

CHARACTERISTICS OF PHONETOGRAPHY ON SUBJECTS WITH DENTOFACIAL BALANCE IN POST VOCAL CHANGE

Características da fonetografia em indivíduos com equilíbrio dentofacial pós-muda vocal

Cláudia Tiemi Mituuti ⁽¹⁾, Cibele Carméllo Santos ⁽²⁾,
Lídia Cristina da Silva Teles ⁽³⁾, Giédre Berretin-Felix ⁽⁴⁾

ABSTRACT

Purpose: to characterize, by means of phonetography, the profile of voice extension in individuals with post changes, dentofacial balanced voice. **Method:** fifteen male individuals participated in this study, in vocal postmutation, aged between 14 and 35 years old. They answered a specific self-response questionnaire, and they were also submitted to an anthropometric assessment of the face, dento-occlusal evaluation, phonetography examination and to an analysis of the usual fundamental frequency of the voice. **Results:** minimum Fundamental Frequency: $\approx 89\text{Hz} \pm 3\text{Hz}$ or $\approx 29\text{st} \pm 14\text{st}$, Maximum Fundamental Frequency: $X=665\text{Hz} \pm 179\text{Hz}$ or $X=63\text{st} \pm 5$, Voice Extension: $X=34\text{st} \pm 6\text{st}$, Minimum Intensity: $X=66\text{dB} \pm 3\text{dB}$, Maximum Intensity: $X=114\text{dB} \pm 5\text{dB}$, Maximum Dynamic Extension: $X=42\text{dB} \pm 4\text{dB}$, Phonetogram Area: $X=936,4\text{dB.st} \pm 258,8\text{dB.st}$ or $X=42,1\text{cm}^2 \pm 11,6\text{cm}^2$, Usual Fundamental Frequency of the "a" vowel: $X=111,26\text{Hz} \pm 15,24\text{Hz}$. **Conclusion:** although national and international studies presented in this work do not consider the dentofacial condition of the subjects, the results were very similar.

KEYWORDS: Voice; Voice Quality; Speech Acoustics; Face; Stomatognathic System

■ INTRODUCTION

The phonetography is an exam that reflects the individual physiological vocal limits or capacities, and is considered a exam of laryngeal maximum

performance. It was described by Damsté¹ and, in 1983; the Union of European Speech Language Pathologists proposed that this to be done as part of the evaluation of the voice of individuals with normal voices². This exam may be performed manually or computerized³, and provides information on the profile of vocal range, through the definition of an area between the intensities obtained from the minimum and maximum frequencies of the vocal range⁴⁻⁶.

The literature has documented the use of phonetography to distinguish normal vocal voices^{5,7,8}, documenting changes in voice due to fatigue, and to evaluate the change in vocal quality after voice therapy⁴, or vocal training for singing^{6,9}. Specifically regarding the standardization of benchmarks, there are studies for the Thai population¹⁰, German¹¹ and Finnish¹². In Brazil, a study that found that phonetography was effective in showing the characteristics of the voice in females elderly¹³, while another determined vocal characteristics during male vocal development¹⁴.

⁽¹⁾ Speech Language Pathologist; Master of Speech Language Pathology by the Dentistry School in Bauru, University of São Paulo – FOB/USP, Bauru, SP, Brazil.

⁽²⁾ Speech Language Pathologist Master of Speech Language Pathology by the Dentistry School in Bauru, University of São Paulo – FOB/USP, Bauru, SP, Brazil.

⁽³⁾ Speech Language Pathologist, Professor from the Department of Speech Language Pathology from the Dentistry College in Bauru/USP – FOB/USP, Bauru, SP, Brazil; PhD in Rehabilitation Sciences at the Hospital for Rehabilitation of Craniofacial Anomalies/USP.

⁽⁴⁾ Speech Language Pathologist, Professor from Department of Speech Language Pathology from the Dentistry College in Bauru/USP – FOB/USP, Bauru, SP, Brazil; Ph.D. in Pathophysiology in Medicine by Universidade Estadual Paulista.

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Studies also indicate to be an association between the dimensions of the vocal tract and the characteristics of voice quality and formants^{15,16}; between voice disorders and oral muscular disorders^{17,18}, being described, too, the relationship between the severity of temporomandibular dysfunction and vocal quality¹⁹.

Despite the literature demonstrate the relationships between the characteristics of the stomatognathic system and speech function, no studies were found to examine the vocal parameters considering facial type and dento-occlusal balance condition. Being phonetography an important instrument for achieving vocal assessment, the objective of this study is to characterize the profile of the vocal range of male subjects with dentofacial balance after voice change, through phonetography.

■ METHOD

The study included 15 male subjects, after voice change, with ages from 14 to 35 years old (average = 18.86). Criteria considered for inclusion were: presenting medium facial type with medium and lower equilibrium; appropriate length of upper and lower lips, Standard I20facial profile, which was considered in relation to the nasolabial angle balance, facial convexity angle, ratio between average anterior facial height and lower anterior facial height, as well as the proportion of the lower face, the relationship of the first permanent molar in class I21; overbite and horizontal measuring between 1 and 4 mm²², not presenting vocal alterations, having completed vocal changes¹⁴, not having syndromic or neurological impairments related to speech or expressive or receptive language, being a native speaker of Brazilian Portuguese, not having undergone laryngeal surgeries, not having prior vocal training, not having hearing complaints, not being alcoholic, not being nor having ever been a smoker, presenting good general health and no symptoms of laryngeal or respiratory alterations on the exam day. For this, all subjects answered a specific form of auto-responder investigating the aspects mentioned above, but also underwent anthropometric measurements of the face, dental-occlusal evaluation, perceptual evaluation of voice as well as assessment of expressive and receptive language.

To examine the phonetography was used VRP Program (*Voice Range Profile*) from *Kay Elemetrics' Multi Speech*, with an unidirectional headset microphone, RM – MZ3R brand, positioned at a distance of 3cm from the lip commissure of the participant. The recordings were performed in an acoustically treated room. For the measurements of phonetography requested to issue the prolonged vowel “a” in modal register, for at least 5 seconds at intensities stronger and weaker as possible. The exam started in C₃ (dó₃, 131 Hz) with continuous ascending and descending scale.

The analyzed measures were:

- *minimum and maximum fundamental frequency of the voice* (F_{MIN} e F_{MAX}), expressed in semitones (st) and Hertz (Hz), which correspond to higher notes and more serious musical scale produced in strong and weak intensities;
- *vocal extention* (VE), expressed in semitones and Hertz, which is the extension of frequency, comprising the total number of musical notes played and analyzed by the difference between the maximum and minimum frequency;
- *minimum intensity and maximum intensity* (I_{MIN} e I_{MAX}), obtained from the lowest point of the lower curve and the highest point of the upper curve of phonetogram;
- *maximum dynamic extension* (MDE) expressed in decibels, the largest difference in intensity between the upper and lower phonetogram curves in the same frequency;
- *phonetogram area*, resulting area of the connection between all points of the lower and upper curve in relation to vocal range, expressed in dB.st and cm². It was obtained from the data of VRP through a program that performs the conversion from dB.st to cm², using the conversion factor of 0.045 cm², in which 10 dB corresponds to 15mm and 12 st corresponds to 36mm².

The measures from all frequencies given in the abscissa of the phonetogram obtained by VRP in the phonetography (Figure 1) were converted from Hertz to semitone in order to allow the calculation of the phonetogram area, for being the semitone a linear measure which presents regular intervals in musical scale in 12 semitones, which does not occur with Hertz, which is an exponential measure. Moreover, the values of the vocal range in the literature have been used in semitones^{5, 8,13,23,24}, enabling later comparisons.

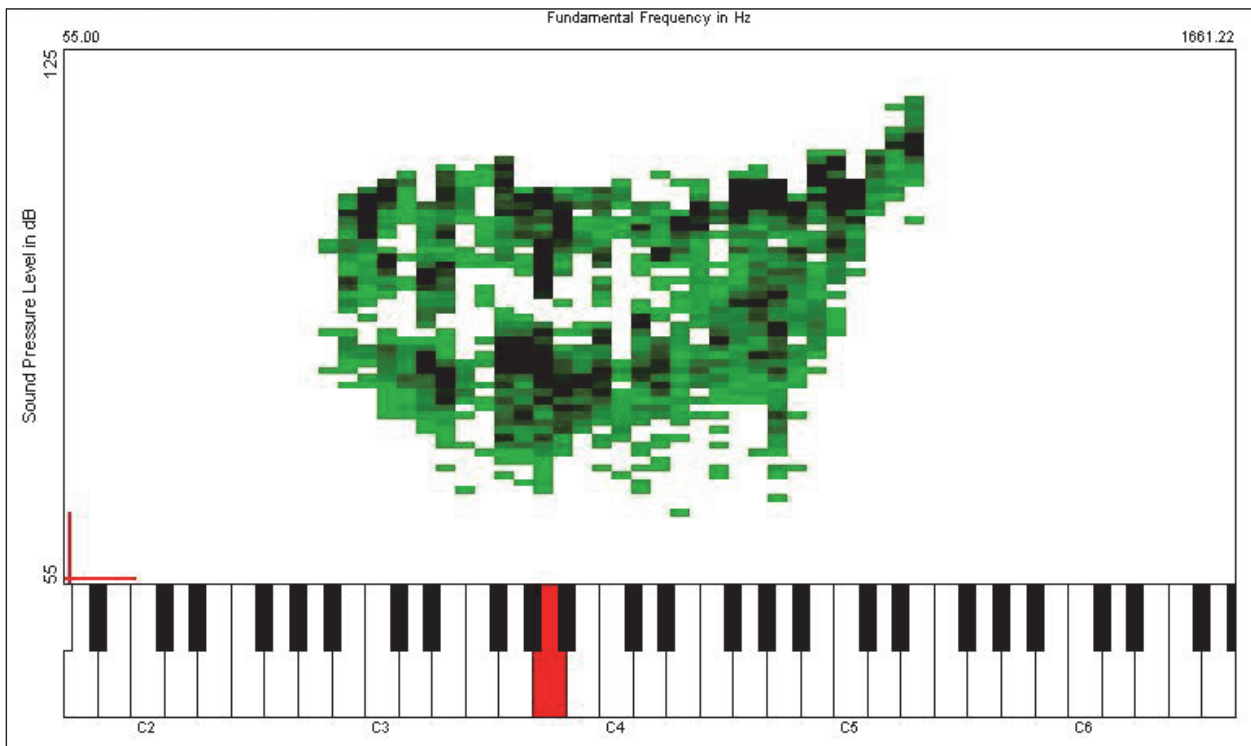


Figure 1 – A screen test of phonetography in which the frequencies are shown in the abscissa of phonetogram and intensity on the axis of ordinates

For the analysis of the fundamental usual frequency, the voices of individuals were recorded in a computer through the *Sound Forge 7.0* program. The recorded speech sample was the sustained vowel “a” in normal tone and intensity, analyzed in the program *Multi Dimensional Voice Program (MDVP)* by *Kay Elemetrics*.

The average values of the fundamental frequency, minimum and maximum frequencies, vocal range, minimum and maximum intensities, maximum dynamic range and the phonetogram area were obtained by the results that are provided by the VRP program, and the average of the fundamental usual frequency by the MDVP program.

This study complied every ethical standard advocated for research involving human beings, having received approval from the Ethics Committee in Research of the institution where it was conducted, case number 88/2006. The subjects were informed

about the procedures and were asked to sign the “Term of Free and Informed Consent” for all participants.

■ RESULTS

From the examination of phonetography, it was found the measures of minimum fundamental frequency, maximum fundamental frequency, range from $F_{\text{MIN}}=89\text{Hz}\pm 3\text{Hz}$ and $F_{\text{MAX}}=665\text{Hz}\pm 197\text{Hz}$, corresponding to $\pm 14\text{st}$ and $63\text{st}\pm 5\text{st}$, and the number of semitones from the vocal range ($VE=34\text{st}\pm 6\text{st}$). We also analyzed the values of the usual fundamental frequency (F_0) of the sustained vowel “a” from the 15 participants who underwent phonetography, where the average value was $F_0=111,26\text{Hz}\pm 15,24\text{Hz}$. Such information is presented in Table 1.

Table 1 – Individual values, average (\bar{X}) and standard deviation (SD) corresponding to the minimum and maximum fundamental frequency, expressed in Hertz (Hz) and semitone (st), habitual fundamental frequency expressed in Hz, and vocal range in semitone (st), from the evaluated participants.

N	FUNDAMENTAL FREQUENCY					VOCAL EXTENSION
	Minimum		Maximum		Usual	(st)
	(Hz)	(st)	(Hz)	(st)	(Hz)	
1	78	27	622	63	104,48	36
2	78	27	784	67	93,54	40
3	87	29	880	69	97,08	40
4	93	30	784	67	115,86	37
5	117	34	659	64	131,63	30
6	78	27	523	60	107,09	33
7	78	27	698	65	85,92	38
8	98	31	988	71	123,53	40
9	87	29	831	68	120,28	39
10	78	27	698	65	99,03	38
11	117	34	440	57	122,75	23
12	82	28	659	64	113,36	36
13	104	32	698	65	136,63	33
14	93	30	294	50	123,38	20
15	69	25	415	56	94,28	31
\bar{X}	89	29	665	63	111,26	34
SD	3	14	179	5	15,24	6

We obtained the phonetography values related to minimum intensity, maximum intensity, represented by $I_{\text{MIN}}=66\text{dB}\pm 3\text{dB}$ and $I_{\text{MAX}}=114\text{dB}\pm 5\text{dB}$, respectively, and MDE, corresponding to $42\pm 4\text{dB}$,

as well as the values of the phonetogram area ($936.4\text{dB.st}\pm 258.8\text{dB.st}$ or $42.1\text{cm}^2\pm 12.6\text{cm}^2$), shown in Table 2.

Table 2 – Individual values, average (\bar{X}) and standard deviation (SD) of the maximum and minimum intensities, and maximum dynamic extension range (MDE) expressed in decibels (dB), and the total area of the phonetogram expressed in dB.st and cm²

n	INTENSITY (dB)		MDE (dB)	AREA	
	Minimum	Maximum		dB.st	cm ²
1	63	112	42	1121.0	50.4
2	67	117	45	1419.5	63.9
3	70	117	39	973.0	43.8
4	66	113	39	844.5	38.0
5	66	120	42	982.5	44.2
6	72	115	40	776.5	34.9
7	73	115	39	1184.5	53.3
8	71	122	44	1144.5	51.5
9	69	115	41	952.0	42.8
10	73	118	40	1013.0	45.6
11	72	102	30	517.5	23.3
12	69	118	41	1011.0	45.5
13	73	116	42	982.5	44.2
14	79	106	26	312.0	14.0
15	69	111	40	812.0	36.5
\bar{X}	66	114	42	936.4	42,1
SD	3	5	4	258.8	11.6

■ DISCUSSION

The phonetography is a measure capable of recording all laryngeal possibilities regarding the frequency and vocal intensity, as it covers sounds more acute and severe than the human larynx is able to produce and the highest and lowest intensities generated during the emission of a vowel^[2,13,24,25]. Despite the importance of the exam, no studies were found related to the reference values of the voice range profile in Brazilian Portuguese speakers without voice disorders in the young-adult age group, with dentofacial balanced conditions. Thus, in the present study it was performed an acoustic evaluation of the voice in Brazilian Portuguese male speakers, after voice change, no alteration or vocal training, who had the Standard I kind of face and dento-occlusal harmony.

The frequency measures were analyzed in the extremes of the vocal range by computed phonetography. In regards to the averages of the minimum frequency ($F_{\text{MIN}}=89\text{Hz}\pm 3\text{Hz}$) and maximum frequency ($F_{\text{MAX}}=665\text{Hz}\pm 179\text{Hz}$) of the phonetogram, the results obtained in this study are similar to those found in studies with men without voice disorders in the post-voice change

($F_{\text{MIN}}=88,89\pm 13,73\text{Hz}$ and $F_{\text{MAX}}=760,96\pm 167,17\text{Hz}$)¹⁴, another which studied voice with training for singing and untrained ($F_{\text{MIN}}=86,1\text{Hz}\pm 14,01\text{Hz}$ and $F_{\text{MAX}}=785,4\text{Hz}\pm 188,38\text{Hz}$)⁹, and similar to those of patients with reflux laryngitis and normal subjects ($F_{\text{MIN}}=83\pm 10,9\text{Hz}$ and $F_{\text{MAX}}=696,6\pm 106,2\text{Hz}$)⁸. Although these studies do not address the Brazilian population, with the exception of a study¹⁴ and do not take into account the facial typology and dento-occlusal harmony, the values were similar.

The average of the vocal extension obtained in this study ($VE=34\text{st}\pm 6\text{st}$) is consistent with that described for the non-professional men singers without changing voice ($VE=37\text{st}$)¹¹; voices of trained and untrained individuals ($VE=34,1\text{st}$)⁶, and two other studies already mentioned ($VE=37\pm 4,70\text{st}$)¹⁴, ($VE=36,6\pm 2,9\text{st}$)⁸. However, the results of the present study was higher than the average obtained by another work ($VE=19,7\pm 2,54\text{st}$)²³ which may be related to the methodology applied, as in this study, the patients underwent computerized automated phonetographs without the presence of the evaluator and the video instructions.

In regards to the fundamental frequency, when comparing the average value ($F_0=111,26\text{Hz}\pm 15,24$) with other studies that also investigated the extent

of F_0 in Brazilian Portuguese speaking men and without vocal alterations, it was observed that the result was similar to a study ($F_{0s}=109,05$)¹⁴. On the other hand, other studies have found fundamental frequency higher than those obtained in the present study, in normal voices ($F_0=120\text{Hz}$)²⁶; standardizing the fundamental frequency in a developed program by the Engineering School of São Carlos ($F_0=127,61\text{Hz}$)²⁷, and to analyze the operation and the type of voice in different microphone positions ($F_0=130,19\text{Hz}$)²⁸. The difference suggests that the dentofacial condition can influence the position of the larynx, and also in the fundamental frequency. In a study conducted after orthognathic surgery it was reported that the change in facial profile of the patient led to changes in the fundamental frequency of the voice and the positioning of the hyoid bone after surgery²⁹.

Considering the average values obtained for the minimum and maximum intensity ($I_{\text{MIN}}=66\text{dB}\pm 3\text{dB}$ and $I_{\text{MAX}}=114\text{dB}\pm 5\text{dB}$), the values were similar to those of two other studies ($I_{\text{MIN}}=66\pm 3,48\text{dB}$ and $I_{\text{MAX}}=118\pm 2,62\text{dB}$)¹⁴ and ($I_{\text{MIN}}=67,6\pm 2,41\text{dB}$ and $I_{\text{MAX}}=115,5\pm 3,84\text{dB}$)²³, but were higher than others ($I_{\text{MIN}}=46,6\text{dB}\pm 5,74\text{dB}$ and $I_{\text{MAX}}=100,3\text{dB}\pm 5,57\text{dB}$)⁹, ($I_{\text{MIN}}=46,2\pm 0,4\text{dB}$ and $I_{\text{MAX}}=95,4\pm 3,7\text{dB}$)⁸ and ($I_{\text{MIN}}=50,9\text{dB}$ and $I_{\text{MAX}}=97,3\text{dB}$)⁶ indicating that the presence of dentofacial equilibrium can facilitate not only the articulation of the headphones, but also the phonation process, allowing to reach higher maximum and minimum intensities, through increased air pressure during phonation, as well as better laryngeal control of the passage of air current^{30, 31}. However, such hypotheses should be tested in future studies, by comparing groups of individuals with dentofacial balanced condition to those with dentofacial deformities.

As for MDE, the result of this study ($\text{MDE}=42\text{dB}\pm 4\text{dB}$) was also similar to reported rates previously described ($\text{MDE}=46\pm 3,68\text{dB}$)¹⁴, ($\text{MDE}=44,2\pm 5,85\text{dB}$)²³, ($\text{MDE}=49,2\pm 3,5\text{dB}$)⁸ and ($\text{MDE}=46,5\text{dB}$)⁶, but lower than what was found in another study ($\text{MDE}=58\text{dB}$)¹¹, that held evidence of distinct phonation tasks employed in the present study.

As to the measure of the phonetogram area the average value ($\text{area}=936,4\text{dB.st}\pm 258,8\text{dB.st}$ or $\text{area}=42,1\text{cm}^2\pm 11,6\text{cm}^2$) was similar to studies described ($\text{area}=51,9\pm 8,85\text{cm}^2$)¹⁴ and ($\text{area}=955,5\pm 100,1\text{dB.st}$)⁸, but higher than others ($\text{area}=568,3\pm 146,58\text{dB.st}$)²³, ($\text{area}=27,6\text{cm}^2$)⁶, and in dysphonic and normal individuals ($\text{area}=25,7\text{cm}^2$)⁷. Considering that the area of phonetogram is understood as being the area resulting from the connection

between all points of the lower and upper curve of the graph, the average obtained in this study was greater than those probably due to the results related to the frequency⁶ and intensity²³ also being higher, reflecting the graph area.

Although the literature did not appear to consider the condition of dentofacial individuals, the results were similar to the $\text{VE}^{6, 8, 11, 14}$ and $\text{MDE}^{6, 8, 14, 23}$, suggesting that the anatomical aspects of the stomatognathic system does not influence such vocal acoustic parameters. Moreover, according to the findings of this study, the fundamental frequency, minimum and maximum intensity, and the phonetogram area can be influenced by the position of articulators, which have intrinsic relationship with the laryngeal speech function.

In the literature, no studies were found that considered the acoustic vocal anatomical conditions of the face and occlusion in men. Although the studies presented did not consider the condition of dentofacial individuals, some results were similar.

In Brazil, there are no studies of standardized reference values for men, despite the phonetography be used as an instrument for voice evaluation. It is suggested that the phonetography be used in other studies to continue the investigation of the possible relationship of vocal parameters in various facial typologies and dento-occlusal relationships.

■ CONCLUSION

This research allowed us to study the profile of the vocal range of individuals with dentofacial balance after voice change through phonetography. The averages from the usual, minimum and maximum frequency were $F_0=111,26\text{Hz}$ (29st), $F_{\text{MIN}}=89\text{Hz}$ (63st) and $F_{\text{MAX}}=665\text{Hz}$, respectively, the average vocal range of 34st and average values of minimum and maximum intensities and maximum dynamic range of $I_{\text{MIN}}=66\text{dB}$, $I_{\text{MAX}}=114\text{dB}$ and $\text{EDM}=42\text{dB}$, and an average area of phonetogram of 936.4dB.st (42.1cm^2).

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RESUMO

Objetivo: caracterizar, por meio de fonetografia, o perfil da extensão vocal em indivíduos sem alterações pós-muda vocal e equilíbrio dentofacial. **Método:** participaram deste estudo 15 homens com idades entre 14 e 35 anos com pós-muda vocal. Eles responderam a um questionário específico, e também foram submetidos a uma avaliação antropométrica da face, a avaliação dento-oclusal, o exame fonetografia e também a uma análise da frequência fundamental habitual da voz. **Resultados:** frequência fundamental mínima: 89Hz \pm 3Hz ou 29st \pm 14st; Frequência fundamental máxima: 665Hz \pm 179Hz ou 63st \pm 5st; Extensão Vocal: 34st \pm 6st; Intensidade mínima: 66 dB \pm 3dB; Intensidade máxima: 114dB \pm 5dB; Extensão Dinâmica Máxima: 42dB \pm 4dB, Área do Fonetograma: 936,4 dB.st \pm 258,8 dB.st ou 42,1 cm² \pm 11,6 cm²; Frequência Fundamental Habitual para a vogal “a”: 111,26 Hz \pm 15,24 Hz. **Conclusão:** apesar de os estudos nacionais e internacionais apresentados neste trabalho não considerarem a condição dentofacial dos indivíduos, os resultados foram semelhantes.

DESCRIPTORIOS: Voz; Qualidade da Voz; Acústica da Fala; Face; Sistema Estomatognático

■ REFERENCES

- Damsté PH. The phonetogram. *Pract. Otorhinolaryng.* 1970;32:185-7.
- Schutte HK, Seidner W. Recommendation by the Union of European Phoniaticians (UEP), *Folia Phoniatri-(Basel)*. 1983;35(6):286-8.
- Montejo J, Garmendia G, Cobeta I. Comparación entre los resultados del fonetograma manual y el fonetograma automático. *Acta Otorrinolaringol Esp.* 2006;57:313-8.
- Holmberg EB, Ihre E, Sodersten M. Phonetograms as a tool in the voice clinic: changes across voice therapy for patients with vocal fatigue. *Logoped Phoniatri Vocol.* 2007;32(3):113-27.
- Ma E, Robertson J, Radford C, Vagne S, El-Halabi R, Yiu E. Reliability of speaking and maximum voice range measures in screening for dysphonia. *J Voice.* 2007;21(4):397-406. Epub 2006 May 5.
- Siupsinskiene N. Quantitative analysis of professionally trained versus untrained voices. *Medicina.* 2003;39(1): 36-46.
- Ikeda Y, Masuda T, Manako H, Yamashita H, Yamamoto T, Komiyama S. Quantitative evaluation of the voice range profile in patients with voice disorder. *Eur Arch Otorhinolaryngol.* 1999;256:S51-5.
- Pribuisiene R, Uloza V, Saferis V. Multidimensional voice analysis of reflux laryngitis patients. *Eur Arch Otorhinolaryngol.* 2005;262(1):35-40.
- Sulter AM, Schutte HK, Miller DG. Differences in phonetogram features between male and female subjects with and without vocal training. *J Voice.* 1995;9(4):363-77.
- Chen SH. Voice range profile of Taiwanese normal young adults: a preliminary study. *Zhonghua Yi Xue Za Zhi (Taipei)*. 1996;58(6):414-20.
- Hacki T. Vocal capabilities of nonprofessional singers evaluated by measurement and superimposition of their speaking, shouting and singing voice range profiles. *HNO.* 1999;47:809-15.
- Leino T, Laukkanen AM, Ilomäki I, Mäki E. Assessment of vocal capacity of Finnish university students. *Folia Phoniatri Logop.* 2008;60(4):199-209. Epub 2008 May 19.
- Teles-Magalhaes LC, Pegoraro-Krook MI, Pegoraro R. Study of the elderly females' voice by phonetography. *J Voice.* 2000;14(3):310-21.
- Oliveira CF. Características biológicas e vocais durante o desenvolvimento vocal masculino nos períodos pré, peri e pós-muda vocal. Tese (Mestrado em Bioengenharia) – Programa de Pós-Graduação Interunidades em Bioengenharia da USP. São Carlos, 2007
- Dimitriev L, Kiselev A. Relationship between the formant structure of different types of supraglottic cavities. *Folia Phoniatri.* 1979;32:238-41.
- Oliveira VL, Pinho SMR. A qualidade da voz e o trato vocal nos indivíduos de face curta e face longa. In: PINHO, S.M.R. Tópicos em voz. Rio de Janeiro: Guanabara Koogan, 2001.
- Garcia RAS, Campiotto AR. Distúrbios vocais x distúrbios musculares orais: possíveis relações. *Pró-fono.* 1995;7(2):33-9.
- Ringel RL, Chodzko-Zajko WJ. Vocal indices of biological age. *J. Voice.* 1987;1:31-7.
- Silva AMT, Morisso MF, Cielo CA. Relationship between the severity of temporomandibular disorder and voice. *Pró-Fono.* 2007;19(3):279-88.

20. Reis SAB, Abrão J, Filho LC, Claro CAA. Análise facial numérica do perfil de brasileiros Padrão I. R Dental Press Ortodon Ortop Facial. 2006;11(6):24-34.
21. Angle EH. Classification of malocclusion. Dent. Cosmos. 1899;41(3):248-64.
22. Langlade M. Diagnóstico Ortodôntico. São Paulo: Editora Santos; 1995.
23. Titze IR, Wong D, Milder MA, Hensley SR, Ramig LO. Comparison between clinician-assisted and fully automated procedures for obtaining a voice range profile. J Speech Hear Res. 1995;38:526-35.
24. Wuyts FL, Heylen L, Mertens F, Du Caju M, Rooman R, Van De Heyning PH, et al. Effects of age, sex, and disorder on voice range profile characteristics of 230 children. Ann Otol Rhinol Laryngol. 2003;112(6):540-8.
25. Camargo TF, Barbosa DA, Teles LCS. Características da fonetografia em coristas de diferentes classificações vocais. Rev Soc Bras Fonoaudiol. 2007;12(1):10-7.
26. Felipe CAN, Grillo MHMM, Grechi TH. Normatização de medidas acústicas para vozes normais. Rev Bras Otorrinolaringol. 2006;72(5):145-9.
27. Araújo SA, Grellet M, Pereira JC, Rosa MO. Normatização de medidas acústicas da voz normal. Rev Bras Otorrinolaringol. 2002;68(4):540-4.
28. Fukuyama E. Análise acústica da voz captada na faringe próximo à fonte glótica através de microfone acoplado ao fibrolaringoscópio. Rev Bras Otorrinolaringol. 2001;67(6):776-86.
29. Jorge TM, Brasolotto AG, Gonçalves ES, Filho HN, Berretin-Felix G.. Influence of orthognathic surgery on voice fundamental frequency. J Craniofac Surg. 2009 Jan;20(1):161-4.
30. Behlau M, Dragone MLS, Nagano L. Voz saudável e disfonia. In: Behlau M, Dragone MLS, Nagano L. A voz que ensina: o professor e a comunicação oral em sala de aula. Rio de Janeiro: Revinter; c2004. p.5-15.
31. Santos CC, Mituuti CT, Berretin-Felix G, Teles LCS. Características da fonetografia em mulheres com equilíbrio dentofacial. Rev Soc Bras Fonoaudiol. 2010;15(4):584-8.

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Mailing address:

Giédre Beretin-Félix

Departamento de Fonoaudiologia

Al. Dr. Octávio Pinheiro Brizolla, 9-75 –

Vila Universitária – Bauru, SP – Brasil

CEP: 17012-901

E-mail: gfelix@usp.br