Effectiveness of Laryngostroboscopy for Monitoring the Evolution of Functional Dysphonia after Rehabilitator Treatment

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Abstract The aim of this study is to evaluate the effectiveness of the laryngostroboscopy for monitoring the evolution of patients with functional dysphonia before and after the logopedic vocal treatment. We performed a prospective observational study of 65 dysphonic patients diagnosed of functional dysphonia, where we analyzed four stroboscopic parameters (glottal closure, vocal fold vibration, mucosal wave and phase symmetry) by a protocol based on systematic subjective evaluation of the stroboscopic images before and after the rehabilitator treatment; and the results were stratified according to the clinical course. All patients, before the treatment, had some abnormality in at least one of the four analyzed aspects. After the vocal treatment, we found improvement of the four parameters in different degrees, and we just found a statistically significant relationship between the evolution of the glottal closure and the clinical course. We believe that the laryngostroboscopy, systematized through a protocol, is a useful technique for the diagnosis of functional abnormalities in patients with functional dysphonia but it is

not a very useful technique for evaluating the results after the rehabilitator treatment, as there is not a statistically significant relationship between clinical course and the change in the most stroboscopic parameters, so it shouldn't be the only technique used for these proposes.

Keywords Effectiveness · Laryngostroboscopy · Functional dysphonia · Vocal treatment

Introduction

Until relatively recently there were no objective and exact procedures for voice evaluation, and many professionals depended on their own hearing. In 1992, however, the *International Association of Logopedics and Phoniatrics* stated that evaluation of dysphonia on the basis of the professional's own sight and hearing alone is not sufficient, and that objective standardized instrumental protocols are required [1–3]. Objective evaluation protocols are necessary for monitoring of clinical course, for comparison of pre- and post-treatment status, for comparison between treatment groups in clinical and experimental studies, and, increasingly, for legal purposes.

Although we consider that the human ear is a very useful instrument for voice analysis, subjective assessments are clearly difficult to compare between different professionals, and even a single professional may give different evaluations of a single voice sample [4].

The voice is a multidimensional phenomenon, so any simple measure will give only partial information. The current trend is thus to use multidimensional measures of vocal function, combining perceptual and instrumental measures [5].

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The main instrumental measures currently available for objective evaluation of voice are morphofunctional techniques, notably laryngostroboscopy, and acoustic analysis.

In the present study we evaluate voice by laryngostroboscopy, in patients diagnosed of functional dysphonia before and after the logopedic vocal treatment with the aim of evaluating its effectiveness in monitoring the evolution.

Materials and Methods

We performed a prospective observational study of 65 dysphonic patients diagnosed of functional dysphonia by the Phoniatics Unit of our hospital, over 5-year period (mean age 34 years, range 13–59 years; 57 women, 8 men).

For laryngostroboscopy we used a Storz^R model 8010 laryngostroboscope equipped with a rigid Storz^R model 8706 CH 90°-10 mm laryngoscope. Images were visualized and recorded with an Endovision DX-CAM^R video system and a Sony monitor. For the examination and interpretation we followed the standard procedure of Hirano and Bless [6]. Each case was documented by two different protocols: a protocol based on systematic subjective evaluation of the stroboscopic images [the four parameters included in analysis were glottal closure (complete or incomplete), fold vibration (present or absent), right and left mucosal wave (normal or absent/abnormal), and phase symmetry (symmetric or asymmetric)], and a narrative description and digital recording. All parameters were analyzed before and after the vocal treatment.

Vocal rehabilitator treatment was performed in all cases. It was performed after a mean of 23.2 days after the initial diagnosis. The average duration of each session was 45 min and the number of sessions varies depending on the circumstances; in most cases between 30 and 40 sessions was required, over 6–12 months. The stages of this vocal treatment can be summarized en:

- 1) Initially, and whenever possible, we started with a vocal rest for about 10 days, to reduce the tension mechanisms that the patient has automated and try to get the ventricular bands back and to recover the normal mobility of the true vocal folds.
- 2) Relaxation exercises, choosing between different techniques, which should continue even after the end of treatment to install a definitive muscle relaxation habits.
- 3) Respiratory exercises, to achieve the automation of the cost-diaphragmatic breathing mechanism in the supine, sitting and standing positions, with associated movements of arms and head to eliminate muscle contractions during breathing and to change the bad respiratory habits that affect the vocal function.

- 4) Impostation exercises to create gradually the vocal schema and the vibratory sensations in the resonance cavities, to facilitate the relaxation of the tongue muscles and to increase the flexibility of the jaw. In this step it's important to achieve a physiological glottal attack [7].

When the speech therapist finishes the vocal treatment, patients were classified into two groups (clinical improvement/no clinical improvement), based in the opinion of the phoniatic and the speech therapist, based on their subjective perceptual assessment of the voice, using especially GRBAS scale, and on the acoustic and gestural characteristics of voice after treatment. We consider a perceptual clinical improvement if the score of the scale GRBAS decreases en seven or more points. The results of the stroboscopic analysis were stratified according to the clinical course [8].

We compared for each studied stroboscopic parameter, by contingency tables, the qualitative variable (clinical improvement, no clinical improvement) with the qualitative variable (stroboscopic improvement/no stroboscopic improvement), using the *Chi square* test, to determine whether a significant statistical association exists between both variables, calculating the *P* value associated with the statistic contrast and rejecting the null hypothesis (no differences between the two groups) when the *P* value is <0.05.

Results

The results of the four laryngostroboscopic parameters included in analysis, before and after the vocal treatment are listed in Table 1:

We found that all patients showed alteration of at least one of these parameters in the diagnosis moment.

After the vocal treatment, and in patients who had presented alterations in any of these parameters, we found improvement of vocal vibration in 52.27 % of cases, improvement of mucosal wave in 50 % of cases, improvement of asymmetry in 68.75 % of cases and improvement of glottal closure in 33.9 % of cases, (regardless of the clinical course). In the other cases the analyzed parameters remain unchanged or have even worsened in some cases.

Patients were classified by the phoniatic and the speech therapist into two groups regard to their clinical course: 57 patients (87.7 %) who presented clinical improvement and 8 patients (12.3 %) without any clinical improvement; and then the stroboscopic results were stratified according to the clinical course.

We calculate, individually, the relationship between the evolution of each of the four analyzed parameters and the clinical course. For that we considered in the same group

Table 1 Results of laryngostroboscopic parameters before and after the vocal treatment

Parameter	Pre-treatment		Post-treatment	
Glottal closure	(Incomplete)	(Complete)	(Incomplete)	(Complete)
	59	6	42	23
	(90.8 %)	(9.2 %)	64.6 %	(35.4 %)
Fold vibration	Absent/altered	Present	Absent/altered	Present
	44	21	25	40
	(67.7 %)	(32.3 %)	(38.5 %)	(61.5 %)
Mucosal wave	Absent/altered	Present	Absent/altered	Present
	38	27	21	44
	(58.5 %)	(41.5 %)	(32.3 %)	(67.7 %)
Phase symmetry	Asymmetric	Symmetric	Asymmetric	Symmetric
	16	49	6	59
	(24.6 %)	(75.4 %)	(9.2 %)	(90.8 %)

those patients whose stroboscopic findings remained without change and those who have deteriorated, and in another group whose findings have improved (Table 2):

We found a statistically significant relationship between the evolution of the glottal closure and the clinical course, so the glottal closure has remained the same in all cases who have not improved, while we didn't find a significant relationship in the other three analyzed stroboscopic findings (vocal fold vibration, mucosal wave and symmetry phase).

So, in patients who didn't have clinical improvement, the stroboscopic examination revealed improvement of the vibration and of the asymmetry in 37.5 % and improvement of the mucosal wave in 25 % of cases; while in these patients who have had clinical improvement, the stroboscopic exploration showed improvement of glottal closure in 35 %, improvement of vibration in 35 %, improved in mucosal wave in 30 % and improvement of asymmetry phase in 14 % of cases.

Discussion

Laryngostroboscopy is generally considered nowadays to be the most useful technique for diagnosis of vocal disorders, since it allows detailed examination of the vocal cords and (through detailed analysis of digital recordings) detection of dysphonias, vibratory asymmetries, structural

alterations, small masses, submucosal scarring and other alterations that are not visible under normal light. It is also extremely sensitive for the detection of paresis and paralyses of the vocal cords due to minimum laryngeal tumor [9, 10].

Sataloff et al. [9] analysed 1,876 laryngostroboscopic procedures performed over a 5-year period in "professional voice users" with dysphonia and known diagnosis. They found that in 29 % of patients the stroboscopy not only confirmed the existing diagnosis but also supplied additional diagnostic information, while in 18 % of patients the stroboscopy indicated that the existing diagnosis was incorrect.

Dejonckere et al. [11] compared the evaluations of laryngostroboscopic videos by various speech therapists, and found good inter-observer (differences of evaluation between different observers) and intra-observer (differences evaluated by the same observer at different times) consistency for all examined parameters.

Elias et al. performed a stroboscopic study of 65 professional singers without voice problems, obtaining "abnormal stroboscopic findings" (potentially confusable with six different pathological entities) in 58 % of patients. Such abnormalities may be mistakenly identified as the cause of voice problems at a patient's first consultation [12]. Heman-Ackah et al. performed laryngostroboscopic exams in 20 singers, 7 of whom reported voice problems, and 13 of whom

Table 2 Relationship between the evolution of the stroboscopic parameters and the clinical course

Parameter	Clinical improvement (57 patients)				No clinical improvement (8 patients)				Chi square (<i>P</i> value)
	Worse	Same	Better	Total	Worse	Same	Better	Total	
Glottal closure	3	34	20	57	0	8	0	8	0.043
Fold vibration	3	34	20	57	1	4	3	8	0.59
Mucosal wave	1	39	17	57	1	5	2	8	0.57
Phase symmetry	0	49	8	57	1	4	3	8	0.126

perceived their voice as normal. The results obtained indicated that the presence of lesion in the vocal cords was more common among the subjects who considered their voice to be normal, while hypomobility of the vocal folds was more common in the subjects who reported voice problems [13].

Regarding functional dysphonia, Sama et al. [14] say that the laryngoscopic characteristics commonly associated with this type of dysphonia are common in the normal population and cannot distinguish dysphonic patients from normal subjects.

Thus, we consider that the reliable diagnostic use of stroboscopic data requires the phoniatrist to be aware of the range of laryngeal behaviours that may occur in normal subjects, and that a degree of caution needs to be applied. This may be particularly important when we are dealing with minor voice problems in professional voice users.

Speyer et al. [15] analyzed the digitized stroboscopic images of benign larynx pathologies after 3 months of voice therapy and found in about 50 % of patients a significant improvement in lesion size and improvement of the vibration of vocal cords and of the of glottal closure.

Despite the various objective and subjective tools, currently there is no standard measure of the vocal function and the “meta-analysis” of the results of vocal treatments are limited due to the diversity of the functional measurement methods [16].

Preciado et al. performed a case–control study to select the most appropriate methods for the measurement of vocal function. The studied methods included: anamnesis, clinical examination, laryngostroboscopy, perceptual evaluation, basic aerodynamic tests and acoustic and spectrographic analysis. They found no evidence that any of these methods distinguishes, with sufficient sensitivity, between dysphonic and normal voices, since their values are always overlap [17].

In 1992, Arias et al. recommended the use of a standard protocol to evaluate the laryngeal structure and function in patients with vocal disorders, which has to be designed to cover all essential parameters needed to achieve an accurate descriptive diagnosis and to obtain an appropriate and individualized treatment plan. They also recommended a standardized assessment of the changes after vocal therapy. These protocols should include, at least: laryngoscopy, videostroboscopy, acoustic analysis, subjective evaluation and perceptual evaluation of voice [18].

Dejonckere et al. evaluated the functional results of voice therapy in 45 patients with various organic and functional vocal disorders before and after the vocal therapy, by GRBAS scale, laryngostroboscopy, aerodynamic tests, acoustic analysis and subjective evaluation. The results show that there is a lot of inter-individual and inter-dimensional variation in the results; and in the same patient, one dimension can be improved significantly while

another is significantly worse. The five measures considered separately were considered of a limited value [19].

So, Dejonckere presented in the Phoniatrics Committee of The European Society of Laryngology (ELS) a multi-dimensional basic protocol, based on the literature review, the experience of the members of the committee and the plenary discussions within ELS, in order to achieve a better agreement and uniformity on the evaluation methodology of voice disorders and to allow comparisons between the results of the vocal treatment in different centres. He proposed a minimum and multidimensional system of basic measures which can be suitable for all common dysphonias and which includes five basic elements: GRBAS scale, videostroboscopy (glottal closure, vibration, mucosal wave and symmetry), acoustic analysis (jitter, shimmer, F0), aerodynamic studies (phonation ratio) and subjective evaluation [19–21].

Conclusion

The laryngostroboscopy, systematized through a protocol, is a useful technique for the diagnosis of functional abnormalities in patients with functional dysphonia, detecting at least some alterations in the parameters most commonly analyzed. However it shouldn't be the only technique used for the diagnosis given the high percentage of abnormal stroboscopic findings found in healthy people.

The laryngostroboscopy, however, is not very useful for evaluating the results after the vocal treatment, as we didn't find a statistically significant relationship between clinical course and the change of the analyzed stroboscopic findings (except in the case of glottal closure), so we consider that it shouldn't be the only technique used for this purpose, since in some patients the improvement of stroboscopic findings is not corresponding with the perceptual improvement of voice.

Conflict of Interest The authors declare that they have no conflict of interest.

References

1. Bless DM (1991) Measurement of vocal function. *Otolaryngol Clin N Am* 24(5):1023–1033
2. Lockhart MS (1998) Objective assessment of voice intervention: a clinical audit. *Int J Lang Commun Disord* 33:316–321
3. Di Nicola V, Fiorella ML, Luperto P, Staffieri A, Fiorella R (2001) Valutazione obiettiva de disfonia. Possibilità e limitazioni *Acta Otorhinolaryngol Ital* 21(1):10–21
4. Rabinov CR, Kreiman J, Gerratt BR, Bielamowicz S (1995) Comparing reliability of perceptual ratings of roughness and acoustic measure of jitter. *J Speech Hear Res* 38(1):26–32
5. Carding P, Carlson E, Epstein R, Mathieson L, Shewell C (2001) Re: Evaluation of voice quality. *Int J Lang Commun Disord* 36(1):127–134

6. Hirano M, Bless DM (1993) Videostroboscopic examination of the larynx. Singular Publishing Group Inc., San Diego, pp 15–32
7. Bustos Sánchez I (1991) Reeducción de problemas de la voz. 4^a Edición. Ed. Impresos y Revistas SA, pp 129–205
8. Núñez Batalla F, Corte Santos P, Sequeiros Santiago G, Señaris González B, Suárez Nieto C (2004) Evaluación perceptual de la disfonía: correlación con los parámetros acústicos y fiabilidad. *Acta Otorrinolaringol Esp* 55:282–287
9. Sataloff RT, Spiegel JR, Hawkshaw MJ (1991) Stroboscovideolaryngoscopy: results and clinical value. *Ann Otol Rhinol Laryngol* 100(9):725–727
10. García-Tapia Urrutia R (1996) Estroboscopia. In: García Tapia R, Cobeta Marco I. Diagnóstico y tratamiento de los trastornos de la Voz. Editorial Garsi, S.A. Madrid, pp 111–124
11. Dejonckere PH, Crevier L, Elbaz E, Marraco M, Millet B (1998) Quantitative rating of video-laryngostroboscopy: a reliability study. *Rev Laryngol Otol Rhinol (Bord)* 119(4):259–260
12. Elias ME, Sataloff RT, Rosen DC, Heuer RJ, Spiegel JR (1997) Normal stroboscovideolaryngoscopy: variability in healthy singers. *J Voice* 11(1):104–107
13. Heman-Ackah YD, Dean CM, Sataloff RT (2002) Stroboscovideolaryngoscopic findings in singing teachers. *J Voice* 16(1): 81–86
14. Sama A, Carding PN, Price S, Kelly P, Wilson JA (2001) The clinical features of functional dysphonia. *Laryngoscope* 111(3): 458–463
15. Speyer R, Weineke G, Hosseini EG, Dejonckere PH (2002) Effects of voice therapy as objectively evaluated by digitized laryngeal stroboscopic imaging. *Ann Otol Rhinol Laryngol* 111(10):902–908
16. Klein S, Piccirillo JF, Painter C (2000) Comparative contrast of voice measurements. *Otolaryngol Head Neck Surg* 123(3): 164–169
17. Preciado JA, Garcia Tapia R, Infante JC (1998) Multi-dimensional analysis of vocal function. A case-control study. *Acta Otorrinolaringol Esp* 49(6):467–474
18. Arias C, Bless DM, Khidr A (1992) Use of standard protocols in the evaluation of voice disorders. *Rev Laryngol Otol Rhinol (Bord)* 113(4):359–364
19. Dejonckere PH (2000) Clinical implementation of a multidimensional basic protocol for assessing functional results of voice therapy. A preliminary study. *Rev Laryngol Otol Rhinol* 121(5): 311–313
20. Dejonckere PH, Remacle M, Fresnel-Elbaz E, Woisard V, Crevier-Buchman L, Millet B (1996) Differentiated perceptual evaluation of pathological voice quality: reliability and correlations with acoustic measurements. *Rev Laryngol Otol Rhinol* 117(3):219–224
21. Dejonckere PH, Bradley P, Clemente P (2001) Committee on Phoniatrics of the European Laryngological Society (ELS). A basic protocol for functional assessment of voice pathology, especially for investigating the efficacy of (phonosurgical) treatments and evaluating new assessment techniques. Guideline elaborated by the Committee on Phoniatrics of the European Laryngological Society (ELS). *Eur Arch Otorhinolaryngol* 258(2): 77–82