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Validity, reliability and reproducibility of the VLS parameters form for the collection of videolaryngostroboscopic basic findings

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Abstract

Objective The videolaryngostroboscopy parameters form (VLSP form) is a diagnostic tool for the collection of videolaryngostroboscopic basic findings through the evaluation of 12 parameters. The aim of the present study is to preliminarily investigate intra- and inter-rater reliability, validity and responsiveness of the VLSP form.

Methods A study on a total amount of 160 forms for the evaluation of VLS basic findings was carried out. 80 forms were scored through the VLSP form and 80 with the Voice Vibratory Assessment with Laryngeal Imaging (VALI) form Stroboscopy (S) by four expert phoniatricians, that blindly scored the VLS recordings of 5 subjects without voice disorders and 5 patients with organic voice disorder before and after successful phonosurgery. Intra-rater and inter-rater analysis have been performed for both forms. The scores obtained through VLSP form and VALI form S have been compared to analyse concurrent validity, while VLSP scores before and after phonosurgery have been compared to analyse responsiveness. Finally, each rater annotated the "difficulty" in rating every parameter and its "importance" for the diagnosis.

Results The VLSP form showed good inter- and intra-rater reliability. It showed a good accuracy for the documentation of changes of laryngeal anatomy and function after phonosurgery, similarly to the VALI form S. The 12 parameters of the VLSP form were judged "Slightly Important" in 28.3% of the samples, "Very Important" in 64.8% of the samples, "Not Difficult" in 73.1% of the samples.

Conclusions The results of the present study suggest that the VLSP form is comparable to the VALI form S for the evaluation of videolaryngostroboscopic parameters and is a valid, reliable and reproducible diagnostic tool. It can help voice clinicians in the evaluation of VLS examinations and it allows for a punctual assessment of modifications in laryngeal anatomy and function in pathological conditions and after phonosurgery.

Keywords Videolaryngostroboscopy · Dysphonia · Larynx · Voice disorders

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Introduction

Videolaryngostroboscopy (VLS) is a basic investigation for the diagnosis of laryngeal diseases, using a stroboscopic light source and a microphone to visualize the oscillatory movements of the vocal folds [1]. It is particularly useful in the fields of phoniatrics [2] and laryngeal oncology [3]. Today videolaryngostroboscopy can be performed both through trans-oral approaches, using rigid-telelaryngoscopes, and through trans-nasal digital flexible endoscopes with good quality images. In 2001 the European Laryngological Society (ELS) published a basic Protocol for the assessment of dysphonia [4] which was updated together with the Union of European of Phoniatricians (UEP) in 2023 [5]; these guidelines considered VLS as a mandatory examination for a thorough assessment. In 2002 the Italian Society of Phoniatrics and Logopedics (SIFEL) introduced its multidimensional Protocol for the assessment of dysphonia [6] which follows the ELS guidelines; it contained a form for the collection of the VLS basic findings, which considered several parameters, including those codified by Hirano and Bless [1, 7] as the "Mucosal Wave" and the "Glottic Closure" and other parameters proposed by Bergamini and Ricci-Maccarini in the "SIFEL Protocol", as the "Vocal Fold Motility" and the "Seat of Voice Source", providing for a comprehensive evaluation tool for the videolaryngostroboscopic examination.

In 2018 this form was published with drawings, for helping voice clinicians in the evaluation of videolaryngostroboscopy basic findings [8]. This form, called "VLS Parameters (VLSP) form" (Fig. 1) provides scores for the evaluation of 12 parameters: (1) supraglottic framework behaviour, (2) seat of voice source, (3) vocal fold morphology, (4) vocal fold motility, (5) level of the vocal fold, (6) symmetry of glottic vibration, (7) periodicity of glottic vibration, (8) glottic closure, (9) profile of vocal fold edge, (10) amplitude of vocal fold vibration, (11) mucosal wave, (12) stops of vocal fold mucosa vibration.

The detailed description of each parameter is reported in the former publication [8]. Before completing the form, the voice clinician has to annotate the type of endoscope used for the examination, pitch, loudness and vocal register of the examined voice sample. These aspects give basic information for the correct evaluation of VLS.

In 2017 Poburka, Patel and Bless published two forms for the collection of basic findings of Videolaryngostroboscopy and High-Speed Videoendoscopy, called Voice Vibratory Assessment with Laryngeal Imaging (VALI) forms [9]. The VALI form Stroboscopy (VALI form S) provides scores for the evaluation of 11 parameters, similar to those contained in the VLSP form. They are: (1) glottal closure, (2) amplitude, (3) mucosal wave, (4) vertical level, (5) non vibrating portion, (6) supraglottic activity, (7) free edge contour, (8) phase closure, (9) phase symmetry, (10) regularity, (11) non vibratory observations. The 8th parameter "Phase Closure" contained in VALI form S provides for the evaluation of the duration of the closed phase of the glottic vibratory cycle compared to the open phase and this is correctly evaluated with High-Speed Videoendoscopy. The VALI form S has drawings for the illustration of the parameters, similarly to the VLSP form. Most of the parameters of the VALI form S are scored in percentage of deviation from normal; they do not include the parameters "Vocal Fold Motility" and "Seat of Voice Source", that are contained in the VLSP form. The parameters of the VLSP form and of the VALI form S, with the similar parameters in the two forms, are shown in Table 1.

Materials and methods

Patients and procedures

In order to validate the VLSP form and to investigate its inter-and intra-rater reliability and reproducibility, a retrospective study on a total amount of 160 forms for the evaluation of VLS basic findings was carried out. 80 forms were scored through the VLSP form and 80 through the VALI form S. Four phoniatricians with over 10 years of experience in phonosurgery and laryngostroboscopic assessment were recruited to score 5 subjects without voice disorders (4 females, 1 male) and 5 patients (4 females, 1 male) with organic voice disorder before and after successful phonosurgery. Gender, age, vocal pitch and vocal register data, as well as diagnosis and phonosurgical procedures and the data of normal subjects are shown in Table 2. The raters were provided with an user manual that showed how to rate the VLS samples with the two forms. The raters were informed about age and gender of the subjects, type of endoscope used for VLS, vocal pitch (mean F0) and vocal register (1 modal, 2 falsetto), while were blinded to diagnosis and phonosurgical procedures. All the examinations were performed with a rigid 70° STORZ telelaryngoscope and a stroboscopic light Atmos L200 Endostroboscope; video files were saved and stored as WMV high quality videos. For the intra-rater reliability evaluations, the pre-operative VLS samples were re-evaluated one month later in a different order; raters were blind to both other raters scores and their own previous scores.

Most of the VALI form S parameters of are scored in percentage of deviation from normal, while most of the parameters of the VLSP form do not have a percentage scoring; in order to compare the scores of the two forms, each

Fig. 1 VLS parameters form

Surname_____Name_____
Type of Endoscope: ☐ Rigid endoscope 70° ☐ Rigid endoscope 90° ☐ Flexible endoscope
Vocal Pitch: _____Hz Loudness: _____dB
Vocal Register: ☐ Modal ☐ Fry ☐ Falsetto

1) SUPRAGLOTTIC FRAMEWORK BEHAVIOUR

☐0 Normal (1) ☐1a Slight latero-lateral constriction (≤50%) ☐2a Significant latero-lateral constriction (>50%) (2) ☐1b Slight antero-posterior constriction (≤50%) ☐2b Significant antero-posterior constriction (>50%) (3) ☐1c Slight all-around constriction (≤50%) ☐2c Significant all-around constriction (>50%) (4)

2) SEAT OF VOICE SOURCE

☐0 Vocal fold (VF)-VF (1)
☐1a Ventricular Band (VB)-VB (2)
☐1b VF-VB (3)
☐1c Arytenoid-VB (4)
☐1d Arytenoid/s-Epiglottis (5)
☐1e Arytenoid/s-Tongue base (6)

3) VOCAL FOLD MORPHOLOGY

	Normally trophic	Hypertrophic	Atrophic	Absence of lesions	Presence of lesions
Right VF	☐ a0	☐ a1	☐ a2	☐ e0	☐ e1
Left VF	☐ b0	☐ b1	☐ b2	☐ f0	☐ f1
Right VB	☐ c0	☐ c2	☐ c1	☐ g0	☐ g1
Left VB	☐ d0	☐ d2	☐ d1	☐ h0	☐ h1
Discovered laryngeal lesions:					

4) VOCAL FOLD MOTILITY

	Normal mobile	Hyper adducted	Hypo mobile	Immobile in median position	Immobile in paramedian position	Immobile in Intermediate position	Immobile in abducted position
RVF	☐a0	☐a1	☐a2	☐a3	☐a4	☐a5	☐a6
LVF	☐b0	☐b1	☐b2	☐b3 (1)	☐b4 (2)	☐b5 (3	☐b6 (4)

parameter's possible scorings were associated to numbers and letters, as shown in Fig. 1.

Each parameter of the VLSP form and of the VALI form S was evaluated by the 4 raters who scored the parameter marking it on the form and annotating the "difficulty" in the evaluation of the parameter (0 not difficult, 1 slightly difficult, 2 very difficult). Each parameter of the VLSP form was also scored considering the "importance" for the diagnosis in each patient (0 not important, 1 slightly important, 2 very important).

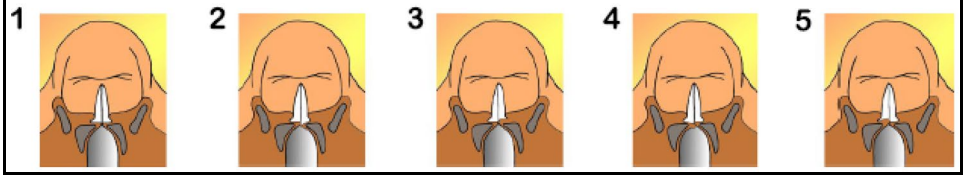
Statistical analysis

Statistical analysis was carried out with GraphPad Prism software (Version 7.0, GraphPad Software, Inc, San Diego,

Fig. 1 (continued)

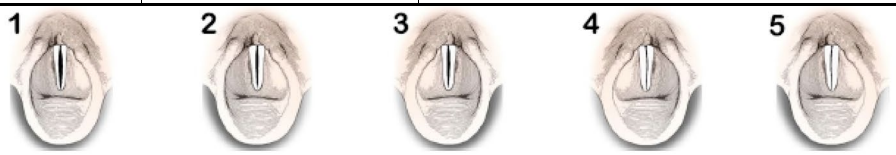
5) LEVEL OF THE VOCAL FOLD

	Normal leveled	Under-leveled	Over-leveled
Right Vocal Fold	a0 (1)	a1 (2)	a2 (3)
Left Vocal Fold	b0 (1)	b1 (4)	b2 (5)



6) SYMMETRY OF GLOTTIC VIBRATION

☐0 Normal Symmetry (1)	1 **Phase Asymmetry** (4,5)	2 **Amplitude Asymmetry** 2a Right>Left (2) 2b Righ<Left (3)

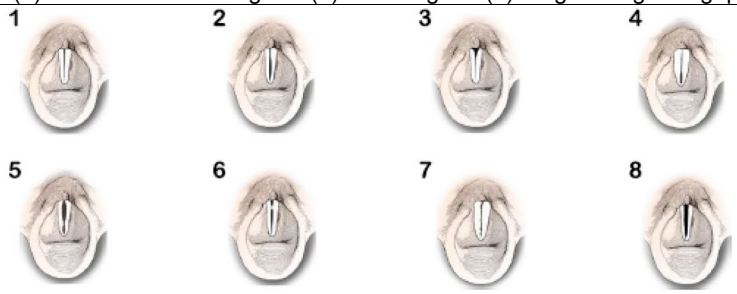


7) PERIODICITY OF GLOTTIC VIBRATION

0 Regular	1 Irregular	2 Inconsistent

8) GLOTTIC CLOSURE

0 Complete (1) 1 Inconstant 2 Slightly incomplete (gap ≤50%) 3 Very incomplete (gap >50%) Type of Glottic Gap in Incomplete Glottic Closure: ☐a Spindle-shaped (2) ☐b Posterior triangle (3) ☐c Anterior gap (4) ☐d Anterior hourglass (5) e Posterior hourglass (6) f Irregular (7) g Total glottic gap (8)



9) PROFILE OF VOCAL FOLD EDGE

	STRAIGHT	CONVEX	CONCAVE	IRREGULAR
Right Vocal Fold	☐a0 (1)	☐a1 (3)	☐a2 (2)	☐a3 (4)
Left Vocal Fold	☐b0 (1)	☐b1 (6)	☐b2 (5)	☐b3 (7)

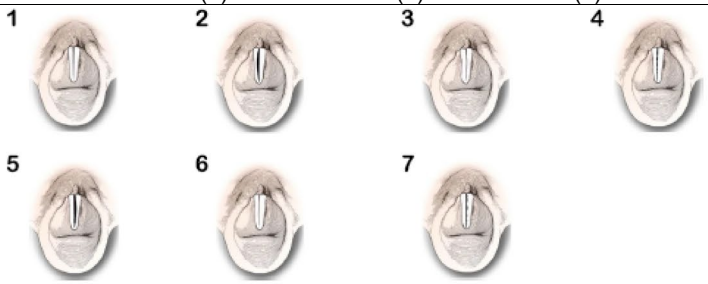
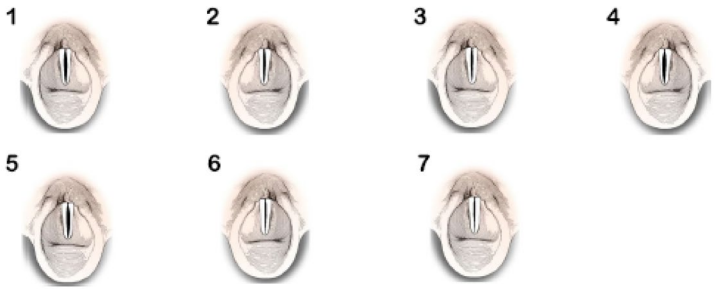


Fig. 1 (continued)

10) AMPLITUDE OF VOCAL FOLD VIBRATION				
	NORMAL (40-60%)	LARGE (>60%)	SMALL (≤40%)	ABSENT (0%)
Right Vocal Fold	☐a0 (1)	☐a1 (4)	☐a2 (3)	☐a3 (2)
Left Vocal Fold	☐b0 (1)	☐b1 (7)	☐b2 (6)	☐b3 (5)



11) MUCOSAL WAVE				
	NORMAL (40-60%)	LARGE (>60%)	SMALL (≤40%)	ABSENT (0%)
Right Vocal Fold	☐a0	☐a1	☐a2	☐a3
Left Vocal Fold	☐b0	☐b1	☐b2	☐b3

12) STOPS OF VOCAL FOLD MUCOSA VIBRATION	
Right VF	☐a0 Absent ☐a1 Occasionally present ☐a2 Constantly present ☐a Entire VF ☐b Anterior third ☐c Middle third ☐d Posterior third
Left VF	☐b0 Absent ☐b1 Occasionally present ☐b2 Constantly present ☐a Entire VF ☐b Anterior third ☐c Middle third ☐d Posterior third

Remarks:_____

_____

Date_____ The Physician: _____

Table 1 Parameters of the VLSP form and of VALI form S, with similar parameters displayed on the same line

VLSP form	VALI form S
1 Supraglottic framework behaviour	6 Supraglottic activity
2 Seat of voice source	–
3 Vocal fold morphology	11 Non vibratory observations
4 Vocal fold motility	–
5 Level of the vocal fold	4 Vertical level
6 Symmetry of glottic vibration	9 Phase symmetry
7 Periodicity of glottic vibration	10 Regularity
8 Glottic closure	1 Glottal closure
9 Profile of vocal fold edge	7 Free edge contour
10 Amplitude of vocal fold vibration	2 Amplitude
11 Mucosal wave	3 Mucosal wave
12 Stops of vocal fold mucosa vibration	5 Non vibrating portion

CA). The D'agostino-Pearson normality test was used to verify Gaussian distributions of continuous variables.

For comparisons between groups, paired t-tests and Wilcoxon tests were used, as appropriate. Inter-rater reliability analysis was carried out with Fleiss *K* statistics, while for intra-rater reliability analysis Cohen *K* statistics were used. For the interpretation of k statistics, the guidelines provided by Landis and Koch were considered [9]: $k < 0.00$ = poor, $k = 0.00$–0.20 slight, $k = 0.21$–0.40 fair, $k = 0.41$–0.60 moderate, $k = 0.61$–0.80 substantial, $k = 0.81$–1.00 almost perfect agreement. An alpha of 0.05 was considered for statistical procedures.

Results

No significant differences were found regarding age, gender distribution, mean vocal pitch and vocal register between the group of normal subjects and the group

Table 2 Cases reports of pathologic and normal subjects

Cases	Pitch and vocal register	Diagnosis	Phonosurgical procedure
Female, 55 y.o	Pitch: pre-op. 280 Hz; post-op. 250 Hz Vocal Register: pre-op. Falsetto; post-op. Falsetto	Glottic insufficiency and scars after partial cordectomy right vocal fold	Injection laryngoplasty with centrifuged autologous fat under flexible endoscopy
Female, 32 y.o	Pitch: pre-op. 270 Hz; post-op. 210 Hz Vocal Register: pre-op. Falsetto; post-op. Modal	Glottic insufficiency for paralysis of the right vocal fold in intermediate position	Injection laryngoplasty with centrifuged autologous fat under flexible endoscopy
Male, 60 y.o	Pitch: pre-op. 260 Hz; post-op. 190 Hz Vocal register: pre-op. Falsetto; post-op. Modal	Glottic insufficiency due to paralysis of the left vocal fold in abducted position	Medialization laryngoplasty with Montgomery implant
Female, 29 y.o	Pitch: pre-op. 360 Hz; post-op. 320 Hz Vocal register: pre-op. Falsetto; post-op. Modal	Bilateral deep vergeture of the vocal folds, severe in the right vocal fold	Detachment of the vergeture by direct microlaryngoscopy. In the right vocal fold with Bouchayer technique; In the left vocal fold with sub-epithelial injection of hyaluronic acid + bilateral fat injection into the vocalis muscles
Female, 37 y.o	Pitch: pre-op. 320 Hz; post-op. 250 Hz Vocal register: pre-op. Variable Falsetto-Modal; post-op. Modal	Severe bilateral scars of the vocal folds after removal of Reinke's edema	Detachment and removal of the scarred tissue in the right vocal fold. with Bouchayer technique, sub-epithelial injection of hyaluronic acid in the left vocal fold + bilateral fat injection into the vocalis muscles
Controls	Pitch and vocal register	–	–
Male, 58 y.o.	Pitch: 118 Hz Vocal register: Modal	–	–
Female, 34 y.o.	Pitch: 224 HZ Vocal register: Modal	–	–
Female, 60 y.o.	Pitch: 216 Hz Vocal register: Modal	–	–
Female, 38 y.o.	Pitch: 208 Hz Vocal register: Modal	–	–
Female, 30 y.o.	Pitch: 229 Hz Vocal register: Modal	–	–

of pathological cases. The scores of all the parameters of VLSP form and VALI form S in the subjects without voice disorder were "0" (normal), with perfect agreement between raters. No additional statistical analysis was therefore necessary To determine the intra-rater reliability of the VLSP form, Cohen *K* (CK) values were obtained by pooling the repeated ratings of each judge for all VLSP form parameters and all VALI form S parameters on the 5 patients with organic voice disorders. Regarding VLSP form parameters, Ck values of 0.97, 0.83, 0.89 and 0.96 were observed for the four raters, respectively; for VALI form S parameters, Ck values of 0.92, 0.86, 0.93 and 0.91 were observed for the four raters, respectively, suggesting almost perfect agreement for all four raters both in VLSP and in VALI S forms judgements.

Concerning inter-rater reliability of the four raters assessing the five patients with organic voice disorders before surgery, Fleiss *K* (Fk) values showed substantial or almost perfect agreements for both VLSP and VALI S forms, as showed in Table 3.

Table 3 Fleiss *K* values and 95% CI for the VLSP form and for the VALI form S

Parameter n. VLSP (VALI)	VLSP form	VALI form S
1 (6)	0.71 (0.47–0.95)	0.71 (0.47–0.95)
2 (-)	1.00	–
3 (11)	1.00	1.00
4 (-)	0.94 (0.82–1.00)	–
5 (4)	0.92 (0.75–1.00)	0.92 (0.75–1.00)
6 (9)	0.83 (0.62–1.00)	0.79 (0.58–1.00)
7 (10)	0.91 (0.74–1.00)	0.89 (0.64–1.00)
8 (1)	0.93 (0.73–1.00)	0.93 (0.73–1.00)
9 (7)	0.69 (0.44–0.94)	0.69 (0.44–0.94)
10 (2)	0.60 (0.33–0.87)	0.87 (0.69–1.00)
11 (3)	1.00	1.00
12 (5)	0.93 (0.69–1.00)	1.00

For the responsiveness analysis of the VLSP form, each parameter's score by each rater in pre- and post-operative conditions was compared. Since VLS parameters are complex and defined by combinations of numbers and letters, a statistical comparison test was not feasible. For this reason, an evaluation on post-surgical modifications was carried out for each parameter in order to establish whether an improvement occurred. For each patients who underwent phonosurgery and for each VSL parameter, the number of raters whose scores improved after phonosurgery was reported as fraction and percentage. Relevant modifications were found for each of the 5 pathological cases with almost perfect agreement in most of the parameters, as shown in Table 4. The percentages of Importance scores for each VLSP form parameter reported by the four raters (0 = not important; 1 = slightly important; 2 = very important) are shown in Table 5. The percentages of Difficulty scores in the evaluation of each parameter (scored as 0 = not difficult, 1 = slightly difficult, 2 = very difficult), both for VLSP form and VALI S form are shown in Table 6. The Fleiss *K* (Fk) coefficient calculated on Difficulty scores showed an overall good inter-rater reliability for all parameters, both in VLSP and in VALI S forms, ranging from $k = 0.37$ (fair agreement) to $k = 1.0$ (perfect agreement), as shown in Table 6.

Table 5 Mean "importance" rates of VLSP form parameters

Parameter	VLSP form		
	Not important (%)	Slightly important (%)	Very important (%)
1	12.5	62.5	25.0
2	0.0	32.5	67,5
3	0.0	15.0	85.0
4	27.5	12.5	60.0
5	30.0	30.0	40.0
6	0.0	20.0	80.0
7	0.0	42.4	57.5
8	0.0	0.0	100.0
9	0.0	25.0	75.0
10	12.5	30.0	57.5
11	0.0	25.0	75.0
12	0.0	45.0	55.0

Discussion

Reliability, validity and responsiveness of the VLSP have been analyzed for the first time. The results of this study regarding the validity, reliability and responsiveness of the VLSP form are similar to those reported in previous studies on VLS evaluation [11, 12]. In particular, VLSP form emerged as a good tool for detecting functional and anatomical changes after phonosurgery, with good inter-rater and intra-rater reliability. The availability of a "user manual" may help the rater, improving the agreement among raters. In the VLSP form the parameter "Vocal Fold Motility", which is not contained in the VALI form S, allows for the evaluation of the position of the immobile vocal fold and the comparison between examinations before and after medialization laryngoplasty with injection laryngoplasty or thyroplasty, as in two cases presented in this study; also the recent ELS and UEP guidelines [5] recommend the use of the parameter "Motility" in the evaluation of VLS. The parameter "Seat of voice source" is also contained in the VLSP form and not in the VALI S form; it allows for the evaluation of the vibrating laryngeal voice source, which is not necessarily represented by the vocal folds. For instance, in supraglottic voice, vibration may occur between the ventricular bands. After a cordectomy, voice source might take place between a vocal fold and the contralateral ventricular

Table 4 Improved ratings after phonosurgery

	Case n. 1	Case n. 2	Case n. 3	Case n. 4	Case n. 5
VLS (VALI)	Improved ratings after phonosurgery (number and % of raters)				
1 (6)	2/4 (50%)	4/4 (100%)	4/4 (100%)	2/4 (50%)	4/4 (100%)
2 (-)	3/4 (75%)	0/4 (0%)	0/4 (0%)	0/4 (0%)	0/4 (0%)
3 (11)	4/4 (100%)	4/4 (100%)	0/4 (0%)	4/4 (100%)	4/4 (100%)
4 (-)	0/4 (0%)	4/4 (100%)	4/4 (100%)	0/4 (0%)	0/4 (0%)
5 (4)	0/4 (0%)	4/4 (100%)	4/4 (100%)	0/4 (0%)	0/4 (0%)
6 (9)	1/4 (25%)	4/4 (100%)	0/4 (0%)	3/4 (75%)	0/4 (0%)
7 (10)	0/4 (0%)	0/4 (0%)	4/4 (100%)	4/4 (100%)	4/4 (100%)
8 (1)	4/4 (100%)	4/4 (100%)	4/4 (100%)	3/4 (75%)	4/4 (100%)
9 (7)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)
10 (2)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)
11 (3)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)	4/4 (100%)
12 (5)	4/4 (100%)	0/4 (0%)	0/4 (0%)	4/4 (100%)	4/4 (100%)

Table 6 Mean "difficulty" scores and Fleiss *K* coefficients of the parameters of VLSP form and VALI form S

Parameter VLSP (VALI)	VLSP form				VALI form S			
	Not difficult (%)	Slightly difficult (%)	Very difficult (%)	Fleiss *K* (95% CI)	Not difficult (%)	Slightly difficult (%)	Very difficult (%)	Fleiss *K* (95% CI)
1 (6)	100.0	0.0	0.0	1.0	95.0	2.5	02.5	0.86 (0.58–1.0)
2 (-)	90.0	10.0	0.0	0.73 (0.43–1.00)	–	–	–	–
3 (11)	80.0	20.0	0.0	0.65 (0.37–0.93)	0.0	10.0	90.0	0.73 (0.43–1.0)
4 (-)	92.5	07.5	0.0	0.79 (0.54–1.00)	–	–	–	–
5 (4)	72.5	27.5	0.0	0.42 (0.12–0.74)	37.5	47.5	15.0	0.65 (0.37–0.93)
6 (9)	57.5	42.5	0.0	0.75 (0.50–1.0)	25.0	70.0	5.0	0.53 (0.2–0.85)
7 (10)	55.0	42.5	2.5	0.37 (0.09–0.66)	27.5	60.0	12.5	0.65 (0.37–0.93)
8 (1)	95.0	05.0	0.0	0.85 (0.68–1.00)	82.5	10.0	07.5	0.77 (0.48–1.0)
9 (7)	80.0	20.0	0.0	0.6 (0.28–0.92)	75.0	12.5	12.5	0.67 (0.41–0.94)
10 (2)	80.0	17.5	2.5	0.53 (0.27–0.78)	37.5	60.0	02.5	0.73 (0.55–1.00)
11 (3)	35.0	65.0	0.0	0.8 (0.54–1.0)	10.0	65.0	25.0	0.5 (0.17-.083)
12 (5)	40.0	57.5	2.5	0.54 (0.27–0.78)	25.0%	45.0%	30.0%	0.42 (0.17–0.68)

band, as in one case presented in this study. The parameter "Vocal Fold Morphology" of the VLSP form is more comprehensive than the similar parameter of the VALI form S "Non Vibratory Observations". In fact, it allows for the documentation of the atrophy of a vocal fold, as in 4 cases of this study and the vocal fold augmentation after injection laryngoplasty, in addition to the assessment of laryngeal lesions. The parameter "Glottic Closure" is more comprehensive than the similar parameter of the VALI form S because it provides for the documentation of the "slightly" or "very" incomplete glottic closure. The use of the VALI form S for this study suggested us to improve 4 parameters of the VLSP form, with a percentage score as in the VALI form S: the parameter 1 "Supraglottic Framework Behaviour" has now the specification of the degree of constriction in percentage; the parameter 8 "Glottic Closure" has been implemented with the specification of the degree of incomplete glottic closure in percentage; the parameters 10 "Amplitude of Vocal Fold Vibration" and 11 "Mucosal Wave" have been implemented with the specification of the degree in percentage as well (Fig. 1).

Concerning Importance ratings of VLSP form, all the 12 parameters were judged "slightly important" or "very important" by the four raters in the large majority of cases, suggesting that all the considered parameters can be considered relevant for the assessment of videolaryngostroboscopy.

Regarding Difficulty ratings, both VLSP form and VALI S form parameters were judged "not difficult" or "slightly difficult" by the raters in the large majority of cases; suggesting a good level of reproducibility for the two forms. In general, the scoring of VLSP form was considered slightly easier than VALI S form for all parameters by the raters, as shown in Table 6. The most marked difference between the two forms in terms of "Difficulty" was registered for parameter 3 of VLSP form (Vocal Fold Morphology), corresponding to the parameter 11 of the VALI S form (Non vibratory observations).

There are some limitations to this study. First, the number of videolaryngostroboscopic examinations in both subjects with and without voice disorders is limited, therefore the data provided should be considered as preliminary. Second, the raters involved in the study were expert phoniatricians, therefore it is not known whether reliability and concurrent validity scores apply to non-experts as well. Finally, no data on divergent validity have been provided. Further studies on larger samples of patients, involving both expert and non-expert raters are necessary.

Conclusions

A form for the collection of videolaryngostroboscopic parameters is a useful tool for the evaluation of the VLS examination. The VLSP form emerged as useful and comparable to the VALI form S for the evaluation of videolaryngostroboscopic basic parameters. In particular, the results of the present study suggest that VLSP form is a valid, reliable and responsive diagnostic tool. It can help the voice clinician in the evaluation of the videolaryngostroboscopic examination and it allows for the assessment of changes in laryngeal anatomy and function in pathological conditions and after phonosurgery.

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Declarations

Conflict of interest The authors declare that there is no conflict of interest.

Ethical approval All procedures performed in this retrospective study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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