Electrical Activity of Extrinsic Laryngeal Muscles in Subjects With and Without Dysphonia

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Summary: Objective. To compare dysphonic individuals to nondysphonic with regards to electrical activity of extrinsic laryngeal muscles related to perceptual and acoustic vocal parameters.

Hypothesis. Dysphonic individuals have higher electrical activity in the supra and infrahyoid muscles than those nondysphonic.

Study Design. Prospective, cross-sectional, case series study.

Methods. Forty-one subjects, divided into two groups according to the presence of dysphonia, underwent evaluation of surface electromyography, auditory-perceptual, and acoustic evaluations of voice during the vocal rest and sustained emissions of the vowel /ɛ/ and count of 20 to 30 at usual and strong intensities.

Results. The dysphonic group differed significantly from the nondysphonic by (1) lower electrical activity normalized by the maximum sustained voluntary activity evaluated in all tasks of phonation in the suprahyoid group; (2) lower recruitment of electrical activity in emissions of strong intensity compared with those of usual intensity in the suprahyoid muscles to emit the vowel /ɛ/ (13.66 ± 5.17 in dysphonic group and 35.20 ± 7.60 in the nondysphonic group, $P = 0.029$) and in the infrahyoid muscles in the count of 20 to 30 (14.90 ± 4.69 vs 42.01 ± 6.15; $P < 0.001$) and to emit the vowel /ɛ/ (11.47 ± 6.52 vs 22.66 ± 9.05, $P < 0.001$); (3) lower vocal intensity to produce the vowel /ɛ/ in usual and strong intensities and count in strong intensity. The electrical activities of the maximum sustained voluntary activity were reduced with increasing degree of dysphonia.

Conclusions. There was lower electrical activity of the extrinsic laryngeal muscles in dysphonic individuals compared with nondysphonic, and related to the degree of dysphonia.

Key Words: Electromyography–Acoustic analysis–Phonation–Dysphonia.

INTRODUCTION

Dysphonia is assessed by perceptual, acoustic, and visual parameters. Recently, the number of research seeking to establish the relation between electrical activity of laryngeal extrinsic muscles and dysphonia has grown.[1–3]

These research use the surface electromyography (sEMG). The sEMG is a different method from the electromyography using needles; which despite allowing the assessment of smaller and deeper muscles, has limitations, as the discomfort to the patient and difficulty to obtain data of dynamic tasks, that is, during speech, suffering more probability of noise or spurious interference.

The sEMG did not establish itself as a tool for diagnosis of dysphonia. The research about this topic are few and it is hard to compare them, because they vary in analyzed muscle groups, examination technique of phonation muscles, sample size, and sign standardization method.

Last decade studies point out that dysphonic patient's electrical activity is higher than that of normal subjects, but because of methodological differences these data were not corroborated by recent research.[4–6]

Vocal tasks requested in sEMG assessment are also diverse and there is no consensus about which one is more precise or adequate. This procedure may suffer the action of diverse variables, for instance the adipose tissue conditions, muscle strength, mechanic artifact by electrodes movements during dynamic tasks as fundamental frequency variations, singing, reading, and others. Moreover, there is an important gap in knowledge in laryngeal muscles contraction physiology, which would allow understanding its behavior in laryngeal functions such as protection, breathing, swallowing, and phonation.

Considering the previous research results, the hypothesis to this study is that dysphonic subjects have higher electrical activity than normal subjects at suprahyoid (SH) and infrahyoid (IH) muscles, because they recruit more muscles fibers during vowel emissions and passage of speech in usual and strong intensities.

Observing the proper technique to sEMG, defining a standard of normalization that keeps the direct relation to voice and emissions that do not require excessive muscle movements, the present study has as purpose to compare dysphonic and normal subjects regarding laryngeal extrinsic muscles electric activity related to voice perceptual and acoustic parameters.

METHODS

Forty-one volunteer subjects, aged between 28 and 57 years, mean 37.92 ± 1.46 years, median 41 years were included. In sex distribution the subjects were predominantly female (36 [87.8%]). These participants did not have the following self-reported conditions or evident to physical examination: cervical joint dysfunction, hearing impairment of any degree

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compromising the examination, and the use of metallic orthoses or prostheses. All participants attended to Divisão de Reabilitação do Hospital dos Servidores do Estado de Pernambuco between February and November, 2012.

The sample was divided in two groups: dysphonic (D group), with 19 subjects (46.34%); and nondysphonic (ND Group), with 22 subjects (53.66%). The division considered the possibility of conflict between voice and speech proposed tasks, sustained vowel /ε/, and counting numbers, respectively, due to idiosyncratic supraglottic adjusts during counting numbers, and the vocal complaint presence itself does not characterize dysphonia, although it is one indicative.

The criteria to dysphonia group inclusion considered the occurrence of divergence between vocal emissions and took the necessary rigor that this kind of examination requires, considering that counting numbers is speech representative and, therefore, where the main complaint lies. It was agreed once a vocal deviation was detected, regardless presence of voice complaint, the subject was classified as dysphonic. But, if there was a deviation detected in sustained vowel, and there was vocal complaint reported, this subject was also placed in the D group. To the ND group, it was agreed that the participant should have absence of vocal complaint and voice deviation; but the subject was also placed in this group if there was a complaint and the voice kept its normal variability in voice quality during sustained vowel and counting numbers tasks according to visual analog scale evaluation (VAS).[7]

VAS was used because it is widely applied to vocal screening.[7] This scale is a 100-mm line, with cutoff, which the numeric correspondence allows the characterization of vocal quality variability in degrees: 1—normal, from zero to 35.5 mm; 2—slight to moderate deviation, from 35.5 to 50.5 mm; 3—moderate deviation, from 50.5 to 90.5 mm; and finally, 4—severe deviation, values higher than 90.5 mm. The criteria are summed up at Table 1.

The intention is not to affirm that vocal complaint should not be a value, yet many of these complaints may not be related to voice deviation but to other disorders, as sore throat, for instance, different from pain during speaking.[8] Similarly, vocal disorders may be present without vocal complaint also is, as pointed out in a study by Corazza et al.[9]

Perceptual evaluation has high sensitivity to detect voice disorders, although it has no condition to establish the presence of laryngeal diseases.[8,9] However, once this procedure showed high alpha Cronbach coefficient among the speech-language pathologists that were judges in this research ($\alpha = .810$; $P < 0.001$, to VAS, and $\alpha = .686$; $P < 0.001$ to numeric scale), it was possible to consider the procedure proper to subjects classification in groups. The sEMG results corroborated the group classification because it showed differences between the groups, which will be presented and discussed as follow.

It was adopted convenience simple random sample, using table of random numbers, by the premise of homogeneous sample exhaustion identified for the absence of discrepancy in sEMG evaluation (outliers), as well for the Altman nomogram, considered the significance level adjustments, of test power and effect to be identified by the research.

The MIOTOOL 200® (Miotec™, Brazil) electromyography was used to collect the electrical potentials of SH and IH muscles groups in microvolt (μV), with the possibility to select four independent channels, with 32 windowing and 2000 gain for each channel. Because there are no references about the gain range used to capture the electrical activity of these muscles, the gain range previously mentioned was adopted, which allowed the adjustment of signal to muscles reaching 574.93 μV, according to the manufacturer's instruction. Three channels were used, each one connected to an active sensor SDS500 by claws; reference cable; calibrator; universal serial bus communication cable; all from Miotec™, Brazil, and disposable child surface electrodes from MEDITRACE (Kendall™, Canada). The sign analysis was performed using the *Miograph 2.0 software*.

The sEMG equipment was connected to an LG notebook (LG Electronics™, São Paulo, Brazil), with main configurations 160 GB HD, Intel Dual-Core Inside 1.7 GHz processor (Intel Corporation™, USA), Windows Vista Premium operational system.

Voice assessment was made by digitally recording voice in a portable computer (Sony Vaio, Intel 2.3 GHz processor; Sony™, Brazil). Voice was captured by a unidirectional head set microphone, Sennheiser PC-20 (Sennheiser™, Germany), placed 3 cm at the side of the mouth, to avoid exhale noise interference. To catalog the voice recordings, the register were processed in *VoxMetria software, 4.7 h version* (CTS Informática™, Brazil). Considering the interest of this research in acoustic data was to assess mean fundamental frequency and loudness in usual and strong intensities, the voice analysis mode was chosen to register sustained vowel /ε/ and counting numbers from 20 to 30.

All participants were guided about their rights and duties in this research, purpose of the study and then signed the informed consent. Later, all of them passed through a structured interview to identify the complaints and the evident signs indicating voice, hearing, and cervical disturbances, to reduce selection bias.

The electromyography and voice recording were made in the speech-language room, where the study took place, with the

TABLE 1.
Criteria for Classifying the Individuals According to Groups of Analysis

Criteria	Group D (Dysphonic)	Group D (Dysphonic)	Group ND (Nondysphonic)	Group ND (Nondysphonic)
Count of 20 to 30 in usual intensity	VAS > 1	VAS = 1	VAS = 1	VAS = 1
Vocal complaint	+ or −	+	−	+
Emission of vowel /ε/ in usual intensity		VAS > 1		VAS = 1

Abbreviations: VAS, degree of vocal change assessed by visual analog scale; +, present; −, absent; + or −, present or absent.