

Laryngopathies by vocal abuse: clinical multidisciplinary evaluation in workers at risk

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Summary

Background: attention to vocal pathologies in occupational categories that provide for a continuous use and often abuse of phonation has grown in recent decades.

Objectives: aim of this study was to evaluate the presence of laryngopathies by vocal abuse in subjects occupationally exposed, namely teachers and singers, compared with non-exercising jobs at risk, also checking if self-assessment tests and spectrographic signals could be predictive of disease observed with endoscopy.

Methods: we therefore proceeded to enroll on a voluntary basis, after information campaign, subjects, who in addition to an anamnestic framework, underwent a multidisciplinary evaluation, which included, besides a fiber optic laryngoscopic examination, the preventive administration of self report test on the perception of the quality of their voice, that is the voice Handicap Index for professional speaking voice and not exposed to risk, and the Singing Handicap Index for the singers, and also the spectrographic analysis of voice output (spoken or sung).

The results obtained were statistically evaluated using the mean, median, standard deviation and used the chi-square test.

Results: the results, in addition to confirming the guessed higher prevalence of disease in voice professionals, provide the opportunity to integrate the common medical diagnostic investigations, such as fiber optic laryngoscopy, with self report test and spectrographic survey, which showed a significant relationship with endoscopic data. In fact, the results confirmed that the VHI and the MSHI, integrated with the spectrographic test can be a valuable tool to assess the implications of bio-psychosocial aspects of professional and non-voice disorders, contributing significantly to validate the provisional diagnosis of diseases.

Conclusions: this study recommends not only the implementation of vocal education during the training of teachers to prepare the vocal professional user, but also a multidisciplinary approach to voice disorders in occupational exposure population, useful approach for general practitioner and for occupational physicians.

KEY WORDS: laryngopathies, vocal abuse, singers, teachers.

Introduction

Laryngopathies are fundamentally characterized by the symptom "dysphonia", which can alter quality and/or quantity of the voice in consequence of structural modification and/or impaired function of one or more organs involved in its production or to an inadequacy of the dynamic relationships between the different components of the respiratory and phonatory apparatus (1, 2).

The symptomatologic complexity, which definitely makes the definition of "disfonic syndrome" more adequate, is characterized by objective signs of acoustic type (alterations in intensity, frequency, timbre and texture) and clinical examination (inspection, endoscopic morphological and dynamic) and/or subjective signs of physical type (phonoasthenia, laryngopharyngeal paresthesia) and psychological type (feeling of unpleasantness or inadequacy of his own voice).

Laryngopathies can be divided into "organic", when morphological alterations and/or neuromuscular anatomical structures delegated to the genesis of the voice appear, and "functional", whose pathogenetic mechanisms are to be found in pathological postures of the intrinsic and/or extrinsic laryngeal musculature,

incorrect use of the bellows lung, and improper behaviors (3). There are also “mixed forms”.

Depending on the etiology non-organic dysphonias can be further subdivided into primitive forms related to voice overload, and in secondary forms determined by a pre-existing pathological situation of both organic and psychological nature.

Objectives

The purpose of this study was to evaluate the prevalence of laryngopathies in workers subjected to excessive use of voice. The attention to these occupational diseases is, in fact, increased in recent decades (4-7). Among those who are employed in this field we enrolled singers and teachers, because of their significant vocal load (8-16).

The analysis was conducted using self-assessment tests and spectrographic analysis of the voice as predictors of morpho-functional alterations, followed after the completion of a video laryngoscopy.

This study could be useful to the practitioner, as well as the occupational physician, in raising awareness in the categories traditionally most at risk of contracting diseases affecting the phonatory organ, in order to follow a path of prevention, both in the implementation of good standard practice in the use of the voice, and in making controls of secondary prevention.

Materials and Methods

During the period October 2011 - June 2012 at the Institute of Occupational Medicine of the University Hospital of Palermo we evaluated 82 subjects, aged between 20 and 65 years, predominantly female, divided into 2 groups, comparable for age and sex: the first group was composed of people whose professional activity involves the use of the vocal apparatus; the second was a control group.

The groups were composed as follows. First group: 41 subjects (35 women and 6 men), 26 teachers and 15 singers (2 tenors, 2 baritones, 9 sopranos and 2 altos), with average occupational exposure of 23.5 years, recruited on a voluntary basis through information campaign. Second group: comparable to the first as far number, age and sex, recruited on a voluntary basis, among customers of ENT and Audiology Industrial Clinic of the same Institute.

The study was conducted according to the Declaration of Helsinki.

For each patient, we compiled a medical record with family, physiological, remote and proximate pathological anamnesis, was given a self-assessment test of the item and we proceeded, therefore, to the recording of the speech spectrum and, finally, to the execution of the video laryngoscopy.

Regarding the self-assessment tests of the voice we used, respectively, the “Voice Handicap Index” (VHI) for teachers and the control group (Figs. 1, 6) and the “Modern Singing Handicap Index” (MSHI) for singers (Fig. 2).

VHI test and MSHI test are equal, even if VHI is a valid test and it is a dependable method to evaluate the voice during a conversation; but not so valid in the evaluation of singers, in particular for the focalization of the vocal handicap that is perceived by singers. For this reason, VHI test has been adjusted for singers: Fussi makes two questionnaires specific for singers, the Classical Singing Handicap Index (CSHI) and the Modern Singing Handicap Index (MSHI); he took inspiration from the Singing Voice Handicap Index (SVHI), a questionnaire formulated by Cohen et al. We have chosen the MSHI test because it is structured in a specular way than VHI test (9).

The VHI, the most known and used self-assessment tool for voice disorders, developed and validated in the United States and in nearly 20 countries, allows to discriminate between consciousness impairment, degree of disability and handicap in the transformation of the disorder ‘dysphonia’ (17).

It provides, in its full version (Jacobson, Johnson, Grywalski et al., 1997) (Fig. 6), the administration of a questionnaire of 30 questions, to which the entity in question must respond by giving a score from 0 to 4 depending on the degree of severity, the Italian version (Luppi, 2002) (Fig. 1) were divided into three sections covering:

- perception of the characteristics of your speech (impairment) due to any alteration in physiological and/or anatomical temporary or permanent;
- psychological impact (disability), understood as a reduction in the ability to perform an activity usually provided by the entity;
- impact of voice problems on daily activities (handicap), resulting in an obstacle to the performance of a role, with social and economic consequences (18, 19).

The score allows an assessment of the type “analytical” for each section and an assessment of “global” in four degrees of severity, as can be understood from the Table 1. The VHI, however, is not significant for the professional voice, because the statements contained are not considerable to the singer performance. This is the reason why specifically modified procedures have been accepted. Among these was chosen for the present study the MSHI, which is articulated in a similar way as the VHI; by MSHI test patients describe:

- a) the effect of the vocal problem during daily and professional activities (disability);
- b) psychological impact (handicap);
- c) the perception of vocal emission characteristics (impairment).

Therefore, the voice spectrography was recorded. This is a digital method for the analysis of the speech signal, as a diagram in gray scale of the harmonic structure of a sample of voice represented by the vowel: a and by the word: aiuola (20, 21).

In normal contact of the true vocal cords, the acoustic signal is represented by a like-periodic complex of sinusoidal signals, whose frequency corresponds to the fundamental frequency (f_0) for opening and closing of the vocal folds (22).

The sinusoidal signals are called ‘harmonics’, as they are the multiple of f_0 . The frequency of the glottic signal

Voice problems impact on daily activities						
		NEVER	ALMOST NEVER	SOMETIMES	ALMOST ALWAYS	ALWAYS
1	They listen to me with difficulty because of my voice					
2	They understand me with difficulty in a noisy environment					
3	They understand me with difficulty even in quiet environment					
4	My family are struggling to hear me					
5	I phone less often than I would like					
6	I tend to avoid large groups for my voice					
7	I do not talk so often with friends, relatives etc. because of my voice					
8	My voice problems limit my social life					
9	I feel excluded in conversations because of my voice					
10	If I speak for a long time, my head is spinning					
Score: _____ (maximum score: 40) 0 1 2 3 4						
Psychological impact						
1	I feel tense when I talk with others about my voice					
2	People seem to be irritated by my voice					
3	I believe that others do not understand my problems					
4	My voice problems make me feel nervous					
5	I am less sociable because of my voice problems					
6	I feel handicapped because of my voice					
7	I get annoyed when people ask me to repeat					
8	I feel embarrassed when people ask me to repeat					
9	I feel incompetent because of my voice					
10	I am ashamed of my voice problem					
Score: _____ (maximum score: 40) 0 1 2 3 4						
Perception of the characteristics of speech						
1	When I speak I remain short of breath					
2	My voice varies throughout the day					
3	Voice seems blown and thready					
4	Voice seems hoarse					
5	I feel like I have to force to produce voice					
6	While I am speaking, the voice varies in an unpredictable way					
7	I try to change my voice to make it better					
8	I find it hard to talk					
9	In the evening my voice is uglier					
10	During a conversation I remain voiceless					

Figure 1 - Italian version (Luppi, 2002) of Voice Handicap Index (VHI) (Jacobson et al., 1997).

	Impact of issues related to professional activities (disability)				
		NO	A BIT	OFTEN	ALWAYS
1	I feel a vocal fatigue from the beginning of the performance				
2	My speaking voice is altered and fatigued during the performance				
3	I am forced to change aspects of my technique because I feel that the problem affects on the usual technical control				
4	The voice problem forces me to modify or limit the repertoire pieces, possibly with shades of transpositions				
5	I am forced to limit the usual study time because of my voice problem				
6	I feel difficulty in performance on stage with alterations in vocal performance				
7	I can not hold two or more consecutive nights				
8	I have to ask for help the phonic in order to mask my problems				
9	I am forced to follow continuing medical therapies to mask my voice problem				
10	My problems forced me to limit the use of voice in a social context				
	Score: _____ (maximum score: 30)	0	1	2	3
	Psychological impact (handicap)				
1	Performance anxiety is greater than usual				
2	Closed people do not understand the vocal problem that I feel				
3	I am subjected to unwarranted criticism by close people				
4	Voice problems make me feel nervous and unsociable				
5	I am worried if I am asked to repeat a vocalization or phrase sung				
6	I feel my career in danger because of my speech difficulties				
7	Colleagues, agents, critics have noted my speech difficulties				
8	I am forced to cancel some professional commitments				
9	I avoid to program my next commitments				
10	I avoid to speak with people				
	Score: _____ (maximum score: 30)	0	1	2	3
	Perception of speech characteristics (impairment)				
1	I have trouble managing respiratory				
2	My vocal performance varies throughout the day				
3	Voice seems blown and thready				
4	The voice seems hoarse				
5	I feel like I have to force to produce voice				
6	My vocal performance varies in an unpredictable manner during the performance				
7	I try to change my voice to make it better				
8	It is very hard to sing				
9	The evening my voice is uglier				
10	Voice gets tired easily during performance				
	Score: _____ (maximum score: 30)	0	1	2	3

Figure 2 - Italian version of "Modern Singing Handicap index" (MSHI).

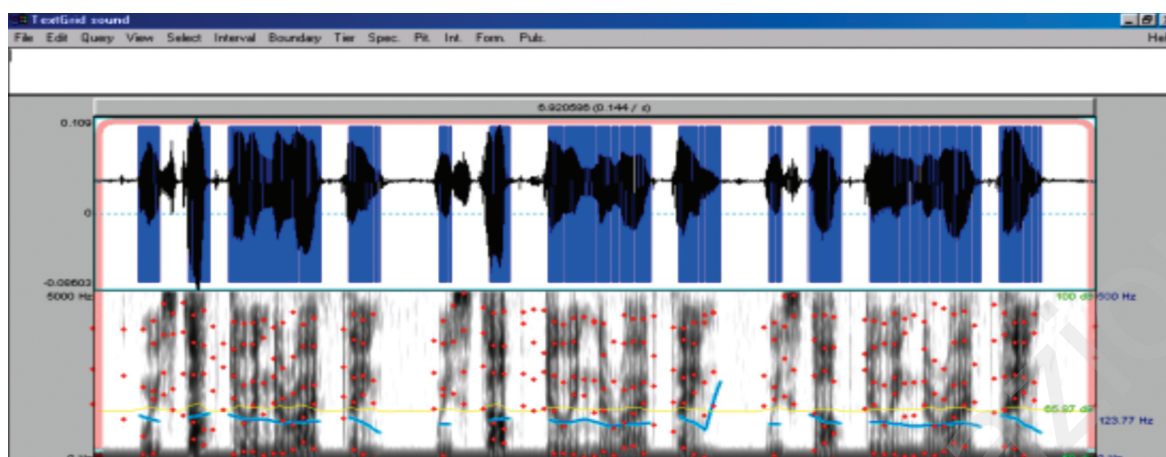


Figure 3 - Vocal signal spectrogram.



Figure 4 - Abducting Vocal folds. Female, 28 years old. Singer.



Figure 5 - Adducting Vocal folds. Female, 28 years old. Control.

remains the same because the supraglottic filter, consisting of anatomical structures (ventricle of Morgagni, false vocal cords, laryngeal vestibule, pharynx, oral cavity, nasal cavity and paranasal sinuses), changes only the harmonic width and phase and not the f_0 .

In pathological conditions, the acoustic signal is aperiodic because the harmonic frequency is not a multiple of the f_0 . The aperiodicity of the acoustic signal in the recording spectrographic involves the presence of "noise", which arises in dysphonia.

The voice signal was recorded with a microphone positioned approximately 10 cm from the patient's mouth at a 45-degree angle from the mouth axis to reduce airflow effects (23). To carry out the spetroacoustic examination were used Praat and Audacity softwares (Fig. 3).

Finally, the study sample was subjected to video laryngoscopy, performed with flexible endoscope model Xion Medical EF-N Amplifon with the camera, and software Medicam Visia-Daisy. This investigation, minimally invasive and generally well tolerated, allows an objective assessment of the morphology of the nasal cav-

ity, nasopharynx, hypopharynx and larynx, allowing, also, not only the acquisition of still-images (Figs. 4, 5) but also to video, in order to evaluate the framework morpho-functional in a dynamic way.

Description of statistical analysis

The results obtained were statistically evaluated using the mean, median, and standard deviation, we also used the chi-square test for other risk factors, such as smoking, the use of drugs and the presence of gastroesophageal reflux disease and for the evaluation of endoscopic findings of pathologies.

Results

The subjects evaluated, 82 in number, belonged to the above-described two groups: the first consisting of teachers and singers all recruited following the acces-

Name _____ Date _____ Follow-up# _____

Voice Handicap Index (VHI)
(Jacobson, Johnson, Grywalski, et al.)

Instructions: These are statements that many people have used to describe their voices and the effects of the voices on their lives. Check the response that indicates how frequently you have the same experience.

(Never = 0 points; Almost Never = 1 point; Sometimes = 2 points; Almost Always = 3 points; Always = 4 points)

	Never	Almost Never	Sometimes	Almost Always	Always
F1. My VOICE makes it difficult for people to hear me					
P2. I run out of air when I talk					
F3. People have difficulty understanding me in a noisy room					
P4. The sound of my voice varies throughout the day					
F5. My family has difficulty hearing me when I call them throughout the house					
F6. I use the phone less often than I would like					
E7. I'm tense when talking with others because of my voice					
F8. I tend to avoid groups of people because of my voice					
E9. People seem irritated with my voice					
P10. People ask, "What's wrong with your voice?"					
F11. I speak with friends, neighbours, or relatives less often because of my voice					
F12. People ask me to repeat myself when speaking face-to-face					
P13. My voice sounds creaky and dry					
P14. I feel as though I have to strain to produce voice					
E15. I find other people don't understand my voice problem					
F16. My voice difficulties restrict my personal and social life.					
P17. The clarity of my voice is unpredictable					
P18. I try to change my voice to sound different					
F19. I feel left out of conversations because of my voice					
P20. I use a great deal of effort to speak					
P21. My voice is worse in the evening					
F22. My voice problem causes me to lose income					
E23. My voice problem upsets me					
E24. I am less out-going because of my voice problem					
E25. My voice makes me feel handicapped					
P26. My voice "gives out" on me in the middle of speaking					
E27. I feel annoyed when people ask me to repeat					
E28. I feel embarrassed when people ask me to repeat					
E29. My voice makes me feel incompetent					
E30. I'm ashamed of my voice problem					

Please circle the word that matches your voice today.

Normal Mild Moderate Severe

P _____ **F** _____ **E** _____ **Total** _____

Figure 6 - Voice Handicap Index (VHI) (Jacobson et al., 1997).

Table 1 - Interpretation of VHI score.

Normal	Mild Alterations	Moderate Alterations	Severe Alterations
0	1-40	41-80	81-120

Table 2 - Anamnestic findings of the sample.

	Smoke et al.	GERD	Therapy
Case Group (n. 41)	19	9	8
Singers	3	5	2
Teachers	16	4	6
Control Group (n. 41)	24	5	4

sion on a voluntary basis after appropriate information campaign conducted at high schools and opera companies, and the second taken from the catchment area of Ambulatory of Otolaryngology and Audiology Industrial Institute of Occupational Medicine, University of Palermo, whose basic requirement was to carry out a task that did not have the use of the voice as a fundamental prerogative. Each group was made up, as mentioned above, of 41 subjects, comparable for age and sex.

The clinical evaluation has considered other factors, not correlated with the excessive use of the voice, that can predispose to dysphonia, like smoking, alcohol, coffee, drugs, and the coexistence of pathologies of the upper aero-digestive tract, and also the pharmacologic therapy. Some drugs, in fact, may result in a deterioration of the voice through a reduction in hydration of the laryngeal mucosa (antihistamines and diuretics) or a reduced bloodstream (sympathomimetic decongestants). Some antihypertensive drugs (ACE inhibitors) may cause a chronic trauma of the vocal folds because induces cough. In the literature no cases of significant voice alteration are reported using oral contraceptives, instead of the replacement therapy with hormone in both men and women. In our study, the use of drugs was restricted to antihypertensive, antihistamines, diuretics and inhibitors of the proton pump. Table 2 summarizes the anamnestic findings of the sample.

Using the chi-square test for the factors analyzed: cigarette smoking, gastro-oesophageal reflux disease and use of drugs, there were no statistically significant differences between the two groups considered, since the values of the p value 99%, are respectively 0.26, 0.24 and 0.21.

Table 3 summarizes the results of the assessment tests.

There are no significant differences between the control group and the case group, however, in relation both to the overall assessment and the single section (Disability, Handicap, Impairment) (Tab. 4).

The endoscopic objectivity was divided into four categories (Tab. 5): normal, morphological alterations (Figs. 7, 8), functional alterations (Fig. 9) and, finally, morpho-functional alterations (Fig. 10).

Applying the chi-square test with endoscopic evidence of pathologies found in the two groups studied, it is clear that the difference is statistically significant, as the p value of 99% turns out to be 0.0001.

As for the spectrographic evaluation we used the "Classification according to spectrographic analysis of the Dysphonia Yanagihara modified by Ricci, Maccari-ni and De Colle" (Fig. 11) (24). All values are in Class 0, except for a subject of the control group and six subjects belonging to the case group (only teachers). The latter are correlated with slight morpho-functional alterations. No alteration was found in the singer group.

Discussion

According to the results it's clear that most of the endoscopic morpho-functional alterations are found within the case group (44% vs 7% in the control group) (p value 0,0001). Within the case group the endoscopic morpho-functional alterations prevalence was slightly higher in teachers (46%) than in singers (40%) p-value of 0.08, thus not statistically significant.

Table 3 - Assessment test global findings of the sample.

	Normal	Mild Alterations	Moderate Alterations	Severe Alterations
Case Group (n.41)	1	35	5	0
Singers	0	13	2	0
Teachers	1	22	3	0
Control Group (n. 41)	8	31	2	0

Table 4 - Details of the results of the assessment tests of the sample.

		Mean	Median	SD	Min	Max	N
Case Group							41
Singers	Disability	6.4	5	5.2	1	20	15
	Handicap	4.9	3	5.7	0	17	
	Impairment	8.1	7	5.1	1	20	
Teachers	Disability	5.3	4.5	5.5	0	21	26
	Handicap	4.6	3	4.5	0	15	
	Impairment	12.7	15.5	8.2	0	30	
Control Group							41
	Disability	4	2	5.1	0	25	
	Handicap	2.4	0	4.1	0	20	
	Impairment	6.3	4	7.6	0	31	

Table 5 - Endoscopic surveys in the sample.

	Normal	Morphological Alterations	Functional Alterations	Morpho-Functional Alterations
Case Group (n. 41)	23	10	6	2
Singers	9	2	3	1
Teachers	14	8	3	1
Control Group (n. 41)	38	2	1	0

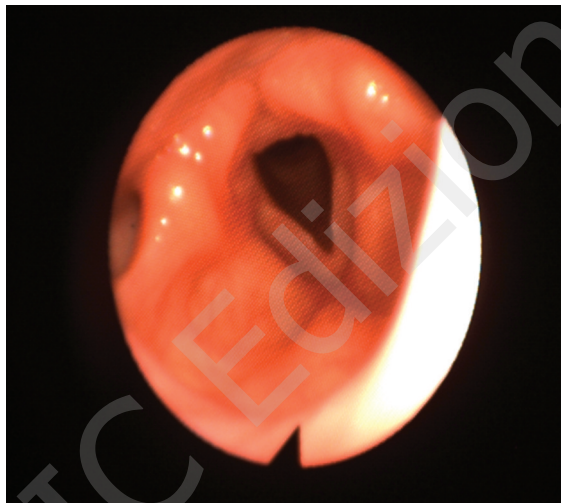


Figure 7 - Hypertrophic Vocal folds. Female, 37 years old. Teacher.

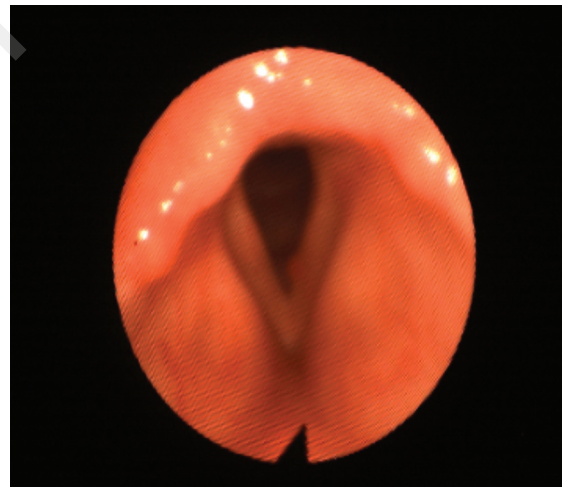


Figure 8 - Small angiomatous neoformation of the anterior third of the left vocal cord. Male, 64 years old. Control.

This fact is easily explained considering that, among the voice professionals, the singers have a particular focus on their vocal characteristics, as they have a greater awareness of their vocal organ, both anatomically and functionally (24). In fact, for training, the singer must acquire a toolkit of pneumophonatoric techniques in order to optimize their performance (25, 26). This means, therefore, a sudden identification of a possible change of voice leading them to carry out special checks, even for the only health care (3, 6, 26). This finding is support-

ed by the results of the assessment tests. In fact, higher values are found in the case group compared to the control group for all three sections evaluated (Disability, Handicap, Impairment). And also, within the group of cases, while there are no substantial differences between disability and handicap among singers and teachers, for the latter have been reported higher values as to the impairment (defined by some authors as organic domain) (27). Finally, by the clinical evaluation, the possible other factors indicating laryngeal pathologies, such

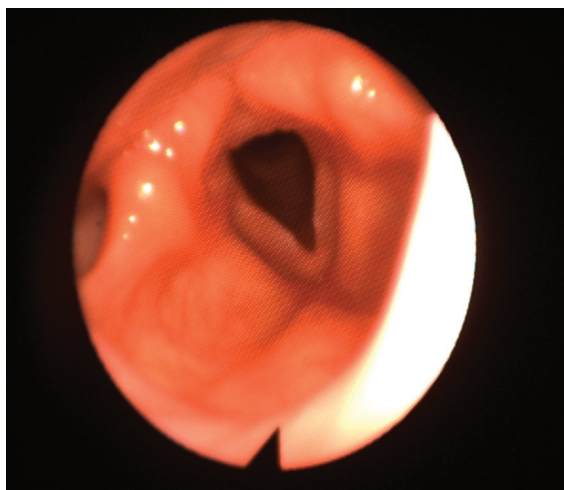


Figure 9 - Incomplete adduction of the posterior third of the Vocal folds. Female, 63 years old. Teacher.



Figure 10 - Total incomplete adduction in hypertrophic Vocal folds. Woman, 46 years old. Teacher.

Class 0 regular

the absence of noise in the spectrum or the presence of noise components that do not predominate on the harmonic components

Class I soft alteration

presence of noise components, which above 2000 Hz predominate on the harmonic components, the harmonics are still present even above 2000 Hz

Class II mild alteration

presence of noise in the spectrum, the harmonics are present only up to 2000 Hz

Class III serious alteration

presence of noise in the spectrum, the harmonics are present only up to 500 Hz

d: presence of sub-harmonics (diplophony)

t: presence of undulations of the F_0 (trembling voice)

Figure 11 - Spectrographic classification of dysphonia according to Yanagihara, modified by Ricci, Maccarini and De Colle.

as smoking, the use of drugs, as well as the gastro-oesophageal reflux disease, were recognized not determinants, due to a correlation not statistically significant, considering the small number of enrolled subjects.

Conclusions

In the present study the greater predictability among the tests, used before the examination, results in the self-assessment test more than in the spectroacoustic analysis. In fact, MSHI and VHI higher scores, respectively in singers and teachers, correspond to the highlighted endoscopic morphofunctional alterations. For the occupational physician it is essential to implement a multidisciplinary assessment, in collaboration with the

otolaryngologist, a phoniatician and a speech therapist, as part of health surveillance of people who present dysphonia due to their job. This study, in the light of the findings, may be useful to the practitioner, as well as the occupational physician, in raising awareness in the categories, traditionally most at risk of contracting diseases affecting the phonatory organ, in order to follow a path of prevention, both with the implementation of good standard practice in the use of voice, and with the effectuation of specialist controls like secondary prevention.

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