66. Kooijman PG, De Jong FICRS, Thomas G, et al. Risk factors for voice problems in teachers. *Folia Phoniatr Logop*. 2006;58:159–174. https://doi.org/10.1159/000091730.
67. Rubin JS, Lieberman J, Harris TM. Laryngeal manipulation. *Otolaryngol Clin North Am*. 2000;33:1017–1034. https://doi.org/10.1016/S0030-6665(05)70261-9.
68. Rêgo EM, Martin MM, Filho AID, et al. Efeitos da liberação miofascial sobre a flexibilidade de um paciente com distrofia miotônica de steinert. *Revista Neurociências*. 2012;20:404–409.
69. Behm DG, Wilke J. Do self-myofascial release devices release myofascia?. Rolling mechanisms: A narrative review *Sports Medicine*. 2019;49:1173–1181. https://doi.org/10.1007/s40279-019-01149-y.