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Vocal parameters, muscle palpation, self-perception of voice symptoms, pain, and vocal fatigue in women with muscle tension dysphonia

Parâmetros vocais, palpação muscular e autopercepção de sintomas vocais, dor e fadiga vocal em mulheres com disfonia por tensão muscular

Keywords

Voice
Voice Disorders
Dysphonia
Myalgia
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ABSTRACT

Purpose: To identify muscle tension dysphonia (MTD) signs and symptoms, as well as to analyze the results of vocal parameters, the physical clinical examination of muscle palpation, the self-perception of vocal symptoms, vocal pain, and fatigue of women with MTD and compare them with women with healthy voices. **Methods:** a cross-sectional study with 45 women (23 with MTD and 22 controls), similar median age between groups. The speech-language and otorhinolaryngological evaluation determined the diagnosis of MTD. All participants responded to the Voice Symptoms Scale (VoiSS), Vocal Fatigue Index (VFI), and Nordic Musculoskeletal Questionnaire (NMQ) protocols. They were also assessed by a palpatory evaluation of the perilaryngeal musculature, auditory-perceptual evaluation, and acoustic analysis of the voice fundamental frequency. The speech sample included sustained vowels "a", "i" and "e" and connected speech, recorded in a silent environment, and submitted to auditory-perceptual evaluation by three judges. In the acoustic analysis, the fundamental frequency and maximum phonation times were extracted. **Results:** The MTD group had worse results in VoiSS, VFI, and NMQ, in addition to greater resistance to palpation and a high vertical position of the larynx. The vocal parameters also showed greater deviation in the MTD group, except for the fundamental frequency. There was no relationship between vocal symptoms, fatigue, or pain with the general degree of dysphonia in the MTD group, indicating important symptoms in mild or moderate vocal deviations. **Conclusion:** women with MTD presented vocal symptoms, vocal fatigue, muscle pain, resistance to palpation and deviated vocal parameters when compared to vocally healthy women.

Descritores

Voz
Distúrbios Vocais
Disfonia
Mialgia
Fonoaudiologia

RESUMO

Objetivo: identificar sinais e sintomas de DTM, bem como analisar os resultados de parâmetros vocais, do exame clínico físico de palpação muscular, da autopercepção de sintomas vocais, dor e fadiga vocal de mulheres com DTM e comparar com mulheres vocalmente saudáveis. **Métodos:** estudo transversal com 45 mulheres (23 com DTM e 22 controles), mediana de idade similar entre os grupos. A avaliação fonoaudiológica e otorrinolaringológica determinaram o diagnóstico de DTM. Todas as participantes responderam aos protocolos Escala de Sintomas Vocais (ESV), Índice de Fadiga Vocal (IFV) e Questionário Nórdico de Sintomas Osteomusculares (QNSO). Elas também foram avaliadas pelo exame de palpação da musculatura perilaríngea, avaliação perceptivo-auditiva e análise acústica da voz da frequência fundamental. A amostra de fala incluiu vogais "a", "i" e "é" sustentadas e fala encadeada, gravada em ambiente silente, e submetida à avaliação perceptivo-auditiva por três juízes. Na análise acústica, a frequência fundamental e tempos máximos de fonação foram extraídos. **Resultados:** O grupo DTM apresentou piores resultados na ESV, na IFV e no QNSO, além de maior resistência à palpação e posição vertical de laringe alta. Os parâmetros vocais também apresentaram maior desvio na DTM, exceto para a frequência fundamental. Não houve relação entre sintomas vocais, fadiga ou dor com o grau geral da disfonia no grupo DTM, indicando sintomas importantes em desvios vocais leves ou moderados. **Conclusão:** mulheres com DTM apresentaram sintomas vocais, fadiga vocal, dor muscular, resistência à palpação e parâmetros vocais desviados quando comparadas às mulheres vocalmente saudáveis.

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INTRODUCTION

Muscle tension dysphonia (MTD) is an adverse condition, with excessive tension in the larynx's extrinsic and intrinsic muscles, which associated with several etiological factors, causes a vocal disorder of functional origin(1-3). It can be classified into primary MTD, a condition in which muscle activity presents a hyperfunction in the absence of organic changes, or secondary MTD, a condition of muscle hypercompensation to organic changes or glottic insufficiency(1).

The diagnosis of MTD is based on several resources, such as clinical history, patient's self-report, and physical examination, including methods of palpation at rest and during phonation, laryngoscopy, aerodynamic measures, and voice assessment(1,4-7). The cause-effect relationship between extrinsic muscle tension and voice disorders remains a challenge, but the evaluation of the musculature is considered essential in the diagnosis of these disorders(1).

The most common vocal characteristics in MTD include roughness, breathiness, tension, high fundamental frequency, phonatory effort, hard vocal attack, vocal fatigue, in addition to deviated acoustic parameters(2,4,8-10). MTD seems to be related to muscle pain, especially in regions close to the larynx, which can negatively influence the subject's quality of life(8,11-14).

Vocal fatigue, widely reported in MTD cases(14-16), consists of the self-perception of negative sensations associated with vocal production, such as tiredness, vocal restriction, physical discomfort, in addition to recovery after vocal rest(16). Since these are factors measured by the patients' self-perception, it is understood that protocols with self-report measures, such as the Vocal Fatigue Index(15,16), the Voice Symptoms Scale(17), and pain self-perception protocols, such as the Nordic Musculoskeletal Questionnaire(18), are fundamental in the evaluation of people with MTD, due to the relationship between these symptoms and dysphonia.

Several therapeutic approaches have been described with positive results in the vocal behavior of these patients(4,7,8,13,19,20). However, future research is still necessary for further clarification on clinical speech therapy and otorhinolaryngological assessment, patient self-perception instruments, and criteria for differential diagnosis and therapeutic intervention(8,21), since the literature presents little evidence to compare the results. Results of various instruments routinely used in the MTD vocal clinic compared to results of vocally healthy women.

In this sense, the objective of this study was to identify signs and symptoms of MTD in women, as well as to analyze the results of vocal parameters, the physical clinical examination of muscle palpation, the self-perception of vocal symptoms, pain, and vocal fatigue of women with MTD and to compare with vocally healthy women.

METHODS

This is a cross-sectional study composed of a control group and a convenience sample, which evaluated women with dysphonia due to muscle tension compared to vocally healthy women. The study was carried out in an outpatient voice clinic, belonging to the Otorhinolaryngology Service of the Irmandade Santa Casa de Misericórdia de Porto Alegre hospital.

The period for recruiting patients and collecting data for the study was between 2018 and 2019. The criteria and procedures for inclusion in the MTD group were: being aged between 18 and 55 years old, being female, and complaining of dysphonia. In a second step, these patients were referred for otorhinolaryngological evaluation (laryngological examination to verify the laryngeal image) and speech-language evaluation (interview on clinical and occupational data, auditory-perceptual analysis(22), and acoustic analysis, as well as physical clinical examination with perilaryngeal muscle palpation(4)). These evaluations were carried out in separate moments, with the conclusion of the case defined by consensus. In the presence of dysphonia voice evaluation and muscular resistance to palpation, normal or altered laryngological exam, the diagnosis of dysphonia due to muscle tension was determined for inclusion in the study. In case of doubt, the case was discussed and the diagnosis was confirmed by consensus. Patients who met the described criteria were recruited by phone for inclusion in the present study. Subjects with neurological disease or who had previously undergone speech therapy were excluded. The control subjects were included for convenience, being invited by public call, or because they were known to researchers or patients. The selection of this group included the absence of self-reported vocal complaints and age matching with the subjects in the MTD group.

Forty-five participants (23 women with MTD and 22 controls) were included in this study. There was no statistically significant difference between the groups (MTD and control) concerning age ($p=0.914$) and professional use of the voice ($p=0.301$), indicating homogeneity for comparison. The median age was 44.0 (34.0 - 50.0) years in the MTD group and 43.0 (31.8 - 53.3) years in the control group. Regarding the professional use of the voice in the work environment, seven women (30.4%) used their voice professionally in the MTD group, while 11 (50%) used it in the control group. The laryngological characteristics identified in the MTD group were: absence of alteration (n=10), glottic gaps without associated lesion (n=7), vocal nodules + medial-posterior triangular gap (n=5), cyst + medial-posterior triangular gap (n=1). Of the seven patients with glottic gaps without an associated lesion, two had vestibular phonation associated with the longitudinal gap, one had only a longitudinal gap, four had an anteroposterior triangular gap.

All participants, belonging to the MTD or control group, responded to the self-assessment protocols regarding self-perception of vocal symptoms, vocal fatigue, and muscle pain. Then, they underwent a physical clinical examination with palpation of the perilaryngeal musculature and auditory-perceptual and acoustic evaluations of the fundamental frequency of the voice. In the control group, it was decided not to perform the invasive laryngological examination procedure since the subjects did not present complaints and vocal changes. All of these steps were carried out in the same meeting after filling out the informed consent and inclusion in the research. Then, the data were forwarded for statistical analysis.

Self-perception of vocal symptoms, vocal fatigue, and muscle pain

The following self-assessment protocols were used to measure symptoms: Vocal Symptoms Scale - VoiSS(17), translated and adapted version of the Vocal Fatigue Index (VFI) protocol(15), and Nordic Musculoskeletal Questionnaire - NMQ(11,18). Participants were instructed by the researcher on the protocols and answered the questions individually, without interference from the researcher.

The VoiSS is a validated questionnaire for Brazilian Portuguese with 30 questions divided into three domains: limitation, emotional and physical. Each question is scored from zero to four, according to the frequency of the symptom: never, rarely, sometimes, almost always, and always, with scores calculated by the simple sum of the points. A cut-off point of 16 points or more suggests dysphonia. The higher the scores in this protocol, the greater the perception of the general level of change in the voice(17).

VFI is a protocol translated and adapted into Brazilian Portuguese from the original Vocal Fatigue Index(16), which includes 19 questions in three domains: fatigue and vocal restriction, physical discomfort associated with the voice, and recovery with vocal rest. Each question is answered according to the frequency of occurrence of the symptoms, ranging from zero to four, according to the occurrence of the symptom: never, almost never, sometimes, almost always, and always. The purpose of this protocol is to identify a set of symptoms that signal vocal fatigue(15).

The NMQ is a questionnaire validated for Brazilian Portuguese that aims to identify and standardize the measurement of the reporting of musculoskeletal pain symptoms in different regions of the body(18). For the present study, we sought to use the procedures adopted by a previous study that used the questionnaire in dysphonic patients(11), measuring the intensity of pain with a 100mm analog scale, where the participant should mark a trace referring to the degree of pain. In this case, 0mm=no pain and 100mm=very intense pain, for each region or area of the body. The following areas were evaluated: upper back, back of the neck, lower back, elbows, wrists/hands/fingers, hips/thighs, knees, ankles/feet. Due to the relationship with MTD, the following regions or parts of the body were included: temporal region, masseter, front of the neck, submandibular and laryngeal region according to previous literature(11).

Physical clinical examination of muscle palpation

The evaluation of muscle palpation was performed using the *Laryngeal Manual Therapy Palpatory Evaluation protocol*(4), a non-validated test, but with wide clinical application in the speech therapy area. This protocol examines the resistance of the laryngeal muscles to palpation and also the vertical position of the larynx in the neck.

For the present study, this evaluation was carried out by a speech therapist, postgraduate in the voice area, with more than five years of experience in the application of the protocol and with clinical experience in the area of voice and laryngeal palpation. We opted for this measurement methodology similar to a previous study in the area(10). Resistance is assessed in four items (right and left sternocleidomastoid muscle, supralaryngeal area, laryngeal resistance to lateral pressure), each item ranging from 1 (minimum resistance) to 5 (maximum resistance), the lower the resistance, the greater mobility, and flexibility the structure presents.

The vertical position of the larynx is measured by palpation, being classified as 1 (high), 2 (neutral), 3 (low), and 4 (forcibly low). For the procedure, the evaluator positions the fingers from one hand horizontally on the subject's neck, with the lowest finger positioned at the level of the clavicles. The authors point out that the high position of the larynx usually allows the examiner to place three fingers between the region of the clavicles and the lower part of the cricoid cartilage; neutral position allows two fingers; low position, one finger; forcibly low position shows a completely compressed space. This evaluation fundamentally depends on the experience of the evaluator, as it presents an anatomical variation in relation to the evaluator's fingers and the configuration of the subject's neck. The results indicate greater tension in cases of the high or forcibly low position of the larynx. The larynx is expected to be in a neutral position(4).

Auditory- perceptual analysis of the voice

For the auditory-perceptual evaluation, the speech samples of the participants were considered, composed by the sustained emission of the vowels "a" and "i", in addition to the connected speech with the counting of numbers from 1 to 10, in usual frequency and intensity. Emissions were recorded on a Sony ICD-PX440 digital recorder, with a Karsect HT-9 headset microphone, located 5 cm from the subject's mouth, in an orthostatic position, and in a quiet environment. The samples were recorded similarly and transferred to a computer file, without the need for editing or equalization. The storage was done randomly for later analysis by the judges.

The auditory-perceptual assessment was performed by three judges, who analyzed the type of voice and the intensity of the deviation using the GRBAS scale(22), and the resonance characteristics. The GRBAS scale(22) is a Japanese scale, used internationally, to assess the global degree of dysphonia (G) by identifying the contribution of four independent factors, being roughness (R), breathiness (B), asthenia (A), tension (S), ranging from 0 to 3, where 0=normal / no deviation, 1=mild deviation, 2=moderate deviation, 3=intense deviation. Voice resonance was classified as: normal, laryngeal, pharyngeal, laryngopharyngeal, laryngopharyngeal with nasal compensation, hypernasal, or hyponasal.

The judges were speech therapists, voice specialists, with an average of 6.7 years of clinical experience in the area (minimum=5, maximum=9 years), and were blinded to the MTD and control groups. All received prior training with anchor voices for different types of voices and degrees of deviation. The analysis was performed in the same acoustic condition, in a quiet environment with the reproduction of voices in speakers, and each evaluator was at the same distance from the sound output. The three judges were in the same room, accompanied by a fourth independent researcher (responsible for monitoring the responses and for repeating the audio files). Each judge made the assessment individually. Only the samples in which there was an agreement between the judges regarding the G parameter were considered. We chose to present the results of the GRBAS scale parameters in a mode dispersion measure because this scale uses integers that correspond to the degrees of severity of dysphonia. Each voice record was repeated three times to complete the analysis.

For the reliability of the values obtained in the auditory-perceptual evaluation of the voices, the analysis of inter and intra-evaluator agreement was performed. For the analysis of the intra-rater agreement, 20% of the voices were repeated. The three judges had an internal agreement percentage of at least 82% in the six parameters evaluated, with no significant difference in the percentage of agreement between them (Cochran's test).

Acoustic analysis of the voice and maximum phonation times

For the acoustic analysis of the voice, the speech material was recorded in the same condition already mentioned, in a separate file, containing only the sustained vowel "e" and was edited by the program VoxMetria version 4.9 (CTS Informática). Then, this file was analyzed by the same program, eliminating the beginning and end of the emission to avoid instability and interference in the analysis.

We chose to analyze only the fundamental frequency parameter (F_0) as it is a robust parameter with greater extraction reliability in quiet environments, but without acoustic treatment. It is noteworthy that the F_0 is a reflection of the biodynamic characteristics of the vocal folds in the interaction with the subglottic pressure, with normality considered in a range of 150 to 250Hz for adult women[21,23].

The measurement of maximum phonation times included the maximum time to sustain the emission of the vowel "a" and the fricative phonemes voiceless and voiced "s" and "z". The women were instructed to sustain the sound as long as possible after an inspiration. The procedure was performed twice. This measurement was made utilizing a digital stopwatch and by a speech therapist specialized in voice, without blinding in relation to the MTD and control groups. It was decided to average the maximum time of the two emissions of each aforementioned sound. Values shorter than 10 seconds should be considered non-normal, with high significance for adult subjects[21].

Statistical analysis of the data

Statistical analysis was performed using SPSS version 18.0 (SPSS Inc., Chicago, IL). Descriptive statistics were presented through frequency and percentage. Normality was tested using the Shapiro-Wilk test. Variables with nonparametric distribution were presented as median, interquartile range, minimum and maximum. The Chi-square, Mann-Whitney, and Kruskal-Wallis tests were performed. The Cochran's Q test was used to analyze the agreement of the judges in the auditory-perceptual assessment of the voice. In all situations, the significance level of 5% was considered.

The Kappa coefficient of agreement between the three judges was 0.9389 for the general degree, 0.8186 for roughness, 0.5026 for breathiness, 0.6972 for tension, and 0.8913 for resonance characteristics. There was no variation for the asthenia parameter. The results showed good inter-rater agreement, with no significant difference in the percentage of agreement by the Cochran test.

Ethical aspects

The study was approved by the Research Ethics Committee of the institution of origin (CAAE: 86530718.7.0000.5345, number: 2.661.198). All participants agreed to participate in this study and signed the Free and Informed Consent Form.

RESULTS

Table 1 shows the values obtained in VoiSS, VFI, and NMQ in women with MTD and in those who are vocally healthy.

Table 1. Voice symptoms, vocal fatigue, and muscle pain between groups MTD and control

	MTD (n=23)			Control (n=22)			P-value
	Median	Min	Max	Median	Min	Max	
Voice Self-perception							
VoiSS total	54.0	33.0	87.0	10.5	1.0	24.0	<0.001
VFI total	47.0	20.0	66.0	2.5	0.0	31.0	<0.001
Muscle Pain self-perception							
Upper back	78.0	0.0	100.0	30.0	0.0	97.0	0.001
Posterior neck region	80.0	0.0	100.0	15.0	0.0	97.0	<0.001
Lower back	62.0	0.0	99.0	5.0	0.0	67.0	<0.001
Temporal region	55.0	0.0	100.0	0.0	0.0	86.0	<0.001
Masseter	0.0	0.0	98.0	0.0	0.0	30.0	0.004
Anterior neck region	40.0	0.0	97.0	0.0	0.0	0.0	<0.001
Submandibular region	13.0	0.0	99.0	0.0	0.0	12.0	0.001
Larynx	50.0	6.0	99.0	0.0	0.0	10.0	<0.001
Elbows	0.0	0.0	100.0	0.0	0.0	55.0	0.005
Wrists / hands / fingers	60.0	0.0	100.0	0.0	0.0	84.0	0.001
Hips / thighs	20.0	0.0	95.0	0.0	0.0	86.0	0.025
Knees	54.0	0.0	100.0	0.0	0.0	82.0	0.001
Ankles / feet	34.0	0.0	95.0	0.0	0.0	73.0	0.001

Mann-Whitney test
Caption: MTD= muscle tension dysphonia; n = number; Min = minimum; Max = maximum.

There was a significant difference in the comparison between groups ($p<0.001$ for VoiSS; $p<0.001$ for VFI; $p\leq0.025$ for NMQ variables). The results indicate that women with MTD have high scores for vocal symptoms and vocal fatigue, in addition to greater pain intensity in all parts of the body measured in this study.

Table 2 shows the results of the auditory-perceptual assessment of the voice, the acoustic analysis of the fundamental frequency, the maximum phonation times, as well as the clinical physical palpatory evaluation of the perilaryngeal muscles. There is a significant difference in the comparison between groups, with deviated results in women with MTD for voice-related analyses ($p\leq0.035$ for auditory-perceptual variables; $p<0.001$ for maximum phonation times) and muscle resistance ($p\leq0.013$). Only F_0 did not show variation between groups (p=0.633).

To perform the statistical analysis of the auditory-perceptual variables, we chose to use the mode of values assigned by the three judges, for each parameter of the GRBAS scale and for the type of voice resonance. The judges reported a predominance of laryngopharyngeal resonance (n=13, 56.5%) and laryngopharyngeal with nasal compensation (n=10, 43.5%) in the MTD group. In the control group, several types of resonance were identified (laryngopharyngeal with and without nasal compensation, laryngeal, normal), with no significant difference between the groups in this aspect (p=0.124) by the Chi-square test.

Regarding the vertical position of the larynx, it is important to note that women with MTD had a median score=1.0 (indicative of a high vertical position of the larynx). Controls had a median score=2.0 (characteristic of neutral position). Quantitatively, there is also a higher occurrence of the high larynx in the MTD group (n=13, 56%), when compared to the control group (n=4, 18%).

Table 3 shows the comparison between the general grade (G) of dysphonia and clinical variables in the MTD group. This

Table 2. Voice assessment and palpation of the perilaryngeal muscles between the MTD and control groups

	MTD (n=23)			Control (n=22)			P-value
	Median	Min	Max	Median (Quartiles)	Min	Max	
G – general degree	2.0 (1.0 – 2.0)	1.0	3.0	1.0 (1.0 – 1.0)	0.0	2.0	0.010
R – roughness	1.0 (1.0 – 2.0)	0.0	3.0	1.0 (0.0 – 1.0)	0.0	2.0	0.026
B – breathiness	1.0 (1.0 – 1.0)	0.0	3.0	1.0 (0.0 – 1.0)	0.0	1.0	0.035
A – asthenia	0.0 (0.0 – 0.0)	0.0	0.0	0.0 (0.0 – 0.0)	0.0	0.0	-
S – tension	1.0 (1.0 – 2.0)	1.0	3.0	1.0 (1.0 – 1.0)	0.0	1.0	0.005
F_0 (Hz)	201.5 (184.2 – 206.6)	149.1	304.8	188.0 (174.3 – 215.1)	128.5	250.0	0.633
MPT /a/	9.5 (5.4 – 11.2)	3.7	16.1	17.0 (14.0 – 23.4)	3.8	33.4	<0.001
MPT /s/	8.3 (6.2 – 15.0)	3.4	24.5	17.9 (14.0 – 28.2)	4.2	38.6	<0.001
MPT /z/	9.2 (5.8 – 15.2)	2.4	27.0	18.4 (15.0 – 27.0)	3.2	40.4	<0.001
Right ECOM palpation	3.0 (1.0 – 4.0)	1.0	4.0	1.0 (1.0 – 1.0)	1.0	2.0	<0.001
Left ECOM palpation	3.0 (1.0 – 3.0)	1.0	5.0	1.0 (1.0 – 1.0)	1.0	2.0	0.001
Supralaryngeal area palpation	1.0 (1.0 – 3.0)	1.0	3.0	1.0 (1.0 – 1.0)	1.0	2.0	0.006
Laryngeal resistance to lateral pressure	3.0 (1.0 – 3.0)	1.0	4.0	1.0 (1.0 – 2.0)	1.0	3.0	0.005
Vertical position of the larynx	1.0 (1.0 – 2.0)	1.0	3.0	2.0 (2.0 – 2.0)	1.0	2.0	0.013

Auditory-perceptual data using the Chi-square test and acoustics using the Mann-Whitney test
Caption: MTD= muscle tension dysphonia; n = number; F_0 = fundamental frequency; GNE = measurement of glottal noise; MPT = maximum phonation time; ECOM = sternocleidomastoid muscle; Min = minimum; Max = maximum

Table 3. Comparison of clinical variables according to the general degree of dysphonia

	General degree of dysphonia			P - value
	Mild (n=11)	Moderate (n=7)	Intense (n=5)	
Age	44.0 (34.0 - 54.0)	35.0 (28.0 – 46.0)	44.0 (32.0 – 55.5)	0.367
Professional use of the voice (n=7)	2 (28.6%)	4 (57.1%)	1 (14.3%)	0.183
F_0 (Hz)	201.5 (189.9 – 205.3)	170.2 (153.1 – 194.3)	218.9 (206.6 – 271.6)	0.004*
VoiSS total	45.0 (38.0 – 61.0)	58.0 (46.0 – 62.0)	62.0 (39.5 – 76.5)	0.573
VFI total	42.0 (30.0 – 53.0)	45.0 (42.0 – 50.0)	52.0 (38.0 – 60.5)	0.439
Upper back pain	82.0 (54.0 – 94.0)	78.0 (40.0 – 90.0)	54.0 (40.0 – 76.5)	0.551
Pain in the posterior neck region	77.0 (60.0 – 81.0)	95.0 (75.0 – 96.0)	70.0 (47.5 – 95.0)	0.291
Lower back pain	51.0 (0.0 – 93.0)	80.0 (53.0 – 98.0)	62.0 (26.5 – 66.0)	0.289
Temporal region pain	32.0 (5.0 – 55.0)	90.0 (70.0 – 98.0)	78.0 (21.5 – 86.5)	0.089
Masseter pain	0.0 (0.0 – 57.0)	10.0 (0.0 – 90.0)	0.0 (0.0 – 29.0)	0.687
Pain in the anterior neck region	37.0 (5.0 – 57.0)	58.0 (0.0 – 88.0)	0.0 (0.0 – 68.5)	0.477
Submandibular region pain	45.0 (0.0 – 61.0)	0.0 (0.0 – 85.0)	0.0 (0.0 – 96.5)	0.652
Laryngeal pain	47.0 (21.0 – 77.0)	57.0 (23.0 – 73.0)	50.0 (24.5 – 90.5)	0.853
Elbow pain	0.0 (0.0 – 5.0)	15.0 (0.0 – 60.0)	43.0 (0.0 – 71.5)	0.470
Wrist / hand / finger pain	52.0 (40.0 – 87.0)	75.0 (0.0 – 97.0)	72.0 (22.5 – 86.0)	0.996
Hip/thigh pain	0.0 (0.0 – 25.0)	19.0 (0.0 – 65.0)	55.0 (53.5 – 76.5)	0.068
Knee pain	61.0 (44.0 – 85.0)	40.0 (0.0 – 70.0)	44.0 (20.0 – 95.0)	0.798
Ankle/feet pain	38.0 (0.0 – 80.0)	10.0 (0.0 – 52.0)	40.0 (14.0 – 61.5)	0.543

Values presented in median and quartiles. Kruskal-Wallis test, except for the variable "professional use of voice" (Chi-square test); *statistically significant difference ($p\leq0.05$)
Caption: MTD = muscle tension dysphonia, n = number; F0 = fundamental frequency, GNE = measure of glottal noise, VoiSS = vocal symptom scale, VFI = vocal fatigue index

Table 4. Comparison between clinical variables and laryngeal disorders in the MTD group

	Without laryngeal disorders (n=10)			With laryngeal disorders (n=13)			P-value
	Median	Min	Max	Median	Min	Max	
G – general degree	1.0	1.0	3.0	2.0	1.0	3.0	0.025†
R – roughness	1.0	0.0	3.0	2.0	0.0	3.0	0.145†
S – breathiness	1.0	0.0	2.0	1.0	1.0	3.0	0.438†
A – asthenia	0.0	0.0	0.0	0.0	0.0	0.0	-
S – tension	1.0	1.0	3.0	2.0	1.0	3.0	0.299†
F_0 (Hz)	202.2	158.1	304.8	194.3	149.1	238.5	0.577‡
MPT /a/	8.7	4.0	16.1	9.45	3.70	15.37	0.852‡
MPT /s/	9.9	4.6	23.2	8.11	3.43	24.04	0.385‡
MPT /z/	8.4	4.2	18.4	9.22	2.40	27.04	0.756‡
Right ECOM palpation	2.5	1.0	4.0	3.0	1.0	4.0	0.707†
Left ECOM palpation	2.5	1.0	4.0	3.0	1.0	5.0	0.749†
Supralaryngeal area palpation	1.0	1.0	3.0	2.0	1.0	3.0	0.799†
Laryngeal resistance to lateral pressure	2.5	1.0	4.0	3.0	1.0	4.0	0.382†
VoiSS total	42	33	87	58	37	80	0.136‡
VFI total	33	20	66	49	36	66	0.050‡
Upper back pain	81	43	95	54	0	100	0.306‡
Pain in the posterior area of the neck	74	0	98	90	0	100	0.214‡
Lower back pain	57	0	93	62	0	99	0.597‡
Temporal region pain	31	0	98	78	0	100	0.106‡
Masseter pain	0	0	98	10	0	92	0.713‡
Pain in the anterior area of the neck	26	0	96	50	0	97	0.571‡
Submandibular area pain	22	0	83	13	0	99	0.693‡
Laryngeal pain	36	6	94	53	10	99	0.293‡
Elbow pain	0	0	95	5	0	100	0.525‡
Wrist / hand / finger pain	50	0	95	72	0	100	0.708‡
Hip/thigh pain	0	0	70	52	0	95	0.120‡
Knee pain	57	0	99	49	0	100	0.925‡
Ankle/feet pain	29	0	95	40	0	90	0.975‡

† Chi-square test or Fisher's exact test; ‡ Mann-Whitney test for other variables
Caption: F_0 = fundamental frequency; n = number; GNE = measurement of glottal noise; ECOM = sternocleidomastoid muscle; MPT = maximum phonation time; VoiSS = vocal symptom scale; VFI = vocal fatigue index; Min = minimum; Max = maximum

analysis was highlighted in the table to present the factors that could be related to a more deviated vocal quality. The table shows the significant relationship between F_0 and the degree of dysphonia, showing a higher F_0 in cases with intense G.

The same analysis was performed in the control group. Although these women were included in the research due to the absence of complaints of dysphonia, it was observed that of the 22 controls, two were classified with G0 (without deviation), 18 with mild G1, and two with G2 (moderate deviation). The comparisons showed that there was no statistically significant difference, indicating that the clinical variables could not be related to the degree of normal variability in vocal quality in the controls.

A comparison of laryngological characteristics with clinical variables in MTD was performed (Table 4). Significant differences were observed with the following variables: general degree of dysphonia (p=0.025) and total VFI score (p=0.050) using the Chi-Square or Fisher's Exact tests and the Mann-Whitney test, indicating that patients with MTD without laryngeal alteration showed less deviated results in the variables mentioned.

DISCUSSION

Dysphonia due to muscle tension is a complex condition with several signs and symptoms associated with vocal disorders, requiring a differential diagnosis from other behavioral conditions due to its difficult definition and the need for specific intervention[3,21]. There are several assessment instruments in the speech therapy clinic, so the choice of the most appropriate procedure must consider specific aspects of dysphonia[24]. In this sense, the present study identified significant differences in the results involving physical clinical palpatory evaluation of the perilaryngeal muscles, auditory-perceptual and acoustic evaluation of the voice, as well as self-assessment protocols in women with MTD compared to vocally healthy women.

Women with MTD had high scores for vocal symptoms compared to women in the control group and with values above the cut-off value of 16 points presented by the literature[17]. Similar results were found in a study with dysphonic women (median of 56 points of total score) and with individuals with behavioral dysphonia (median of 53 points)[24].

Regarding the vocal fatigue index scores, the results identified corroborate the literature (16), which confirms the clinical impression that dysphonic individuals can present vocal fatigue, especially in cases of muscle tension[9,14]. The literature is attentive to the identification of signs of vocal fatigue and laryngeal tension, and it is important to consider self-assessment protocols in the voice clinic, as vocal fatigue seems to be a complex and variable clinical entity[16], which may occur as a consequence of vocal hyperfunction or prolonged use of the voice, especially without sufficient rest[16].

Another point to be highlighted is the high frequency and intensity of pain in women with MTD. Studies have shown similar results[12,13,25]. Among the variables compared between the groups in the present study, the difference in self-perception of pain in the infrahyoid region stands out, as shown in Table 1, since women with MTD had high rates, while control women reported absence of pain. Musculoskeletal tension and pain in regions close to the larynx are closely related to MTD[11,25], but it is noteworthy that dysphonic subjects, or those who use a professional voice, often present pain in different parts of the body[25]. In this context, speech therapy assessment needs to consider that muscle pain is subjective and multifactorial, and that it is often related to fatigue[11].

The vocal characteristics observed in the present study corroborate the literature[8,10,11,20] since the participants with MTD had worse scores in the roughness, breathiness, and tension parameters, the latter showing a greater difference in comparison with vocally healthy women. The excessive and unbalanced functioning of the intrinsic and extrinsic muscles of the larynx can affect the regularity of vocal fold vibration and glottal closure, generating noise in vocal emission[3,20]. This hyperfunction pattern is also associated with increased subglottic pressure and phonatory effort[26], which can lead to vocal fatigue, vocal symptoms[3,17], pain, and extreme discomfort, especially in regions close to the larynx due to continuous effort[13.21.25].

Regarding the vocal quality of the control group, there was a median of the general degree equivalent to mild dysphonia. Voices with a general degree of zero (G0) or with slight deviation (G1) can be classified within the normal variability of voice quality. These variations probably occur due to the diverse vocal styles[27]. The differences between G0 and G1, in the clinical evaluation, can be subtle. In this context, diagnosis and therapeutic indication need to consider other aspects in addition to the auditory-perceptual analysis of the voice[27], such as self-assessment protocols, behavioral analysis, voice acoustics, and laryngological examination[24,26].

The hypothesis of reduced MPT was confirmed, according to previous studies[3,7,10]. Muscle tension and effort can promote hyper contraction of vocal folds to phonation, resulting in pneumophonic incoordination[7], leading to fatigue[21]. Fatigue, in turn, can also cause tiredness, increased muscle tension, lack of flexibility, and vocal control[15,16]. Both cases can be present in MTD, reducing the maximum phonation times due to the lack of glottic efficiency[21]. In addition, muscle tension in the cervical region during inspiratory movement may also be related to this symptom[5,8].

Women with MTD had high scores for resistance and muscle tension to palpation when compared to controls. Similar results were found in the literature for the sternocleidomastoid muscles, supralaryngeal area, and laryngeal resistance to lateral pressure[4,10]. Since the extrinsic musculature maintains the larynx in a stable and natural position[2], the excessive tension of this region negatively influences the balance of the larynx intrinsic muscles, causing functional incoordination and deviated inclination of the laryngeal cartilaginous structures (thyroid, cricoid and arytenoid), significantly impacting vocal quality[2,7].

Regarding the vertical position of the larynx, the MTD group had a median of score 1, which denotes a high position, while the control group had a score of 2, indicative of a neutral position. These results reinforce previous data[2,4], and recent studies on vocal tract morphometry of individuals with behavioral dysphonia[27,28]. These studies show that the tension of the intrinsic or extrinsic muscles of the larynx and the vocal effort can cause changes in the configuration of the vocal tract, with a higher position of the hyoid bone and the larynx and constriction of the laryngeal vestibule, even during rest.

The results of the laryngological evaluation and the clinical characteristics of women with MTD are highlighted, compared to the general degree of dysphonia. The non-relationship between general grade (GRBAS scale) and variables measured in table 3 indicate that women with MTD may have visible muscle tension on palpation, as well as frequent and important symptoms and clinical conditions, regardless of whether the dysphonia is mild, moderate, or severe. Regarding the laryngological evaluation, there is a higher intensity of self-reported pain in women with laryngeal disorders, but without significant difference (Table 4). In addition, pain in the perilaryngeal region was reported by all dysphonic patients, with or without laryngological disorders. The only variables that showed a significant difference were the general degree of dysphonia and symptoms of vocal fatigue, indicating that women with MTD can present vocal symptoms, pain, and deviations in vocal quality regardless of the presence of lesions in the laryngological exam.

Previous results show that the larynx can remain constantly contracted and high in the neck, including at rest, causing an increase in vocal signs and symptoms[27], vocal fatigue[3,14], glottal gaps associated with tension[29], in addition to emotional issues[13]. Therefore, excessive tension in the musculature is an important factor that is associated with the development and maintenance of primary or secondary MTD[1].

Still, in the MTD group, a significant difference was observed in the comparison of the fundamental frequency with the general degree of dysphonia. In the present sample, women with moderate deviation had a median of F_0=170.2Hz. The ones with intense deviation, a median of F_0=218.9Hz, with dispersion values of the interquartile range higher than those expected for normality in female voices[21], although recent data point to values of F_0 around 195.8Hz for Brazilian women without dysphonia[23]. A high-pitched voice can also suggest stiffness and excessive tension of the intrinsic and extrinsic muscles of the larynx, as well as a high vertical position of the larynx in the neck[8,11]. However, it is worth noting that the authors refer that frequency deviations, for low or high, can be observed in cases with tension[21], as well as the forced lowered vertical position of the larynx[4].

Based on the results identified, it is understood that the evaluation of these patients with several symptoms associated with muscle tension can represent a challenge. The differential diagnosis between dysphonia due to muscle tension and other behavioral conditions is essential for the adequate therapeutic choice[21].

The identified characteristics reinforce that the evaluation must be well thought out. Despite the differences evidenced in the analyses, it is emphasized that the generalization of these results must consider the restrictions inherent to cross-sectional studies with subjects from a convenience sample. Attention is suggested to aspects of pain, symptoms, and vocal fatigue in these patients. Recent studies with MTD patients used a sample with a wide age range[30].

Regarding the limitations of the study, we highlight the use of a sample with ages up to 55 years old, in order to exclude the effects of vocal aging in the sample, however hormonal issues involving climacteric and menopause were not considered. In this sense, further research is suggested considering age as a factor to be analyzed in MTD.

Another point to be highlighted as a limitation was the clinical physical examination of muscle palpation performed by an experienced speech therapist, but not blinded. The possibility of muscle changes and adjustments during the application of the protocol justifies the inclusion of only one evaluator, aiming to reduce measurement bias. Thus, it was not possible to perform the blinding of the evaluator regarding the groups during this evaluation. However, it is noteworthy that this methodology is frequently used by studies in the area[10].

CONCLUSION

The present study identified high scores for vocal fatigue, voice symptoms, and self-perception of muscle pain in women with dysphonia due to muscle tension when compared to vocally healthy women. Regarding speech therapy evaluation, statistically significant results were also found, related to tension and resistance to the physical clinical examination of muscle palpation, as well as deviated scores for parameters of the auditory-perceptual analysis of the voice, showing worse results in women with muscle tension dysphonia.

This study analyzed signs and symptoms in women with dysphonia due to muscle tension compared to vocally healthy women. In this sense, the results aim to assist the speech therapist in the decision, through the use of clinical reasoning strategies, which protocol(s) and assessment resources are most suitable for the specific case of the patient with muscle tension dysphonia.

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Authors' contributions

CCM and IOL participated in the design of the study, collection, analysis and interpretation of data, writing and final review of the article; GM collaborated with the analysis and interpretation of data, writing and review of the article; MB and MC, as advisors, participated in the study design, analysis, data interpretation, writing and final review of the article.