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Artigo Original

High speed digital videolaringoscopy: evaluation of vocal nodules and cysts in women

Videolaringoscopia digital de alta velocidade: avaliação de nódulos e cistos de pregas vocais de mulheres

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Keywords

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ABSTRACT

Purpose: To evaluate and compare the parameters of Digital kymography obtained through the High-speed Videolaryngoscopy of women without laryngeal disorders, of women with vocal fold nodules and of women with vocal cysts. **Methods:** A cross-sectional observational study in which 60 women aged 18 years and 45 years were selected. Three study groups were formed: 20 women without laryngeal disorder forming the control group (Group 1), 20 women with diagnosis of vocal fold nodules forming Group 2 and 20 women with diagnosis of vocal cysts forming Group 3. Subsequently the participants were evaluated by High-speed Videolaryngoscopy for analysis and comparison of laryngeal images using Digital kymography. The laryngeal parameters processed by the program KIPS® were: minimum, maximum and mean opening; dominant amplitude of the left and right vocal folds; dominant frequency of the right and left vocal folds; and close. **Results:** The analysis of Digital kymography suggests that the presence of the vocal fold nodules and the vocal cysts tend to restrict more to the maximum and minimum opening of the vocal fold and the dominant amplitude of the opening variation in the middle region of the glottis. **Conclusion:** Digital kymography parameters were similar in the presence of vocal fold nodules and vocal cysts lesions.

Descritores

Disfonia
Qualidade da Voz
Pregas Vocais
Quimografia
Laringoscopia
Voz
Mulheres
Distúrbios da Voz
Laringe

RESUMO

Objetivo: Avaliar e comparar os parâmetros da videoquimografia digital obtidos pela videolaringoscopia de alta velocidade de mulheres sem alterações laríngeas, de mulheres com nódulos de prega vocal e de mulheres com cistos vocais. **Método:** Estudo observacional transversal, no qual foram selecionadas 60 mulheres com idade entre 18 e 45 anos. Três grupos foram formados: 20 mulheres sem alterações laríngeas formando o grupo controle (Grupo 1), 20 mulheres com diagnóstico de nódulos nas pregas vocais formando o Grupo 2 e 20 mulheres com diagnóstico de cistos vocais formando o Grupo 3. Posteriormente, os participantes foram avaliados por Videolaringoscopia de alta velocidade para análise e comparação de imagens da laringe usando videoquimografia digital. Os parâmetros videoquimográficos avaliados pelo programa KIPS® foram: aberturas mínima, máxima e média; amplitudes da prega vocal direita e esquerda; frequências da abertura da prega vocal direita e esquerda; e fechamento. **Resultados:** A análise da videoquimografia digital sugere que a presença dos nódulos e dos cistos de pregas vocais tendem a restringir a abertura máxima e média da prega vocal e a amplitude dominante da variação de abertura na região média da glote. **Conclusão:** Os parâmetros da videoquimografia digital foram semelhantes na presença de nódulos nas pregas vocais e lesões de cistos vocais.

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INTRODUCTION

Known as benign lesions of the larynx, nodules and cysts of vocal folds (VF) have as their main effect dysphonia[1], which can be conceptualized as a disorder in vocal emission caused by the change in the VF vibratory pattern, due to inadequate functional adjustments, lesions on the mucosa or association of these factors[1].

Dysphonia is more prevalent in women, justified by the fact that they have, in relation to men, lower FV, as a smaller area of contact and, therefore, subject to greater frictional force between them[2].

The VF is composed of body and cover. The body is formed by the deep part of the lamina propria and by the thyroaritenoid muscle, and acts in harmony with the covering. The cover is composed of the epithelium and the superficial layer of the lamina propria, and allows the propagation of the mucosal wave vertically[3]. The movement of the mucosal wave is initiated by the subglottal pressure of the expiratory air stream, which exerts a pressure against the inferior border of the VF[3].

In the opening phase of the VF the subglottal air pressure causes lateral and caudo-cranial movement of the mucosal wave, characterized by the phase difference between the lower and upper edges of the tunica mucosa. Such movements can be measured from the analysis of the mucosal wave[4]. The lesions involving the VF generate changes in the mucosal wave, making the quantification of its parameters an ally in the diagnosis and treatment of laryngeal lesions[3].

The vocal fold nodules, more prevalent in females[1], are restricted to the epithelium, being a superficial lesion that can reach the basal membrane[2]. The vocal fold nodules have etiology related to vocal abuse, and respond positively to voice therapy treatment[1].

The vocal cysts preferentially located in the superficial layer of the lamina propria, where the VF blood vessels are located, may also involve the vocal ligament[5], which leads to a reduction in the elasticity of the VF mucosa[5].

The differential diagnosis between vocal fold nodules and vocal cysts is important in Otolaryngology and Speech and Language Pathology since they may have different treatment lines. The treatment recommended in the literature of vocal fold nodules is preferably voice therapy[6]. On the other hand, in vocal cysts, depending on the vocal impact generated by the lesion, surgical removal is indicated[7]. The precise and differential diagnosis of these laryngeal lesions allows an adequate behavior with better treatment results[8].

With the advent of optic fiber technology, the diagnosis of laryngeal disorder is currently based on visual assessment of the laryngeal image of videolaryngoscopy, videostroboscopic or High-speed Videolaryngoscopy (HSV).

Videolaryngoscopy, with or without strobe light, is the conventional method for VF[1] analysis. The activation of stroboscopic light is based on the Talbot Law, capable of capturing fragments of a complete movement[8] providing analysis of mucosal vibration, ideal in the identification of intracordial cysts[5].

The videostroboscopic laryngeal has the disadvantage of dependence on a regular phonation for a minimum of two seconds for the stroboscopic light to activate, which restricts its applicability in some cases[9,10]. Patients with irregular cycles of phonation and/or decreased phonatory time present limitations in the stroboscopic evaluation[8]. The luminous “flashes” as they occur randomly, and not successively with each vibratory cycle, result in sequences of asynchronous images without the possibility of adequate interpretation[11].

Overcoming the limitations found in the videostroboscopic arises the HSV capable of recording the irregular vibrations of the VF and of providing essential information for the clinical diagnosis through a quantitative interpretation of successive glottic cycles[12].

Another characteristic of HSV is the more accurate analysis of the glottal area and the mucoondulatory movement of the VF. It is known that the VF vibratory cycle is divided between the open and closed phases and these can undergo changes at each cycle, a phenomenon that may be responsible for the presence of dysphonia and vocal fatigue[1], so its analysis quantitative and qualitative study is extremely important in the laryngological and voice clinics.

In order to facilitate the interpretation of the laryngeal images and the characterization of the periodicity of the VF motion, Kymographic was also improved, a method of video documentation described in 1996 by Svec and Schutte[13], which, by becoming digital, enabled the two-dimensional analysis of the VF[14,15] in real time, through the junction of a sequence of lines obtained from the video images captured through the HSV, which aims to promote greater diagnostic accuracy through better understanding of vibratory phenomena[13].

By offering several options and means of analysis, HSV has been shown to be effective in the diagnosis of laryngeal lesions and its study is in the ascendancy, but because it is a relatively recent method, it remains without a standardization of the images, especially in the case of laryngeal disorder, where few studies are observed[16,17].

The objective of this research was to evaluate and compare the parameters of Digital kymography (DKG) obtained through the HSV of women without laryngeal disorders, of women with vocal fold nodules and of women with vocal cysts.

METHODS

This is a cross-sectional observational study, approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (UFMG), under the number CAAE 4484811.0.0000.5149.

A total of 69 women aged 18-45 years who attended for otorhinolaryngological evaluation in a doctor’s office from January 2015 to January 2016, were submitted to the laryngeal videostroboscopic procedure. All participants had one of the following medical diagnoses: 1) absence of laryngeal disorders;

2) vocal fold nodules; or 3) vocal cysts. Participants agreed to participate in the study by signing the Free and Informed Consent Form.

For the characterization of the sample, normal VF were considered as normal larynx that did not show disorder and complete glottic closure or with glottic chink[17]. The vocal fold nodules were characterized as bilateral and symmetric lesions in position located in the middle third of the FV, and with presence of double slit[18]. The vocal cysts were defined as unilateral disorder that generated decrease of the wave mucus movement in their region, and with presence of glottic chink[18].

For the laryngeal videostroboscopic laryngeal fiber was used 70° mm Mashida® rigid optical fiber, 200W xenon strobe light, Atmos Endo-Stroboscopel model and Toshiba® microcamera, recorded on Toshiba® DVD. After placing the subject in a comfortable and seated position, the optic fiber was introduced through the mouth and oropharynx after topical anesthesia with xylestesin® 10%, until a satisfactory image of the larynx was obtained, and the participant was asked to pronounce the sustained vowels / i / in the usual way.

At the moment of the videostroboscopic exam, pregnant women with exacerbated nausea reflex were excluded, who were in the menstrual or pre-menstrual period, individuals with cervical surgeries, upper respiratory infectious diseases at the time of examination, or hormonal diseases.

Also excluded were women who did not have the otorhinolaryngological diagnosis confirmed by HSV of: 1) larynx without alteration and complete glottic closure; 2) vocal fold nodules; or 3) vocal cysts. At this stage, nine women were excluded from the 69 participants evaluated, because of the changed of laryngeal diagnostic to polyp of VF (six participants) and sulcus vergeture (three participants).

In the evaluation with HSV, 2000 images were recorded per second using a 70° rigid laryngoscope with 300 W of Xenon light with high-speed Videolaryngoscopy (KayPENTAX Photron Motion, Montvale, NJ, USA) model 9710. The resolution of the image used was 512 × 512 pixels with 8 bit RGB color mode.

The laryngeal images were obtained by recording with the emission of the vowel / i /, at usual frequency and intensity, being selected sequences of images excluding the beginning of the emissions.

All examinations were performed by a single physician, seeking a uniformity in the performance of the evaluations. The analysis of laryngeal images, also performed by a single physician, occurred through the image processing program called KIPS® (Kay's Image Processing Software) supplied by KayPENTAX® (Montvale, NJ, USA)[3].

After HSV, 60 women were selected, who formed three groups. For the control group (G1), 20 women aged 18 to 45 years (mean of 26 years) without vocal complaints were recruited and presented laryngeal image without alteration. The group of individuals with vocal fold nodules (G2) consisted of 20 women aged 18 to 40 years (mean age 31 years). The group with vocal cysts (G3) was formed by 20 women, aged between 18 and 45 years (average of 35 years). Of the 20 women with vocal cysts, nine (45%) had cysts in the right vocal fold and 11 (55%) had left vocal fold.

The three groups were paired by age and defined by means of the otorhinolaryngological evaluation of the same physician after the evaluation with HSV.

The analysis of laryngeal images, also performed by a single physician, occurred through the image processing program called KIPS® (Kay's Image Processing Software) supplied by KayPENTAX®, with the following parameters being selected of the Digital kymography (DKG).

Analysis of Digital Kymography (DKG)

For the creation of DKG of multiple lines, three horizontal lines are represented in Figure 1 by the numbers 1, 2 and 3 and two vertical lines positioned in order to define the limit of the selected VF.

The horizontal lines delimited the FV in four parts so that the number 2 line was positioned at the midpoint of the FV of the individuals without disorders, because it is the area of greater mobility of the same, and in the laryngeal lesions suggestive of nodules or cysts was placed in the lesion area. The upper line of number 1 corresponded to the posterior region of the FV, without covering the respiratory region of the glottis, and a lower line of number 3 was positioned in the anterior region (Figure 1).

The program then automatically performed the two-dimensional creation of the mucoondulatory movement and the comparison of the symmetry of the movement of the VF

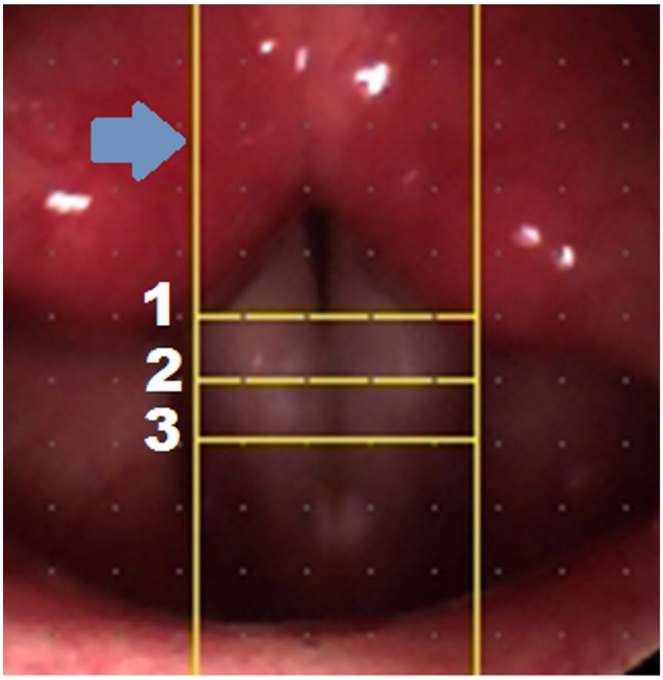

Figure 1. Photograph of a normal larynx, with the vocal folds in the center, delimiting the Digital kymography analysis

mucosa. The images portrayed have also been transformed to shades of gray. The selection of a rectangle in the green images to delimit the analysis region with VF edge design for DKG creation was done manually.

Each vertical row corresponds to the movement of the VF in an area of the glottic cycle (indicated by the horizontal lines 1, 2 and 3), where the X (horizontal) axis represents the vibration amplitude of the VF and the Y axis (vertical), the time. The right vocal fold movement is shown on the right side of the DKG and the left side on the left side (Figure 2).

After creating the DKG images, the system automatically generated a table with numeric values in pixels, providing the following laryngeal parameters:

- **Minimum opening**: minimum opening in the region displayed in the window at the kymographic line. Zero indicates complete closure;
- **Maximum opening:** maximum opening in the region displayed in the window at the kymographic line;

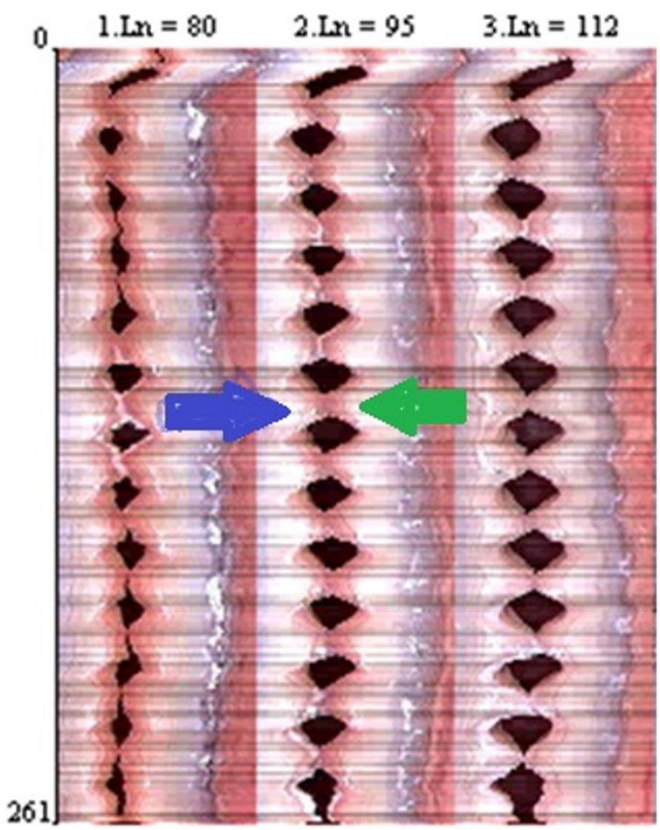

Figure 2. Analysis of the Digital kymography representing the three horizontal lines of Figure 1. The first row corresponding to line 1 (posterior region of the vocal fold), the second row corresponds to line 2 (middle region of the vocal fold) and the third row corresponds to line 3 (anterior region of the vocal fold). The blue arrow corresponds to the right vocal fold and the green arrow corresponds to the left vocal fold

- **Mean opening**: mean opening in the region displayed in the window at the kymographic line;
- **R-amp**: dominant amplitude of the opening variation of the right vocal fold at the kymographic line;
- **L-amp:** dominant amplitude of the opening variation of the left vocal fold at the kymographic line;
- **R-freq**: dominant frequency of the opening variation of the right vocal fold at the kymographic line;
- **L-freq**: dominant frequency of the opening variation of the left vocal fold at the kymographic line;
- **Close:** The ratio of the number of the frames of glottal total closure over the total number of frames in the calculation. Zero means that the vocal folds at that kymographic line never closes; and one means that the vocal folds at that kymographic line never opens.

Statistical analysis of the data was performed using the statistical program R (version 3.2.4). First, a descriptive analysis of the data was carried out with measures of central tendency and dispersion. The Kruskal-Wallis test was used to compare the DKG parameters in the three groups. Multiple comparisons were made using the Nemenyi test. A significance level of 5% was considered in all analyzes.

RESULTS

The DKG analysis from the three horizontal lines were made. Table 1 shows the parameters of the region delimited by Line 1 (posterior region of the glottis). The dominant amplitude of the VF variation was higher in the G1 group compared to the G2 ($p = 0.04$) and G3 ($p = 0.01$) groups.

In the results obtained in the analysis of DKG in Line 2 (middle region of the glottis) the G1 presented greater maximum opening than G2 ($p = 0.01$) and G3 ($p = 0.00$). In the mean opening analysis, it was observed that the G1 group presented higher value than G3 ($p = 0.01$).

The dominant amplitude of the opening variation of the left VF showed that G1 has an amplitude with values greater than G3 ($p = 0.00$). In relation to the dominant amplitude of the opening variation of the right VF, the G1 group presented higher values than the G3 ($p = 0.00$) as presented in Table 2.

Table 3 shows the results of Line 3 DKG, corresponding to the anterior region of the glottis. It was observed that the group G1 presented a greater maximum opening and mean opening than G2 ($p = 0.02$) and G3 ($p = 0.00$).

The results of the DKG suggest that the presence of the vocal fold nodules and the vocal cysts tend to restrict further the maximum and mean opening of the VF and the dominant amplitude of the opening variation in the middle region of the glottis, probably because these lesions mainly in this VF region.

Table 1. The parameters of the region delimited by Line 1 (posterior region of the glottis)

Parameters		Mean	SD	Median	p-value
Minimum opening	**G3**	1.50	4.63	0.00	0.343
	G2	0.25	1.12	0.00	
	G1	0.00	0.00	0.00	
Maximum opening	**G3**	16.00	6.32	15.50	0.092
	G2	14.60	4.71	14.00	
	G1	18.65	7.06	19.00	
Mean opening	**G3**	11.36	4.80	10.81	0.648
	G2	10.08	3.07	9.72	
	G1	10.45	4.58	10.13	
L-amp	**G3**	1.50	1.11	1.19	0.036*
	G2	1.96	1.48	1.20	
	G1	2.95	1.92	2.45	
L-freq	**G3**	264.06	119.34	289.06	0.994
	G2	267.58	91.66	265.63	
	G1	274.61	103.87	246.10	
R-amp	**G3**	1.45	1.22	1.11	0.005*
	G2	1.74	1.21	1.27	
	G1	3.17	2.09	2.79	
R-freq	**G3**	235.94	134.90	242.19	0.807
	G2	266.01	93.89	265.63	
	G1	274.61	103.81	246.10	
Close	**G3**	0.01	0.01	0.00	0.916
	G2	0.01	0.00	0.00	
	G1	0.00	0.00	0.00	

Kruskal-Wallis

Caption: G3 = vocal fold cyst; G2 = vocal fold nodule; G1 = vocal fold without laryngeal disorder; SD = standard deviation; L-amp = amplitude of the left vocal fold; L-freq = frequency of the left vocal fold; R-amp = amplitude of the right vocal fold; R-freq = frequency of the right vocal fold. All values are represented in pixels. Values marked with * represent p≤0.005

Table 2. Comparison of kymographic parameters between groups in Line 2 - the middle region of the glottis

Parameters		Mean	SD	Median	p-value
Minimum opening	**G3**	0.55	2.46	0.00	0.601
	G2	0.30	1.34	0.00	
	G1	0.00	0.00	0.00	
Maximum opening	**G3**	11.80	6.98	12.00	0.000*
	G2	14.15	5.33	14.50	
	G1	19.65	5.41	20.00	
Mean opening	**G3**	6.39	5.77	4.69	0.013*
	G2	8.12	4.71	8.62	
	G1	11.42	4.90	11.77	
L-amp	**G3**	1.24	1.11	1.01	0.002*
	G2	1.81	1.25	1.66	
	G1	2.93	1.81	2.55	
L-freq	**G3**	223.83	131.67	234.38	0.887
	G2	245.70	99.57	234.37	
	G1	257.03	114.98	218.75	
R-amp	**G3**	1.23	1.20	0.92	0.001*
	G2	1.89	1.38	1.58	
	G1	3.18	2.04	2.94	
R-freq	**G3**	241.41	129.47	226.56	0.772
	G2	228.12	116.39	212.89	
	G1	263.67	112.81	230.47	
Close	**G3**	0.01	0.01	0.01	0.864
	G2	0.01	0.01	0.01	
	G1	0.00	0.00	0.00	

Kruskal-Wallis

Caption: G3 = vocal fold cyst; G2 = vocal fold nodule; G1 = vocal fold without laryngeal disorder; SD = standard deviation; L-amp = amplitude of the left vocal fold; L-freq = frequency of the left vocal fold; R-amp = amplitude of the right vocal fold; R-freq = frequency of the right vocal fold. All values are represented in pixels. Values marked with * represent p≤0.005

Table 3. Comparison of kymographic parameters between groups in Line 3 – the anterior region of the glottis

Parameters		Mean	SD	Median	p-value
Minimum opening	**G3**	0.95	3.03	0.00	0.772
	G2	0.25	1.12	0.00	
	G1	1.00	3.23	0.00	
Maximum opening	**G3**	14.35	5.71	15.00	0.001*
	G2	15.95	4.12	17.00	
	G1	19.80	4.63	20.00	
Mean opening	**G3**	10.43	4.62	11.25	0.039*
	G2	10.44	4.07	9.55	
	G1	13.30	4.63	14.16	
L-amp	**G3**	1.21	0.60	1.12	0.065
	G2	1.83	1.36	1.34	
	G1	2.09	1.50	1.42	
L-freq	**G3**	207.42	108.30	187.50	0.619
	G2	235.16	104.34	205.08	
	G1	221.09	86.30	191.41	
R-amp	**G3**	1.05	0.54	1.03	0.589
	G2	1.46	1.06	0.99	
	G1	1.71	1.55	1.15	
R-freq	**G3**	202.34	100.01	191.41	0.913
	G2	210.16	99.33	203.12	
	G1	201.17	77.38	187.50	
Close	**G3**	0.01	0.01	0.01	0.722
	G2	0.01	0.00	0.01	
	G1	0.01	0.00	0.01	

Kruskal-Wallis
Caption: G3 = vocal fold cyst; G2 = vocal fold nodule; G1 = vocal fold without laryngeal disorder; SD = standard deviation; L-amp = amplitude of the left vocal fold; L-freq = frequency of the left vocal fold; R-amp = amplitude of the right vocal fold; R-freq = frequency of the right vocal fold. All values are represented in pixels. Values marked with * represent p≤0.005

DISCUSSION

Nodules and VF cysts are the most prevalent benign lesions of the larynx(19) and because they have different etiological factors(20), present different clinical behaviors. The vocal fold nodules are mostly indicated for speech therapy(7), and the VF cysts, depending on the vocal limitation they generate, are indicated for surgery(7).

The main hypothesis of this research was that HSV, because it is an objective diagnostic procedure with the use of DKG(21,22), which makes possible the analysis of successive glottic cycles(23), would be able to aid in the differential diagnosis of VF nodules and cysts.

The results of this research show that DKG analysis parameters were not able to differentiate lesions nodules and cysts from VF. Comparisons between groups of HSV parameters show that both the vocal fold nodules and the vocal cysts differed from the group without laryngeal disorders, and in these cases, the vocal cysts presented greater distinction, suggesting that these lesions may generate greater limitations in the mucoondulatory movement and in the glottic closure, which the vocal fold nodules. Studies with a larger sample size are necessary to better understand the real contributions of HSV in the differential diagnosis of vocal fold nodules and vocal cysts.

Were found in the literature a single research(24) that aimed to analyze the vibratory characteristics of VF through the videostroboscopic and the HSV image in individuals with vocal fold nodules and vocal cysts. A total of 151 patients, aged between 22 and 84 years, of whom 52 were men and 99 women, and the authors observed that, when comparing the results of both evaluation procedures, HSV was able to more accurately report the characteristics of vibration amplitude of the mucosal wave. Patients previously diagnosed by the videostroboscopic vocal fold nodules had their diagnosis altered after performing the HSV for vocal cysts due to the lower amplitude characteristics of the VF mucosal wave. The different results with this research, where HSV did not present differences between DKG parameters in the vocal fold nodules and vocal cysts groups, can be explained by methodological questions. Our study looked at the quantitative results of DKG, while the other study(24) visually evaluated the images of HSV. In the analysis of the results of this research, it was not possible to observe a pattern of response of the DKG parameters, important for the differential diagnosis of FV nodules and cysts, not confirming the hypothesis of the initial survey.

Over the years, several studies have begun to improve the technique and interpretation of HSV exams, in order to study and better understand the mechanism of phonation in the presence of dysphonia and laryngeal disorders(25-27).

The VF vibratory behavior may be an important source of investigation of the alterations that occur in them, and its subjective analysis, based on the visual interpretation of the laryngeal image, may require some experience on the part of the evaluator[8]. The measurement of glottal area variables that aid in the interpretation of the glottic cycle can become an ally in the differential diagnosis in otorhinolaryngological clinical practice and in the voice clinic. DKG is able to provide excellent insight into the dynamics of FV, including assessment of periodicity, which is difficult to observe only with the image provided by HSV[28].

A study[25] that compared the parameters of the glottal area before and after the removal of polyps of VF in female and male patients observed higher values of maximum area, maximum opening and maximum area rate after laryngeal microsurgery to remove polyps of VF[25]. In our study, vocal folds without alterations also presented higher values in relation to maximum and mean opening when compared to vocal cysts and vocal fold nodules. These parameters may explain the rigidity that the lesion provides in the case of vocal cysts and, in the case of vocal fold nodules, due to the mass effect of the lesion, which prevents glottal closure as opposed to the greater malleability of the mucosal tunica in normal FV. During the closure phase of the VF the elastic properties of the tissue allow it to return to its initial position in the middle of the glottis, and the presence of the lesion in the VF prevents its complete return, making the maximum and mean opening in these patients smaller[28].

The analysis of DKG in the posterior region of the glottis (Line 1) showed that the group without alterations in VF presented higher values of dominant amplitude of the opening variation of the right vocal fold (R-amp) and of the left vocal fold (L -amp) when compared to the groups of vocal fold nodules and cysts. Such results can be explained by the fact that nodular and cystic lesions generate a posterior glottic chink with reduction of the mucosal wave amplitude[7].

The DKG values in the middle region of the glottis (Line 2) of the group of women without laryngeal disorders were higher in the maximum opening, mean opening, R-amp and L-amp parameters. DKG analysis suggests that the presence of vocal fold nodules and vocal cysts tend to further restrict the parameters of the middle region of the glottis because the vocal fold nodules[7,18] and vocal cysts[7] are located in the most often in this VF region.

In the anterior region of the glottis (Line 3) the parameters of maximum and mean opening were higher in the group without laryngeal disorders, reinforcing the sign that the lesions of vocal fold nodules and vocal cysts alter the amplitude of the mucosal movement wave of VF[7,18].

In the three glottic regions evaluated, represented by the DKG lines 1, 2 and 3, the amplitude of the right and left VF was smaller in the group with cyst (G3), compared to the group of nodules (G2), however, without statistical significance. The literature describes that the cystic lesion decreases the movement of the mucosal wave[5], which can be observed in this research. It is reasonable to assume that a sample with a larger number of participants can bring more information about the amplitude of the mucosal wave DKG parameter between nodules and cysts.

The DKG parameters of the dominant frequency of the right vocal fold fold (R-freq) and the left vocal fold (L-freq) did not present differences between groups in any of the regions of the glottis. A survey[29] with 14 women observed insignificant asymmetries between the right and left VF movement, which may justify the results of this research.

The parameter Close that represents the ratio of the number of frames of glottal total closure over the total number of frames in the calculation was close to zero in the three studied regions of the glottis in groups with vocal fold nodules, vocal cysts and no laryngeal disorder. These results suggest that the FV does not close completely in the delimited kymographic line. This result was not evaluated by other studies in the literature.

HSV, because it is a quantitative and objective method, is an important complementary exam to the videostroboscopic[29], since it allows visualization of the actual movement of the FV, especially in cases of aperiodic vocal cycles. Future studies are needed to seek standardization in the evaluation of HSV parameters, and the real understanding of their clinical and diagnostic contributions to laryngeal disorders.

As limitations of the study it is emphasized that the measurements of the DKG analysis present a great variability, therefore, studies with a larger sample size are important for the scientific development.

Another limitation is the fact that a single otolaryngologist performs the analysis of laryngeal images. Future research to assess the degree of inter- and intra-rater agreement in the analysis of VHS images are important to analyze the degree of reproducibility of these measures.

CONCLUSION

The DKG analysis suggests that the presence of vocal fold nodules and vocal cysts tend to restrict further the maximum and mean opening of the VF and the dominant amplitude of the opening variation in the glottis. The middle region of the glottis tends to be the most restrict area of the glottis, probably because these lesions mainly in this VF region.

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Author contributions

RCCDO participated in the idealization of the study, collection, analysis and interpretation of data and writing of the article; PFLG participated of the data collection and interpretation of data; ACCG and MARS participated, as supervisors, in the idealization of the study, analysis, data interpretation and writing of the article.