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Postural and craniocervical dysfunctions and their relationship to the voice of women with cervical pain

Postura e disfunção crânio-cervical e sua relação com a voz de mulheres com dor cervical

Postura y disfunción cranio-cervical y su relación con la voz de las mujeres con dolor cervical

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Caroline Azevedo da Silva
ORCID: https://orcid.org/0000-0003-3255-2670
Universidade Franciscana de Santa Maria, Brasil
E-mail: Caroline-azevedo@outlook.com.br
Letícia Fernandez Frigo
ORCID: https://orcid.org/0000-0001-5407-6607
Universidade Franciscana de Santa Maria, Brasil
E-mail: leticia_frigo@hotmail.com
Sabrina Silva dos Santos
ORCID: https://orcid.org/0000-0002-0108-1151
Universidade Federal de Santa Maria, Brasil
E-mail: sabrinasfono@gmail.com
Carla Aparecida Cielo
ORCID: https://orcid.org/0000-0002-7219-0427
Universidade Federal de Santa Maria, Brasil
E-mail: cieloca@yahoo.com.br

Resumo

Introdução: O alinhamento corporal alterado pode contribuir para o aparecimento de hipertensão muscular na região cervical. Alterações na região cervical podem gerar várias complicações, incluindo dor e hipertensão durante a fonação. Objetivo: Relacionar a postura corporal com alterações funcionais da região craniocervical e a voz de mulheres com queixa de cervicalgia. Métodos: Estudo de caso com dez mulheres com queixa de dor cervical. Avaliações: indice de Disfunção Craniocervical, fotogrametria, tempo máximo de fonação da vogal /a/ e nível de pressão sonora. Resultados: Índice de Disfunção Craniocervical: 100%

disfunção. Tempo máximo de fonação /a/: 100% diminuído. Houve correlação positiva significativa entre essas variáveis. Fotogrametria: todos os participantes apresentaram alterações nos alinhamentos calculados. Nível de pressão sonora: 90% alterado. Conclusão: Houve disfunções posturais e funcionais na região craniocervical e alteração vocal, sugerindo que os desequilíbrios vocais estão mais relacionados às alterações funcionais do que às alterações posturais da região craniocervical.

Palavras-chave: Postura; Fonação; Fotogrametria; Dor de pescoço; Dor musculoesquelética; Voz.

Abstract

Introduction: Altered body alignment may contribute to the onset of muscle hypertension in the cervical region. Alterations in the cervical region can generate several complications, including pain and hypertension during phonation. Objective: To relate the postural with functional alterations of the craniocervical region and the voice of women complaining of musculoskeletal pain in the cervical region. Methods: Case study with ten women complaining of cervical pain. Assessments: Craniocervical Dysfunction Index, photogrammetry, maximum vowel phonation time of the vowel /a/, and sound pressure level. Results: Craniocervical Dysfunction Index: 100% dysfunction. Maximum phonation time /a/: 100% decreased. There was a moderate significant positive correlation between these variables. Photogrammetry: all participants presented alterations in the calculated alignments. Sound pressure level: 90% altered. Conclusion: There were postural and functional dysfunctions in the craniocervical region and vocal alteration, suggesting that vocal imbalances are more related to functional than postural alterations of the craniocervical region.

Keywords: Posture; Phonation; Photogrammetry; Neck pain; Musculoskeletal pain; Voice.

Resumen

Introducción: la alineación corporal alterada puede contribuir a la aparición de hipertensión muscular en la región cervical. Los cambios en la región cervical pueden generar varias complicaciones, incluyendo dolor e hipertensión durante la fonación. Objetivo: relacionar la postura con los cambios funcionales en la región craneocervical y la voz de las mujeres con quejas de dolor musculoesquelético en la región cervical. Métodos: Estudio de caso con diez mujeres con quejas de dolor cervical. Evaluaciones: índice de disfunción craneocervical, fotogrametría, tiempo máximo de fonación de la vocal /a/ y nivel de presión sonora.

Resultados: Índice de disfunción craneocervical: disfunción 100%. Tiempo máximo de fonación /a/: 100% disminuido. Hubo correlación positiva moderada significativa entre estas variables. Fotogrametría: todas las participantes mostraron cambios en las alineaciones calculadas. Nivel de presión sonora: 90% cambiado. Conclusión: Hubo disfunciones posturales y funcionales en la región craneocervical y cambios vocales, lo que sugiere que los desequilibrios vocales están más relacionados con los cambios funcionales que con los cambios posturales en la región craneocervical.

Palablas clave: Postura; Fonación; Fotogrametría; Dolor de cuello; Dolor musculoesquelético; Voz.

1. Introduction

Posture is the position of the body for the purpose of developing a specific activity. Ideal postural alignment requires proper interaction between muscles and joints, hence, maintaining the upright position is a complex task that requires balance and body coordination (Cardoso, Lumini-Oliveira, & Meneses, 2019; Farias, Albuquerque, & Rech, 2011; Fiusa, Fréz, & Pereira, 2015; Macêdo, Patrício, & Sá, 2015; Rubira et al., 2010).

Proper posture is one that has minimal overload of the muscles and ligaments involved. Altered body alignment may compromise the distribution of load on the body, causing increased pressure on joint surfaces and the appearance of muscle hyperfunction. Muscle hyperfunction in the cervical region may interfere with head and neck positioning where the larynx and vocal folds are located (Carneiro, Teles, Cunha, & Cardoso, 2014).

Among the fundamental sets that compose the posture, the cervical spine stands out for being an anatomically complex region of the vertebral segment. It has large ranges of motion and, when its static positioning is altered, important compromises may occur in the stomatognathic system, whose functions are swallowing, breathing and phonation (Carneiro, 2013).

Voice/phonation plays an important role in the context of communication, because through it, human beings express their thoughts, ideas and emotions (Cardoso et al., 2019, Nelli, 2006; Ribeiro, Santos, Bonki, Prestes, & Dassie-Leite, 2012, Ramos et al., 2018). Phonation is produced during exhalation, with vocal fold adduction associated with movements of the speech organs (Vieira, Gadenz, & Cassol, 2015). Dysphonia is a condition defined by any change in the sound mechanism that compromise phonation. Among the types of dysphonia is the functional type, and it may be related to localized alterations in the

cervical region, such as the presence of muscle pain and limited range of motion (Cardoso et al., 2019; Cardoso, Meneses, Lumini-Oliveira, Pestana & Guimarães, 2020, Silverio, Siqueira, lauris, & Brasolotto, 2014).

Pain and increased tension in the craniocervical region may lead to musculoskeletal tension syndrome (MSTS) or muscle tension dysphonia, which may alter laryngeal muscles, impairing vocal control. The stability of the cervical region is considered important because it provides the necessary basis for adequate mobility in the laryngeal region and reduction of local hyperfunction, which positively favors voice production (Cielo et al. 2014; Fachinatto et al., 2015; Ferreira, Penha, Caporossi, & Fernandes, 2011).

Among the evaluative methods for the identification of postural alterations, the Craniocervical Dysfunction Index (CDI) stands out, which allows the analysis of the degree of severity of cervical dysfunction and short-distance photogrammetry, used for the purpose of image interpretation and analysis of angles located in the human body using postural assessment software (Bigaton, Silvério, Berni, Disfenato, Forti, & Guirro, 2010; Cardoso et al., 2020; Souza, Pasinato, Basso, Corrêa, & Silva, 2011). For vocal assessment, the maximum phonation time (MPT) and the sound pressure level (SPL) that indicate breathing control and glottic efficiency can be used (Mendonça, Sampaio, & Provenzano, 2012; Machado, Frigo, Lima, & Cielo, 2020).

Due to the scarce literature relating posture and craniocervical dysfunction and vocal aspects, it is important to investigate and deepen the theme, highlighting the fundamental interaction of interprofessional practices, aiming at an integral view of the patient.

Postural alterations and craniocervical dysfunctions are common in women, and vocal health is an important aspect of individuals' quality of life and seems to be directly related to posture and craniocervical functionality. Thus, this research aimed to relate the postural and functional alterations of the craniocervical region and the voice of women complaining of musculoskeletal pain in the cervical region.

2. Methods

Cross-sectional, quantitative case study approved by the Research Ethics Committee (1.452.296).

Inclusion criteria: female, since the prevalence of muscle pain in women is significant (Silverio et al., 2014); age range from 18 to 30 years old to avoid influence of the period of voice change and voice disorders of aging; complaining of musculoskeletal pain in

the cervical region for at least one year, since the pain becomes chronic after six months and may cause physical, psychological and social implications in the individual (Beirão, 2014).

Exclusion criteria: pregnant women; patients with self-reported acute degenerative neurological, endocrinological, psychiatric, gastric or respiratory diseases that could affect the comprehension and/or performance of the assessments; report of hormonal alterations due to menstrual period or report of influenza and/or respiratory allergies on assessment days; report of another disease that could limit performance in assessments; smoking, alcoholism, vocal complaints, TMJ dysfunction and/or use of orthodontic appliance, because the classification of the severity of the dysfunction was not an objective of this study.

The invitation to participate in the research was made through the disclosure in the classroom of an undergraduate course in Physical therapy, with 14 participants, being excluded three, totaling ten women in the convenience group.

In order to perform the sampling, an interview containing identification and questions about the inclusion and exclusion criteria was performed. From then on, data collection related to posture and craniocervical functionality and voice took place at previously scheduled times.

For the assessment of craniocervical functionality a Craniocervical Dysfunction Index (CDI) instrument was used, containing five items: 1) flexion range of motion, extension, inclination and bilateral rotation with goniometer (35 cm trident model, Brazil); 2) pain during movement (from the movements described in item 1); 3) joint impairment (presence of noise or locking during the movements described in item 1); 4) muscle pain (palpation of the sternocleidomastoid, trapezius and paravertebral muscles bilaterally); and 5) measurement of cervical lordosis with the participant in a sitting position. In each item, the score ranged from 0 to 5. Adding the scores of all items assessed, a total value was obtained to identify the degree of severity of the dysfunction: no dysfunction (0 points), mild dysfunction (1 to 4 points), moderate dysfunction (5 to 9 points) and severe dysfunction (10 to 25 points) (Dias et al., 2018).

A camera (W710, *Sony Cyber-shot*®, Brazil) was positioned 2.4 m away from the participant (who was facing the camera and standing upright), fixed on an aluminum tripod adjustable to 1.53 m above the floor, framing the Anatomical areas of the craniocervical region from the xiphoid process. The bone references that served as a guide for the angular stones were: tragus and acromium bilaterally, palpated and marked with white tape. The images were transferred to the SAPo® postural assessment software (v.0.68) by means of the analysis of the acromial horizontal alignment (AHA), head vertical alignment on the right-

side view (VARS) and head vertical alignment on the left-side view (VALS). The protocol of the program itself was followed, considering the normality level at 0º.

For the voice assessment, the MPT/a/ was collected in a room with noise below 50 dB, measured by digital sound pressure meter (Dec-500 model, Instrutherm, Brazil). The participant, in an orthostatic position, was asked to breathe in and sustain the vowel /a/ in usual pitch and loudness, sustaining it as long as possible in one exhalation. The measurement was performed three times and timed in seconds using the longest value (Speyer et al., 2010; Carrasco, Oliveira, & Behlau, 2010; Cielo, Lasch, Miglioranzi, & Conterno, 2011). As a reference, the average normality for adult women – 15 to 25 seconds – was adopted, with lower values suggesting air escape to phonation and higher values suggesting glottic hyperfunction (Behlau, Madazio, Feijó, & Pontes, 2013).

The SPL was collected with the digital sound pressure meter (Dec-500 model, Instrutherm, Brazil) positioned in front of and 30 cm away from the participant's mouth during the emission of the vowel /a/, considering the modal value (Cielo, Frigo, & Christmann, 2013). The range 64 to 65 dB was used as a normality reference for women (Behlau et al., 2013).

The IBM SPSS Version 23 software was used as a computational tool for statistical analysis. For data normality analysis, the Shapiro Wilk test was used. For the correlation between the variables, Pearson's correlation coefficient was calculated at 5% significance level ($p \leq 0.05$). Correlation coefficient variations between 0.01 and 0.39 were classified as low associations; those between 0.4 and 0.69, as moderate; and between 0.7 and 1, as high (Pestana & Gageiro, 2014).

3. Results

Table 1 shows degree of severity of craniocervical dysfunction according to CDI.

Table 1 – Degree of severity of craniocervical dysfunction according to Craniocervical Dysfunction Index

	No dysfunction	**Mild** **n (%)**	**Moderate** **n (%)**	**Severe** **n (%)**
Participants 10 (100%)	--	2 (20)	3 (30)	5 (50)

Source: Authors.

Table 2 shows angles in degrees, analyzed by the SAPo® postural assessment software.

Table 2 – Angles in degrees analyzed by SAPo® postural assessment software.

Participants	AHA	VARS	AVLE
1	-3º	16.7º	11.5º
2	-0.5º	8º	10º
3	-2.8º	15º	13º
4	-2.2º	12.8º	9º
5	0º	15º	20.4º
6	1.2º	21.5º	17.3º
7	-0.4º	19º	15.8º
8	-1.5º	9.4º	10.3º
9	-0.3º	5.6º	9.5º
10	-0.5º	2.1º	2.9º

Label: AHA: acromial horizontal alignment; VARS: vertical head alignment (right side view); VALS: vertical head alignment (left side view); º: degree.
Source: Authors.

Table 3 shows MPT/a/ and SPL results.

Table 3 – Maximum Phonation Time /a/ and Sound Pressure Level results.

Participants	MPT/a/	SPL
1	9.12 s	62 dB
2	9.62 s	61 dB
3	14.49 s	74 dB
4	8.68 s	77 dB
5	10.46 s	67 dB
6	14.82 s	69 dB
7	8.27 s	64 dB
8	7.97 s	61 dB
9	6.53 s	60 dB
10	9.1 s	62 Db

Label: MPT/a/: maximum phonation time of vowel /a/; SPL: sound pressure level.
Source: Authors.

Table 4 shows correlations between the analyzed variables.

Table 4 – Correlations between the analyzed variables.

Correlation	r	P
MPT/a/ x CDI	0.653	0.0406*
MPT/a/ x AHA	0.0703	0.8469
MPT/a/ x VARS	0.5457	0.1026
MPT/a/ x VALS	0.4382	0.2052
SPL x CDI	0.5612	0.0913
SPL x AHA	-0.3061	0.3897
SPL x VARS	0.4399	0.2032
SPL x VALS	0.2412	0.5019

Label: MPT /a/: maximum phonation time of the vowel /a/ in seconds; SPL: sound pressure level in decibel; CDI: Craniocervical Dysfunction Index; AHA: acromial horizontal alignment in degrees; VARS: vertical head alignment (right side view) in degrees; VALS: vertical head alignment (left side view) in degrees; r: correlation coefficient; p: significance coefficient; *: statistical significance.
Source: Authors.

All study variables come from populations with normal distribution: MPT/a/ (p=0.0606), SPL (p=0.0740), CDI (p=0.3144), AHA (p=0.5736), VARS (p=0.9216) and VALS (p=0.8052).

4. Discussion

Few studies in the literature highlight the relationship between posture and cervical functionality to vocal quality. Through the CDI, it was possible to identify that all participants had some type of craniocervical dysfunction, highlighting that 50% were diagnosed with severe dysfunction (Table 1). The dysfunction related to the craniocervical region is a common condition in the population and may be characterized by cervical pain at rest or during movement of the region, limitations, noise and muscle tension. It is estimated that two thirds of the population suffered from cervical pain at some point in their lives (Bigaton et al., 2010; Dias et al., 2018).

The MPT implies the efficiency of the coordination between the respiratory and phonatory levels, since the individual uses the maximum of his/her vital capacity for the maximum support of the phonation (Rubin, Blake, & Mathieson, 2007; Souza et al., 2011; Mendonça et al., 2012; Behlau et al., 2013). Decreased MPT (Table 3) suggests air escape on phonation, which may be due to lack of respiratory control, lack of glottic efficiency or lack of laryngeal control (Speyer et al., 2010; Carrasco et al., 2010; Behlau et al., 2013). Possibly, the more alterations in the craniocervical region, the greater will be the MPT/a/ involvement.

In our research, it was possible to verify a significant positive correlation (Table 4) between the CDI and MPT/a/, showing that as the degree of craniocervical dysfunction increased, the MPT/a/ also increased. This suggests that the increase compensatory tensions due to craniomandibular dysfunction may also increase glottic tension and MPT/a/, even though all MPT/a/ were below normality (Table 3).

The more alterations in the craniocervical region, the greater the muscle tension may be, which may cause alteration in the laryngeal muscles. In some cases, this tension may be so intense that it is called Musculoskeletal Tension Syndrome or Muscle Tension Dysphonia (Cielo et al. 2014). Our results agree with a research that revealed a strong link between craniocervical muscle tension and the presence of dysphonia. There is evidence of signs of musculoskeletal tension in subjects undergoing the removal of benign laryngeal lesions such as nodules and cysts, showing that muscle tension is a causal factor for dysphonia (Rubin et al., 2007; Kooijman et al., 2005). Similarly, such conditions were observed in 25 teachers with dysphonia, concluding that the higher the CDI values, the greater the vocal alteration and the worse the voice quality (Kooijman et al., 2005).

Another study found in the group composed of participants without vocal complaints the prevalence (100%) of mild craniocervical dysfunction, and in the group composed of dysphonic women, moderate and severe dysfunction (62.5%) (Fachinatto et al., 2015). A study with 30 dysphonic women and 30 without voice disorders investigated the location, frequency and intensity of muscle pain in these individuals. The frequency and intensity of musculoskeletal pain were higher in dysphonic women, revealing that pain may be related to dysphonia (Silverio et al., 2014). On the other hand, another study identified cervical disorders in 32 women with dysphonia and 18 without voice disorders. There were significant cervical alterations in women with or without dysphonia, but it was not possible to determine a causal relation between cervical pain and dysphonia (Menoncin, Jurkiewicz, Silvério, Camargo, & Wolff, 2010).

The act of producing the voice requires the individual to position himself/herself correctly. Postural activity in relation to the head and cervical region interferes with vocal production in some cases (actors and dancers frequently voice in different positions with no adverse effects). Any deviation located in this region, such as accentuated physiological curves, causes functional alterations that lead to head and neck imbalance, developing compensatory muscle functions (Macêdo et al., 2015). A study of 35 telemarketers and 35 non-voice professionals found increased musculoskeletal pain in telemarketers due to their

work style, negatively affecting voice-related quality of life (Santos, Silverio, Dassie-Leite, Costa, & Siqueira, 2018).

In a study on the influence of different body postures on voice production, the analyses of 25 vocal and photographic samples of a male individual were performed. Voice production in the upright posture was compared regarding alterations in head and neck position and alterations in head and upper trunk. There was significant worsening in vocal quality and resonance, and the voice became sharper, suggesting that the best vocal production occurs in the upright posture (Carneiro & Teles, 2012).

A study on postural habits and vocal behavior of Physical Education professionals, with 17 professionals (14 women and 3 men), showed postural alterations that compromised breathing and vocal production (Machado, Hammes, Cielo, & Rodrigues, 2011).

In our work, postural assessment using the SAPo® software found that all participants presented alterations in the calculated alignments (Table 2). These results are similar to those from a research that compared the posture of 20 women without vocal complaint with 23 dysphonic women and found that dysphonic women presented shoulder alignment, alterations in scapular positioning and head anteriorization (Nelli, 2006).

In a research that used the *Corel Draw* software as an instrument to assess posture among women without vocal and dysphonic complaints, there was no significant difference between the average head protrusion values among the studied groups (Souza et al., 2011).

Regarding the SPL, which is determined by glottic resistance, only one of the participants (10%) presented this value as expected (Table 3), 40% were increased and 50% decreased. Decreased SPL suggests lower subglottic air pressure and either incomplete or weak glottic muscle closure, which may occur due to respiratory incoordination, lack of glottic efficiency or lack of laryngeal control. The increase in SPL value is due to increased airflow and subglottic pressure, with greater vocal fold adduction and may occur due to glottic hyperfunction, which in the long term may be harmful (Machado et al., 2020). Our results point to a lack of SPL control that may be related to the discrepancies of muscle tension and craniocervical dysfunctions presented.

This work had as its limitations the number of participants, the lack of a control group for comparison with the outcome of the study group, and the scarcity of studies related to the theme. This study intended to contribute with scientific evidence that associate multidisciplinary interactions.

5. Conclusion

The group of women complaining of musculoskeletal pain in the cervical region presented postural and functional dysfunctions in the craniocervical region and vocal alteration, suggesting that vocal imbalances are more related to functional rather than postural alterations in the craniocervical region.

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Porcentagem de contribuição de cada autor no manuscrito

Caroline Azevedo da Silva – 40%

Leticia Fernandez Frigo – 30%

Sabrina Silva dos Santos – 10%

Carla Aparecida Cielo – 20%