

Endoscopic and Phoniatic Evaluation in Singing Students

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Summary: Objectives. In To analyze laryngostroboscopic findings and ENT/phoniatic examination results in a group of singing students and in a control group of non-singing subjects to emphasize the importance of ENT/phoniatic examination and of laryngostroboscopy before taking up singing.

Methods. 56 singing students and 60 healthy euphonic non-singer volunteers were recruited. In each subject a perceptual assessment and a self-assessment (VHI) of the voice were performed. The singing students filled out the Singing-VHI. All subjects underwent flexible fiberoptic endoscopy and laryngostroboscopy. All subjects were evaluated through the Reflux Symptom Index (RSI) and the Reflux Finding Score (RFS).

Results. At laryngostroboscopy, 60.7% of students presented pathological findings, versus 20% of controls ($P < 0.0001$). Incomplete glottic closure (35.7% vs. 13.3%), supraglottic hypertonus (16.1% vs. 5%), organic lesions (bilateral nodules, cysts, sulcus vegeture) (17.9% vs. 3.3%), posterior erythema (16.1% vs. 5%) and laryngeal edema (14.3% vs 3.3%) were more frequent in the students. The most common symptoms in singers were phonasthenia (37.5 % vs 6.7%; $P = 0.0001$) and mucus sensation (17.9% vs. 5%, $P = 0.03$). S-VHI showed higher values in students with pathological laryngostroboscopy ($P < 0.0001$). Finally, average RSI and RFS were higher in students.

Conclusions. Due to the high percentage of organic and functional voice disorders in singing students, it would be desirable that every subject who is going to start singing underwent an ENT/phoniatic investigation with videostrobolaryngoscopy to ascertain vocal folds healthy condition.

Key Words: Laryngostroboscopy–Phoniatic evaluation–Dysphonia–Singing students–S-VHI.

INTRODUCTION

In Italy, there has been an exponential increase in singing schools during the last few years, with students of all ages signing up in the attempt to improve their vocal performances. Every year, newly enrolled students show how the art of singing can be of interest to a wide array of people of different ages and expectations. According to our observation, newly enrolled singers include children and adolescents with a passion for singing, middle-aged people with many years of experience in leisure-time singing jobs, and even people aged over 60 who have retired and would like to see their dream of a lifetime come true, having always been self-taught singers. Voice teachers and vocal coaches provide precious teaching, which involves singing, breathing, posture, articulation, diction, microphone techniques, interpretation, and many other aspects. Recently, Beeman has underlined how, presumably, teachers who are familiar with rehabilitation techniques are more prone to monitor the speaking behaviors of their students, to teach them healthy vocal behaviors, and then to monitor their singing behaviors.¹ However, students often neglect the anatomic and functional state of their singing organ, the larynx. Another important point is that the voice, and even

more singing, is the result of the function of not only the larynx but also of a much more complex system known as “pneumo-phono-articulation,” which includes the pulmonary bellows as well as the resonance and articulation apparatuses. Hence, it is evident that whoever wishes to take up singing as an art should first of all know the anatomic and functional conditions of his or her larynx, and of all the organs, which involve the phonation mechanism and the pneumo-phono-articulation system (nasal and naso-sinusal structures, pharynx, middle and internal ear, auditive tube, lower respiratory tract).

When Lundy and colleagues² studied a group of asymptomatic singing students by means of specific anamnestic questionnaires and videolaryngostroboscopy, they found benign lesions (vocal nodules and cysts) in the vocal cords of 8.3% of the subjects and a high incidence of posterior erythema, suggesting possible reflux, in 73.4% of the subjects. The high incidence of asymptomatic laryngeal alterations in singing students shows how it is necessary to take steps to prevent worsening of the conditions.² Tepe and colleagues³ also confirmed that there is a high incidence of voice-related problems in young singers who are apparently asymptomatic; their specific questionnaires showed that more 50% of the subjects had experienced laryngeal problems. Again, the symptoms consistent with reflux (morning hoarseness) appeared to be particularly frequent.³ The authors, too, emphasized the fact that vocal coaches should consult otolaryngologists, phoniaticians as well as speech and language therapists to identify and consequently promptly treat any young singers with voice problems and to develop training strategies that can reduce the incidence of these problems. Recent reports have demonstrated that professional singers are not only vulnerable to organic and functional disorders in the larynx, but

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more frequently show symptoms and signs of laryngeal reflux, or cordal hemorrhage and chondritis.⁴⁻⁶

The paper published by Schneider and Bigenzahn in 2002⁷ focuses on the possibility of professional singers developing laryngeal damage: videostroboscopic examinations in 545 apparently healthy subjects (whose voice performance was bound to increase in the future) showed that around 30% of them had organic or functional alterations in the larynx with negative perceptible assessment. Moreover, the authors postulate that these alterations could become clinically symptomatic once the voice performance increases, and they also stress the importance of appropriate analysis of the larynx in subjects who are about to increase the use of their voice to prevent further damage to the glottic plane structures.⁷

There are few reports available on the topic in the relevant literature; however, all authors seem to agree that there should be a close relationship between vocal coaches, students, and phoniaticians or otolaryngologists or speech therapists. A recent systematic review and meta-analysis dealing with the study of vocal disorders' prevalence in singers has initially identified 2371 articles, out of which only 11 studies were selected; most of these studies were carried on through specific questionnaires.⁸ In fact, in the literature, there are no reports of ear, nose, throat (ENT), phoniaticians, and laryngostroboscopic evaluations applied to newly enrolled singing students.

The purpose of this study is to assess the videolaryngostroboscopic data and the results of examinations carried out by speech therapists, phoniaticians, and otolaryngologists in 56 subjects enrolled in the first year of a singing school. The study also covers a comparison between the group of singing students and a control group of 60 non-singer normal subjects, equivalent as far as age and sex are concerned.

MATERIALS AND METHODS

The study involved a group of 56 singing students (32 females and 24 males) attending the first year (at the end of the first semester) of several Schools of Music in Italy and a control group of 60 healthy euphonic non-singer subjects (34 females and 26 males) from the same geographical area as the study group. The age of the students ranged from 19 to 41 years (total mean age of the students: 26.5 ± 6.3 ; mean age of females: 26.4 ± 5.8 ; mean age of males: 27.1 ± 6.7). The age of the control group ranged from 21 to 44 years (total mean age: 27.9 ± 6.1 ; mean age of females: 27.3 ± 5.9 ; mean age of males: 28.7 ± 6.4). The group of study (singing students) and the control group were comparable in age and sex. All students were attending a course of Contemporary Commercial Music. Only 12 (12 of 56, 21.4%) students had already undergone an ENT evaluation with transnasal flexible fiberoptic laryngoscopy, carried out in other clinical centers. The evaluation of all subjects started with an interview to gather information about their medical background, voice and singing history, their vocal activity, and their habits. The questions dealt with their general clinical history, focusing on hereditary diseases, neurologic diseases including cephalalgia, hormonal and immunity disorders, asthma and other respiratory conditions, and gastroenterological diseases. In the second part of the interview, students were asked about their ENT and

voice history (sensation of nasal obstruction, continuous rhinorrhea, postnasal drip, hearing loss, diagnosis of postural misalignment with or without disorder of the temporomandibular joint, frequent pharyngolaryngitis, sensation of mucus in the throat, dysphonia, alterations in the singing voice, previous ENT or phoniatic evaluations, and any treatment administered). The last section of the interview dealt with the subjects' type of vocal activity (performances in clubs, in choirs, work involving significant vocalization, time spent at lessons, rehearsals, and performances) and their habits concerning smoking, exposure to irritants, alcohol consumption, caffeinated beverages abuse, and antihistamines consumption.

For all subjects, a perceptual evaluation and a self-assessment of the voice was obtained. The perceptual voice evaluation was assessed according to the GRBAS Scale by Hirano (G: global grade of dysphonia, R: roughness, B: breathiness, A: asthenia, S: strain).⁹ Each parameter was jointly rated by three experienced speech-language pathologists from the same institution (ENT Audiology Phoniatic Unit, University Hospital, Pisa) against a semiquantitative scale going from 0 for normal voice to 3 for severe disturbance. The self-assessment of the voice was made by means of the Italian version of the Voice Handicap Index (VHI) questionnaire,^{10,11} divided into three subscales for the evaluation of functional, physical, and emotional consequences of the vocal disturbance. The subjects reported the frequency of the problem to which a number from 0 to 4 was assigned (never = 0 points; almost never = 1 point; sometimes = 2 points; almost always = 3 points; always = 4 points). The total score ranges from 0 to 120.^{10,11} Moreover, to evaluate vocal disability in singers, a specific questionnaire (the Italian version of the Singing-VHI [S-VHI]) was used with the aim of measuring the physical, social, emotional, and economic impacts of voice problems on the lives of singers.^{12,13} The S-VHI is a 36-item self-administered questionnaire, which is able to assess difficulties related to voice health status typical of the singer, as demonstrated by its psychometric properties of reliability and validity.^{12,13} The items address symptoms, which are frequently reported to laryngologists and speech-language pathologists by singers. Finally, all subjects (study and control group) filled out the Reflux Symptom Index (RSI) and the physicians completed the Reflux Finding Score (RFS) to assess the probability that some symptoms and signs could be correlated with laryngo-pharyngeal reflux (LPR).^{14,15}

All subjects underwent a physical ENT examination including rhino-pharyngo-endoscopy, videolaryngoscopy with flexible endoscope (Olympus ENF-P4), (Tokyo, Japan), and laryngostroboscopic examination with rigid endoscope (KayPENTAX RLS-9100 Digital Strobe System), (Tokyo, Japan). The diagnosis of a possible disease of the larynx of each subject in the study and in the control groups was determined based on the clinical history and by both rigid and flexible laryngeal videoendoscopy including stroboscopy. The rhino-pharyngo-endoscopy results were assessed based on the presence or absence of turbinate hypertrophy, nasal septum deviation, pathologic rhinorrhea, and presence of retropharyngeal mucus.

The videolaryngoscopic and videolaryngostroboscopic examinations were performed at ENT Audiology Phoniatic Unit (University Hospital, Pisa) by three independent clinicians with

at least 15 years' experience as phoniaticians or laryngologists. All stroboscopic examinations were stored on disk for re-evaluation at a later time by senior authors. Subsequently, the images were autonomously evaluated by three independent clinicians with at least 15 years' experience as phoniaticians or laryngologists according to the following parameters: mucosal appearance of the vocal folds, glottic closure, and presence of supraglottic hypertonus. Mucosal alterations of the vocal folds were further classified as organic lesions (divided into nodules, polyps, cysts, sulcus vergeture [type 2 sulcus]), submucous edema (monolateral, bilateral, associated with vocal fold congestion), and erythema (localized in the posterior glottis only, in the posterior glottis and in the vocal folds, in the vocal folds only). The patterns of glottic closure were assessed as normal or incomplete (glottis never completely closed) by the presence of a gap; the latter were further classified as incomplete, spindle-shaped, hourglass, anterior, or posterior gap.^{16,17} Clinical impressions and findings of three examiners were compared for interrater reliability.

Statistical analysis

A chi-square test was carried out to compare the percentages of the pathologic subjects in the study group vs. the control group. A Student *t* test was additionally used to compare the mean values obtained for the numerical parameters age, VHI, S-VHI, RSI, and RFS. Analyses were carried out with the *SPSS Statistics* version 20 (IBM; Armonk, NY, USA).

RESULTS

General medical history interview, ENT, and voice history features

Study group

The general medical history interview in the group of study revealed three cases of bronchial asthma during childhood and eight cases of allergy. None of the students showed hereditary, neurologic, hormonal, or immunity system disorders. As far as the ENT and voice history features are concerned, 13 subjects reported having a sensation of nasal obstruction, 10 subjects described the sensation of mucus in the throat, five subjects reported continuous rhinorrhea. Phonasthenia had previously occurred in the past in 21 (37.5%) cases. All subjects were attending the first year (at the end of the first semester) of singing school, 26 (46.4%) of these were at their first singing experience, whereas the other 30 (53.6%) had already been singing as self-educated singers for some years. The time spent on lessons was 2 hours a week, with an average time of 1 hour a day for personal practice. Students were reported to spend an average of 3 hours per week in rehearsals, and 2 hours per week in performances. None of them used their voice regularly in open-air activities or part-time work. Sixteen subjects (28.6%) of the group of study reported to smoke at least 10 cigarettes a day and 25 subjects (44.6%) to drink at least three coffees a day. Two subjects reported habitual antihistamines consumption.

Control group

The general medical history interview in the control group revealed two cases of bronchial asthma during childhood and six

cases of allergy. None of the subjects showed hereditary, neurologic, hormonal, or immunity system disorders. Regarding the ENT history, 10 subjects reported having a sensation of nasal obstruction, three subjects described the sensation of mucus in the throat, and six subjects reported continuous rhinorrhea. Phonasthenia had occurred in the past in four (6.7%) cases. None of the subjects used their voice regularly in open-air activities or part-time work. Twenty subjects (33.3%) reported smoking at least 10 cigarettes a day, and 21 subjects (35%) reported drinking at least three coffees a day. Two subjects reported habitual antihistamines consumption.

Perceptual evaluation (GRBAS)

The perceptual evaluation of the 56 students according to the GRBAS scale assigned 0 to all parameters in 26 (26 of 56; 46.4%) students (normal voice), 24 (24 of 56; 42.9%) students were classified as G1R1B1A0S0 (slight grade of roughness and breathiness in the voice), and six (6 of 56; 10.7%) students as G1R0B0A0S1 (slight grade of strain in the voice).

The perceptual evaluation of the 60 subjects of the control group assigned 0 to all parameters in 52 (52 of 60; 86.7%) subjects (normal voice), seven (7 of 60; 11.6%) subjects were classified as G1R1B1A0S0, and one (1 of 60; 1.7%) as G1R0B0A0S1.

Making a comparison between the study and the control groups, with regard to the perceptual evaluation of the voice (GRBAS), a statistically significant difference was obtained for the normal or pathologic comparison ($P < 0.0001$), for roughness comparison, breathiness (G1R1B1A0S0) ($P = 0.0001$), and strain (G1R0B0A0S1) ($P = 0.04$).

VHI

The VHI score was less than 40 points in every subject. The average of VHI in the group of study was 7.39 ± 8.1 , whereas in the control group was 4.35 ± 4.4 , with a statistically significant difference ($P = 0.01$).

S-VHI

The average S-VHI in the group of study was 35.7 ± 22.1 ; S-VHI in singers classified as healthy from laryngostroboscopic investigation (22 of 56) was 17.7 ± 12.5 (range 2–34); S-VHI in singers classified as pathologic from laryngostroboscopic investigation (34 of 56) was 47.3 ± 18.9 (range 10–79). Comparison of the S-VHI values between healthy and pathologic singers resulted as highly significant ($P < 0.0001$).

Reflux Symptom Index (RSI) and Reflux Finding Score (RFS)

All singing students and subjects of the control group filled out the RSI score at the time of the visit. The average of the RSI in the study group was 5.59 ± 6.1 , whereas average RSI in the control group was 2.75 ± 3.9 ($P = 0.003$). In the study group, 14 students (14 of 56, 25%) (nine males, five females) showed RSI values suggestive of LPR (RSI > 13).¹⁴ In the control group, five subjects (5 of 60, 8.4%) (three males, two females) showed values of RSI suggestive of LPR.

Physicians completed the RFS at the time of the visit for all study subjects. The RFS average in the study group was 3.04 ± 3.1 , whereas RFS average in the control group was 1.36 ± 1.8 ($P = 0.0006$). In the study group, seven singing students (7 of 56, 12.5%) (four males, three females) revealed RFS values suggestive of LPR (RFS > 7);¹⁵ in the control group, only one subject (1 of 60, 1.7%) (male) revealed values of RFS suggestive of LPR.

Clinical characteristics, GRBAS, VHI, S-VHI, RSI, and RFS results in the study and control groups are summarized in Table 1.

Rhino-pharyngo-endoscopic investigation

Rhino-pharyngo-endoscopic investigation in the study group revealed two cases of nasal septum deviation, pathologic rhinorrhea in four students, and presence of retropharyngeal mucus in six students. Rhino-pharyngo-endoscopic investigation in the control group revealed three cases of nasal septum deviation, pathologic rhinorrhea in four subjects, and presence of retropharyngeal mucus in five subjects. The comparison between the group of study and the control group did not result in being statistically significant as far as the endoscopic evidence is concerned.

Videolaryngostroboscopic and laryngoscopic evaluation

Study group

All subjects of the study group and all subjects of the control group successfully underwent videolaryngoscopic and videolaryngostroboscopic evaluation without any particular side effect.

The results of the videolaryngoscopic and videolaryngostroboscopic examinations in the study group showed a pathologic finding in 34 singers (34 of 56, 60.7%; 20 females, 14 males), whereas the results were normal in 22 subjects (22 of 56, 39.3%). The 34 singers with pathologic laryngostroboscopy showed pathologic findings variously associated with each other. To be more specific, an organic lesion of the vocal folds was detected in 10 subjects (10 of 56, 17.9%): in six cases (6 of 56, 10.7%) this was identified as bilateral nodules, in two cases as unilateral intracordal cyst (2 of 56, 3.6%), and in two cases as sulcus vergeture (type 2 sulcus) (2 of 56, 3.6%). Laryngeal edema was detected in eight students (8 of 56, 14.3%), five of whom had it associated with vocal fold congestion; erythema was seen in nine patients (9 of 56, 16.1%), always located in the posterior glottis. Twenty subjects (20 of 56, 35.7%) showed an incomplete pattern of glottis closure, classified as incomplete in three cases, spindle-shaped in four cases, hourglass in nine cases, and posterior in the remaining four cases (Figure 1). In nine cases, bilateral supraglottis hypertonus was found (9 of 56, 16.1%; seven of nine in self-educated singers and two of nine in students at their first singing experience). Videolaryngostroboscopy examination revealed pathologic findings in 20 (66.7%) of the 30 students with a previous history of self-educated singing activity, as well as laryngeal alterations in 14 (53.8%) of the 26 students who were at their first singing experience.

Control group

The results of the videolaryngoscopic and videolaryngostroboscopic examinations in the control group

TABLE 1.
Clinical Characteristics, GRBAS, VHI, S-VHI, RSI, and RFS Results in the Study and the Control Group

	Study Group (Singers) (n = 56)	Control Group (n = 60)	Statistical Difference
Male/Female	24/32	26/34	NS
Age	26.5 ± 6.3	27.9 ± 6.1	NS
Bronchial asthma	3 (5.4%)	2 (3.3%)	NS
Allergy	8 (14.3%)	6 (10%)	NS
Sensation of nasal obstruction	13 (23.2%)	10 (16.6%)	NS
Sensation of mucus in the throat	10 (17.9%)	3 (5%)	$P = 0.03^*$
Continuous rhinorrhea	5 (8.9%)	6 (10%)	NS
Phonasthenia	21 (37.5%)	4 (6.7%)	$P = 0.0001^*$
Smoke at least 10 cigarettes a day	16 (28.6%)	20 (33.3%)	NS
Drink at least 3 coffees a day	25 (44.6%)	21 (35%)	NS
First singing experience	26 (46.4%)	—	—
Self-educated singers	30 (53.6%)	—	—
GRBAS:			
G0R0B0A0S0 (Normal)	26 (46.4%)	52 (86.7%)	$P < 0.0001^*$
G1R1B1A0S0	24 (42.9%)	7 (11.6%)	$P = 0.0001^*$
G1R0B0A0S1	6 (10.7%)	1 (1.7%)	$P = 0.04^*$
VHI (mean \pm SD)	7.39 ± 8.1	4.35 ± 4.4	$P = 0.01^\dagger$
S-VHI (mean \pm SD)	35.7 ± 22.1	—	—
RSI (mean \pm SD)	5.59 ± 6.1	2.75 ± 3.9	$P = 0.003^\dagger$
RFS (mean \pm SD)	3.04 ± 3.1	1.36 ± 1.8	$P = 0.0006^\dagger$

* Chi-square test.

† t Test.

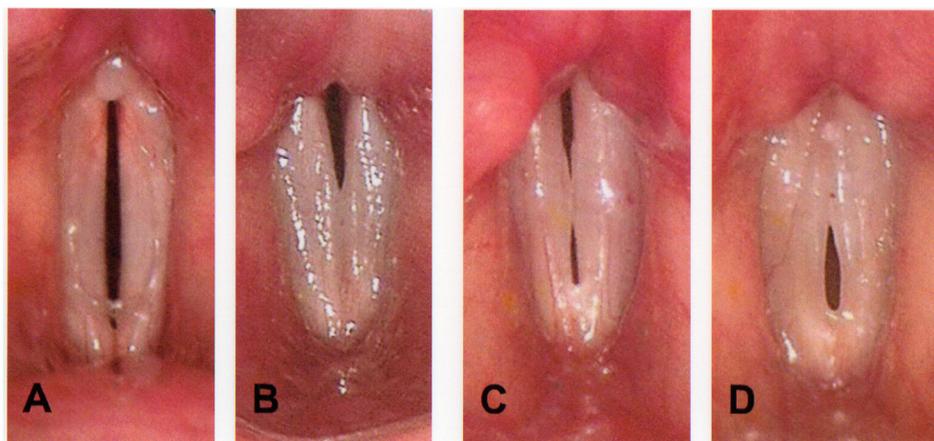


FIGURE 1. Patterns of incomplete glottic closure found in singing students: incomplete (A), posterior gap (B), hourglass (C), and spindle-shaped (D).

showed a pathologic finding in 12 subjects (12 of 60, 20%; eight females, four males), whereas the results were normal in 48 subjects (48 of 60, 80%). The 12 subjects with pathologic laryngostroboscopy showed pathologic findings variously associated with each other. To be more specific, an organic lesion of the vocal folds, such as bilateral nodules, was detected in two subjects (2 of 60, 3.3%). Laryngeal edema was detected in two subjects (2 of 60, 3.3%), both of them with associated vocal fold congestion; erythema was detected in three subjects (3 of 60, 5%), always located in the posterior glottis. Eight subjects (8 of 60, 13.3%) showed an incomplete pattern of glottis closure, classified as spindle-shaped in two cases, hourglass in four cases, and posterior in the remaining two cases. Bilateral supraglottis hypertonus was found in three cases (3 of 60, 5%).

The distribution of the pathologic videolaryngostroboscopic data and related statistical differences between the study and the control group is illustrated in [Table 2](#).

DISCUSSION

Vocal fold organic or functional disorders in singers are not very rare clinical findings for ENT specialists, laryngologists, and Speech language pathologists, especially in cases of singing students at the beginning of their course or if they are self-educated professional singers. Unfortunately, despite this phenomenon being important for the singers' future career, it has not been studied extensively. In this study, we focused on the detection of organic or functional alterations of the vocal folds in singing students enrolled in the first year (at the end of the first semester) of their course of study. We found a high incidence of abnormal laryngeal findings in asymptomatic singing students after their first semester of lessons, which agrees with the reports of other authors such as Lundy et al, Tepe et al, or Schneider and Bigenzahn,^{2,3,7} who revealed a high number of vocal fold abnormalities in professional voice users. In a recent report by Myint et al, a higher prevalence of abnormal findings in healthy professional singers, compared with previous studies, was found (90.2% including reflux and 88.2% excluding reflux were abnormal in

videolaryngostroboscopic examination). The authors attributed this higher percentage to a more inclusive definition of abnormal pathologies, improvements in videolaryngostroboscopic technology, and possibly increased experience with videolaryngostroboscopy interpretation.¹⁸ Moreover, in a study by Sataloff et al, even the singing teachers showed laryngeal abnormalities following videolaryngostroboscopic examination (86.1% structural pathologies such as masses, cysts, ectasias, and signs or symptoms of laryngopharyngeal reflux), although they were asymptomatic and identified themselves as healthy.¹⁹

In our study, videolaryngostroboscopic examinations showed an alteration in 60.7% of the subjects in the study group. In particular, organic lesions (nodules, cysts, and sulcus vergeture) were found in 17.9% of the subjects, and laryngeal edema in 14.3%. Functional alterations in the absence of organic lesions have been detected in 35.7% of subjects (incomplete glottic closure) and in 16.1% of cases in the form of supraglottis hypertonus. On the other hand, only 20% of the control group subjects showed alterations following laryngostroboscopic examination, and only two cases revealed small-sized bilateral nodules. For all the laryngostroboscopic findings, a statistically significant difference was observed, as proof of the fact that students on their first year of singing studies showed more frequent pathologic findings following laryngostroboscopy, compared with non-singing subjects of the same age.

Evidently, singing activity, if not adequately supported by a correct singing technique, can contribute to cause an organic or functional alteration of the glottic plane. In fact, more than half of the study group subjects were self-educated singers, with a part-time singing activity in clubs.

As reported by several authors, many singing teachers and professional singers have a partial perception of their laryngeal status even if videolaryngostroboscopy shows a high prevalence of organic or functional abnormalities.¹⁸⁻²¹

If this is true for singing teachers and professional singers who have a substantial larynx proprioception, this is even more true for singing students who have not yet developed a satisfactory

TABLE 2.
Pathologic Videolaryngostroboscopic or Rhino-pharyngo-endoscopic Data and Related Statistical Differences Between Study and Control Group

Laryngostroboscopic Examination			
	Study Group (Singers) (n = 56)	Control Group (n = 60)	P
Pathologic laryngostroboscopic examinations (n; %)	34/56; 60.7%	12/60; 20%	$P < 0.0001^*$
Pathologic laryngostroboscopic examinations (sex)	20 females 14 males	8 females 4 males	$P = 0.001^*$ $P = 0.002^*$
Pathologic laryngostroboscopic examinations (mean age \pm SD)	female: 28.25 ± 6.5 male: 30.36 ± 6.3	female: 30.63 ± 7.7 male: 33.75 ± 8.8	NS
Organic lesions:	10 (17.9%)	2 (3.3%)	$P = 0.01^*$
– Bilateral nodules	– 6 (10.7%)	– 2 (3.3%)	
– Intracordal cyst	– 2 (3.6%)	—	
– Sulcus vergeture	– 2 (3.6%)	—	
Laryngeal edema	8 (14.3%)	2 (3.3%)	$P = 0.03^*$
Posterior erythema	9 (16.1%)	3 (5%)	$P = 0.05^*$
Incomplete glottic closure	20 (35.7%)	8 (13.3%)	$P = 0.005^*$
– Incomplete	– 3 (5.4%)	—	
– Spindle-shaped	– 4 (7.1%)	– 2 (3.3%)	
– Hourglass	– 9 (16.1%)	– 4 (6.7%)	
– Posterior gap	– 4 (7.1%)	– 2 (3.3%)	
Supraglottis hypertonus	9 (16.1%)	3 (5%)	$P = 0.05^*$
– Self-educated singers	7/9 (77.8%)	—	
– First singing experience	2/9 (22.2%)	—	
Rhino-pharyngo-endoscopic Examination			
	Study Group (Singers) (n = 56)	Control Group (n = 60)	P
Nasal septum deviation	2 (3.6%)	3 (5%)	NS
Pathologic rhinorrhea	4 (7.1%)	4 (6.7%)	NS
Retropharyngeal mucus	6 (10.7%)	5 (8.3%)	NS

* Chi-square test.

confidence in the use of their voice. Nevertheless, singing for years as self-educated singers does not guarantee any adequate self-perception of voice disorders compared with students at their first singing experiences. In fact, it has to be considered that, in our study, 30 of these students had been self-taught singers for several years before attending the school and, although a higher level of self-diagnostic ability concerning voice disorders has to be expected here, 65% of this subgroup had pathologic videolaryngostroboscopic findings.

VHI results have shown that singing students have an insufficient perception of their vocal disturbances (the VHI score was less than 40 points in every subject) in the spoken voice, even if the average VHI value is higher than the values obtained with controls (7.39 ± 8.1 vs. 4.35 ± 4.4 ; $P = 0.01$).

On the contrary, the specific VHI score for singers (S-VHI), recently validated for the Italian language,¹³ has proven to be a more sensitive instrument to detect vocal alterations in first-year singing students. Students with normal laryngostroboscopic examination show a clearly lower S-VHI value compared with students with pathologic laryngostroboscopic examination (17.7 ± 12.5 vs. 47.3 ± 18.9 ; $P < 0.0001$). As demonstrated by Cohen et al, among singers, the S-VHI is also more sensitive

to clinical changes than the VHI,²² which proves the validity of the S-VHI in measuring treatment outcomes in the singing population.

The majority of the abnormal laryngostroboscopic findings might be classified as functional alterations (29 subjects). Incomplete glottic closure (35.7% of the pathologic laryngoscopies) including incomplete, spindle-shaped, hourglass or posterior gap, and supraglottic hypertonus (16.1% of the pathologic laryngoscopies) was considered in this subgroup. It might be postulated that the lack of complete closure has an impact on the effort to control the air leak during singing, with consequent compensatory activity of the laryngeal muscles; with time, compensatory supraglottic hypertonus may cause the development of an objectively pathologic voice, which can be perceived by the singer him- or herself.

Supraglottic hypertonus, more frequently observed among the self-educated singers than in the unexperienced students, could be the consequence of singing activities performed without following good vocal techniques. In this case, singers often try to increase the volume of their voice using the extrinsic muscles of the larynx. This might be a method for increasing the strength of a singing voice, but it should not be considered the most

efficient one. Indeed, the larynx would not be able to use this compensation to produce a powerful voice for a long time without causing a condition of overload. In these cases, the outcome might be a worsening of the quality of the voice in singers at some point during their career.

In 10 cases of the study group who underwent videolaryngostroboscopy, the presence of organic lesions was observed; these were divided into bilateral nodules in six cases, unilateral intracordal cyst in two cases, and sulcus vergeture in the other two cases. Surprisingly, none of these singers perceived any vocal difficulty when singing or speaking. It is known that nodules are etiologically related to overuse and abuse of the voice, singing beyond one's vocal comfort range, performing excessive activities involving speaking, teaching, etc.²³ Without the correct diagnosis and vocal training while maintaining the same singing approach, there is a high likelihood of future dysphonia in these cases because of the persistent vocal fold tension that leads to abnormal anatomic and cellular conditions.²⁴ In case of cysts or sulcus vergeture, the absence of self-perception of dysphonia is not so atypical. In our study group, however, cysts were small in dimensions, and sulcus vergeture involved only a small portion of the vibratory margin of the vocal folds, causing a slight dysphonia in the perceptive evaluation (G1 in the GRBAS scale). In most cases, these conditions are congenital and the subjects are accustomed to perceiving their altered voice as if it were normal. They can still perform their singing activity, but an altered vocal apparatus is a risk factor for the development of dysphonia, especially in cases of vocal overload such as singing without employing the adequate techniques.

In eight singers, laryngeal edema was observed, which was associated with vocal fold congestion in five cases; these pathologic findings could be interpreted as a sign of vocal overuse or abuse. The subjective threshold for tolerance to a voice workload cannot be known in advance,² and it is known that it can vary from subject to subject. In case of fragility of the vocal apparatus, especially if other risk factors such as smoking or use of drying agents are associated, it is even more important to make singers aware of the likelihood of developing a dysphonic voice, and in this regard they must be informed that thorough vocal hygiene and appropriate vocal training are recommended.

Erythema in the posterior glottis (arytenoids only), which suggests irritation because of laryngopharyngeal reflux, was seen in nine subjects. RSI and RFS have clearly proven as more substantial compared with the values recorded in the control group, with a statistically highly significant difference (RSI, $P = 0.003$; RFS, $P = 0.0006$). Although the average RSI and RFS values in the study group have not resulted, suggestive of Laryngopharyngeal reflux disease (LPRD) (5.59 ± 6.1 ; 3.04 ± 3.1), it is interesting to underline that, considering RSI and RFS of each subject studied, values of RSI suggestive of possible LPRD (RSI > 13) have been detected in 14 of 56 (25%) singing students vs. 5 of 60 (8.4%) controls; values of RFS suggestive of possible LPRD (RSI > 7) have been detected in 7 of 56 (12.5%) singing students vs. 1 of 60 (1.7%) control.

Reflux laryngitis is quite common in singers,^{2,25} probably because of their lifestyle, especially if they perform Contemporary Commercial Music (which is often associated with eating

late at night, drinking alcoholic and caffeinated beverages, smoking). This laryngeal condition is another risk factor for the development of dysphonia, and preventive measures can help avoid more serious vocal fold pathologies. Moreover, an accurate ENT examination can reveal pathologic conditions such as nasal septum deviation, postnasal drip, which may determine incoordination between respiratory and phonatory systems, that can facilitate the appearance of dysphonia.

The results of this study allow confirmation of how ENT or phoniatric and Speech language pathologist evaluations with videolaryngostroboscopy have been useful for screening first-year singing students to detect any altered status of their phonatory apparatus. It is necessary to make singers at the beginning of their studies aware of their larynx status, to obtain a correct diagnosis, and to be assigned to the most suitable vocal education program. With the aid of the right precautionary measures, singers might avoid developing more serious clinical conditions of the vocal folds, which would have an impact on their work and, as a consequence, on their social activity. However, further studies, with a greater number of singers involved, are necessary to confirm the high prevalence of asymptomatic vocal fold alterations.

CONCLUSIONS

Considering the results of our study, according to the most recent literature, videolaryngostroboscopy brings to light both organic and functional voice disorders in singing students. Because of the high percentage of such disorders in subjects attending the first year of singing school, it would be desirable that every subject who is going to start a singing course underwent videostroboscopy to ascertain the healthy condition of the vocal folds. The results of this study might encourage people who are going to attend a singing course to undergo an ENT or phoniatric investigation with videolaryngostroboscopy to certify the healthy condition of the vocal folds.

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