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International consensus

International consensus (ICON) on basic voice assessment for unilateral vocal fold paralysis



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ABSTRACT

There is a growing need for evaluation tools allowing the quantification of the outcome after voice surgeries. Since the end of the 1990s, multiple unfruitful attempts have been made to reach a consensus, including the Dejonckere protocol for the European Laryngological Society in 2001. This suggested to perform objective and quantifiable measures in the following domains: perception, acoustic, aerodynamic, self-evaluation by the patient and videolaryngostroboscopy. But in a PubMed® search with the keywords "Voice Assessment" and "Voice Outcome" since 2001 retrieving 452 articles, only 33 of them were using methods taking into account the first four dimensions proposed by Dejonckere. To elaborate a new and simpler protocol, we chose to focus on unilateral vocal fold paralysis (UVFP), which represents a homogeneous disease in terms of physiology. This protocol was elaborated on the basis of a review of the literature and of the database and experience of the IFOS panel members. In summary, our group recommends the use and implementation of the ELS "basic protocol" with some minor modifications. Voice audio recordings are an indispensable prerequisite, and may even have medico-legal implications. We recommend the systematic use of the Voice Handicap Index (VHI). Perceptual analysis must be performed by using Hirano's GRB scale and voice breathiness has to be prioritized. Currently, acoustic analysis remains optional given the lack of data to support clinical usefulness. Aerodynamic studies should include at a minimum an evaluation of the Maximum Phonation Time, calculated in seconds following multiple trials in order to obtain a recording representing the patient's best possible glottis closure.

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1. Introduction

The growing need for evaluation tools allowing for the quantification of the outcome after voice surgeries is pushing clinicians to adopt new instruments proposed by researchers. However, interpretation of these results remains difficult, due in part to deficient

clinician experience but also to the often-lacking scientific foundation on which these tools were created. Since the end of the 1990s, multiple unfruitful attempts have been made to reach a consensus [Denver consensus organized by Titze [1]; Dejonckere protocol for the European Laryngological Society [2], multi-parametric protocol presented by Giovanni [3]. Currently, two relevant groups exist: the Special Interest for Voice and Voice Disorders group of the American Speech-Language-Hearing Association (ASHA) [4] and the Speech-Language-Pathology committee of the European Laryngological Association.

In parallel, the Working Group of Clinical Voice Assessment was founded in 2007 by the ASHA's executive committee, under the

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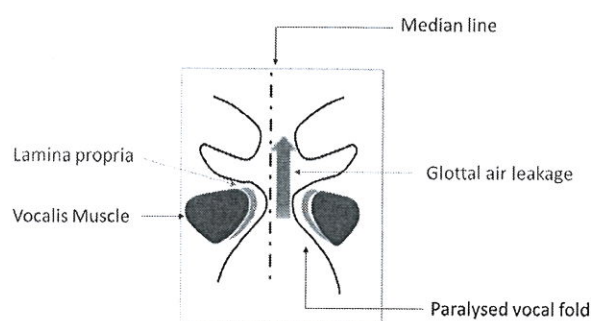


Fig. 1. Dysphonia secondary to a UVFP is due in part to insufficient glottic closure that can be more or less pronounced.

is found to be of weak intensity. Interestingly, quantification of the amount of air leakage during laryngostroboscopy seemed not reliable [30–32]. Regardless, laryngoscopy remains an important evaluation tool recommended by both the ELS protocol and the American Academy of Otolaryngology, and its realization should not be challenged [33].

4. Our study

We hereby present the results extracted from the analysis of the database belonging to one of the groups of the panel (A Giovanni, A Mattei and M Roux). From January 2013 to Mai 2016, we collected data from 153 patients (75 men and 78 women) followed for a UVFP not previously treated. The etiologies were grossly as follows: 30% idiopathic, 32% post-thyroid surgery and 30% post-thoracic surgery. Exclusion criteria included patients with an underlying neurological or medical etiology.

Perceptual analysis was performed by 3 experienced speech-language pathologists with over 5 years of experience in our department. The G, R and B items of Hirano's scale were analyzed on a scale ranging from 0 to 3. Each speech-language pathologist interpreted the audio recordings separately. The audio recordings used for perceptual analysis were taped with the following material:

- AKG C4000 B Microphone (Germany);

Table 2

Data from the perceptual analysis. For each grade G, R and B, patients are distributed from 0 to 3 according to the severity of their dysphonia for each parameter. In parenthesis in the 2nd column is the number of patients prior to the application of exclusion criteria, with the G grading being performed during the initial consultation.

	G	R	B
0	0 (0)	2	6
1	15 (39)	26	23
2	38 (75)	33	31
3	26 (39)	17	18
Not analyzed	—	—	1
Total analyzed	79 (153)	79	78

- numeric-analog convertor RME Fireface UC (Germany);
- analysis software and signal edition: Praat;
- focal XS Book Music System speakers (France) situated at 50 cm from the auditor in a quiet room.

We excluded recordings that had incoherent grade G and B assessments from the various members of the jury. In fact, our goal was to obtain sufficiently proto-typical voices in order to render future comparison with objective measures useful. We retained a total of 78 recordings from those collected, the findings of which are outlined in Table 2. Of note, none of the patients were graded as G0. The fact that the examiners were aware of the diagnosis and the objective of our study is a potential bias and limitation of our project.

The comparative analysis of G, R and B results is illustrated in Fig. 2 and demonstrates that the G grade is not an independent criterion from B and R. It seems that G grading is strongly linked to elevated B and R scores. In other words, a patient classified as B3R2 and a patient classified as B2R3 will both end up being classified as G3. For this reason, we will favor the B grade for the remainder of our study and for the final proposed protocol.

Objective acoustic and aerodynamic measures were recorded with the EVA apparatus EVA [34]. We describe in Table 3 the results of these measures in correlation with the perceptual B grade.

We also analyzed Voice Handicap Index (VHI) data as it relates to G grading. Indeed, we decided to compare a global subjective evaluation (VHI) with a global perceptual evaluation by using the

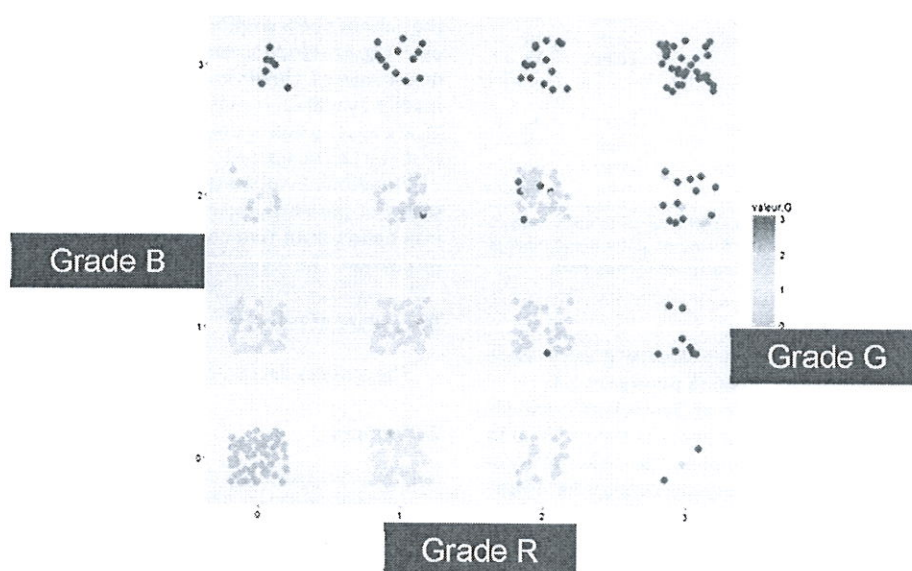


Fig. 2. Distribution of patients according to G, R and B grades. One point represents 1 patient. The axis of abscissas shows the grade R from 0 to 3. On the Y-axis, the grade B from 0 to 3. One color is assigned to each patient according to the grade G: blue for 0, green for 1, yellow for 2, red for 3.

Table 3

Data from objective analysis: comparison of various acoustic parameters between grades B0, B1, B2 and B3.

	B0	B1	P	B2	P	B3
BA	148 (88)	226 (72)	0.01	263 (201)	0.04	496 (241)
MPT	10.7 (5.1)	9.5 (4.6)	0.01	5.9 (3.3)	0.05	3.6 (3.2)
Jitter	0.38 (0.16)	0.81 (0.76)	<0.01	1.5 (1.1)	0.15 (NS)	1.9 (0.95)
SNR > 1 kHz	76 (10)	64 (21)	<0.01	48 (24)	0.01	30 (14)

BA: buccal airflow; MPT: maximum phonation time; SNR: signal to noise ratio > 1 kHz. Statistical significance defined as $P < 0.05$. Because of the small number of B0 cases it was judged meaningless to compare B0 vs. B1.

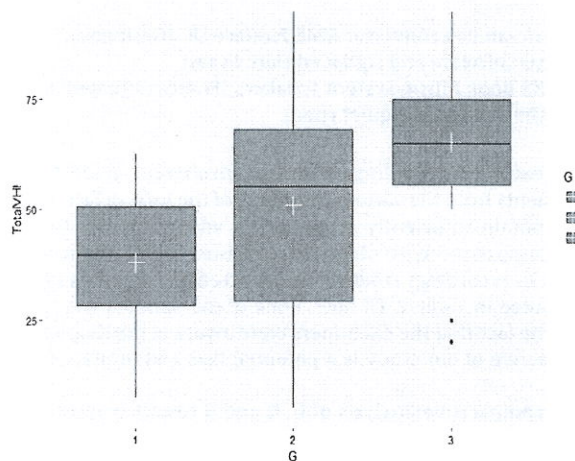


Fig. 3. Correlation between VHI and G grade. The axis of abscissas shows grade G (G1, G2, G3 from left to right). On the Y-axis, the VHI (Voice Handicap Index).

Table 4

Data from the perceptual and objective analyses of a series of 75 patients operated in Marseille for Montgomery Implant placement.

	Preoperative Mean (standard deviation)	Postoperative Mean (standard deviation)	P-value	n (/75)
G	2.5 (0.7)	1.6 (0.7)	<0.01	43
B	2.2 (0.9)	1.2 (0.9)	<0.01	43
VHI-30 (/120)	69.6 (25.2)	21.6 (22.4)	<0.01	36
Self-evaluation (Dejonckere/10)	6.7 (2.1)	3.5 (2.5)	<0.01	34
BA (cm ³ /s)	605 (317)	351 (161)	<0.01	45
MPT (s)	5 (3.5)	8 (6.2)	<0.01	53
Jitter (%)	2.3 (2.3)	0.8 (0.6)	<0.01	50
SNR (dB)	10 (6.5)	14 (5.2)	<0.01	51

BA: buccal airflow; MPT: maximum phonation time; SNR: signal to noise ratio > 1 kHz. Statistical significance defined as $P < 0.05$. The N column states the number of patients for which the analysis was performed. This is non-published data.

G grade. These results are illustrated in Fig. 3. Mean VHI scores were 38% for grades G1, 51% for grades G2 and 65% for grades G3.

These findings confirm the pertinence of Dejonckere's evaluation strategy. In order to validate the usefulness of the protocol in serving the Voice Outcome Index, we applied the same protocol on a series of 75 patients who had undergone surgery for Montgomery implant placement. Of note, some of these patients were also included in the initial patient database.

The results are in the following Table 4.

These results can be instructively compared to a second series from another group forming the panel (G. Desuter) (Table 5).

Table 5

Data from the perceptual and objective analyses of a series of 48 patients operated in Brussels for Montgomery Implant placement between 2003 and 2010.

	Preoperative Median [P ₂₅ –P ₇₅]	Postoperative Median [P ₂₅ –P ₇₅]	P-value
G	3 [3; 3]	1 [1; 1]	<0.001
B	3 [3; 3]	1 [1; 1]	<0.001
VHI-30 (/120)	94 [78; 103]	28 [13.2; 50]	<0.001
MPT (s)	6.5 [4.8; 8.0]	11.5 [9.5; 16.3]	<0.001
Jitter (%)	4.10 [3.10; 5.68]	1.48 [0.90; 2.38]	<0.001

MPT: maximum phonation time; SNR: signal to noise ratio > 1 kHz). Statistical significance defined as $P < 0.05$. This is non-published data.

5. The final protocol

In summary, our focus group recommends the use and implementation of the "basic protocol" brought forth by the ELS with some minor modifications. We recommend the systematic use of the Voice Handicap Index (VHI) in order to better evaluate the clinical situation and the severity of the patient's voice quality of life. It is also possible to ask the patient to rate his/her voice quality by using a visual analog scale. Other questionnaires (VoSS, SF36, EASE) can be used as adjuncts.

Perceptual analysis must be performed by using Hirano's GRB scale. No definitive proof exists regarding the increased pertinence of a visual analog scale compared to the standard 0/1/2/3 scale, but both methods can be employed. Judgment regarding voice breathiness is to be prioritized. Voice audio recordings are an indispensable prerequisite, and may even have medico-legal implications. When voice is evaluated in the post-operative setting, it is preferable to have an examiner blinded to the patient's history.

Currently, acoustic analysis remains optional given the lack of data to support clinical usefulness. The examiners' report will vary based on personal experience. Regardless, acoustic analysis should not replace a voice audio recording, even when taking into account individual perceptual judgment variability. To date, no proof exists regarding the ability of acoustic analysis to adequately summarize a patient's vocal profile. Future studies examining this topic are required.

Aerodynamic studies should include at a minimum an evaluation of the Maximum Phonation Time, calculated in seconds following multiple trials in order to obtain a recording representing the patient's best possible glottis closure. Calculating buccal airflow by using an aerophonometer is an additional investigation that can be considered. However, this requires a specialized instrument not readily available in most centers. Using a spirometer to measure Vital Capacity and estimate the Phonatory Quotient is another test that can be considered.

Therefore, by using the protocol, we were able to compare two series of patients operated for Montgomery implant placement originating from two centers that participated in the round table discussion. The results were absolutely conclusive.

Disclosure of interest

The authors declare that they have no competing interest.

References

- [1] Titze I. Workshop on acoustic voice analysis. Iowa City, Iowa: National center for voice and speech; 1995.
- [2] Dejonckere PH, Bradley P, Clemente P, Cornut G, Crevier-Buchman L, Friedrich G, et al. 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 2001;258(2):77–82.

- [3] Yu P, Garrel R, Nicollas R, Ouaknine M, Giovanni A. Objective voice analysis in dysphonic patients: new data including nonlinear measurements. *Folia Phoniatr Logop* 2007;59(1):20–30.
- [4] Verdolini K, Rosen C, Branski R. Classification manual for voice disorders – I, special interest division 3, voice and voice disorders. American speech – language hearing division. Mahwah, NJ: Erlbaum; 2006.
- [5] Kempster GB, Gerratt BR, Verdolini Abbott K, Barkmeier-Kraemer J, Hillman RE. Consensus auditory-perceptual evaluation of voice: development of a standardized clinical protocol. *Am J Speech Lang Pathol* 2009;18(2):124–32.
- [6] Hirano M. Objective evaluation of the human voice: clinical aspects. *Folia Phoniatr (Basel)* 1989;41(2–3):89–144.
- [7] Dejonckere, Dejonckere PH, Crevier L, Elbaz E, Marraco M, Millet B, et al. Clinical implementation of a multidimensional basic protocol for assessing functional results of voice therapy. 2000.
- [8] Price D, Sataloff R. A simple technique for consistent microphone placement in voice recording [technical note]. *J Voice* 1988;2(3):206–7.
- [9] Sielska-Badurek E, Osuch-Wójcikiewicz E, Sobol M, Kazanicka E, Rzepakowska A, Niemczyk K. Combined functional voice therapy in singers with muscle tension dysphonia in singing. *J Voice* 2017;31(4):509.
- [10] D'haeseleer E, Claeys S, Van Lierde K. The effectiveness of manual circumlaryngeal therapy in future elite vocal performers: a pilot study. *Laryngoscope* 2013;123(8):1937–41.
- [11] Meerschman I, Van Lierde K, Peeters K, Meersman E, Claeys S, D'haeseleer E. Short-term effect of two semi-occluded vocal tract-training programs on the vocal quality of future occupational voice users: "Resonant Voice Training Using Nasal Consonants" versus "Straw Phonation". *J Speech Lang Hear Res JSLHR* 2017;60(9):2519–36.
- [12] Rzepakowska A, Sielska-Badurek E, Osuch-Wójcikiewicz E, Niemczyk K. Multiparametric assessment of voice quality and quality of life in patients undergoing microlaryngeal surgery—correlation between subjective and objective methods. *J Voice* 2017.
- [13] Angadi V, Dressler E, Stemple J. A multidimensional study of vocal function following radiation therapy for laryngeal cancers. *Ann Otol Rhinol Laryngol* 2017;126(6):483–92.
- [14] Salmen T, Ermakova T, Möller A, Seipelt M, Weikert S, Rummich J, et al. The value of Vocal Extent Measure (VEM) assessing phonosurgical outcomes in vocal fold polyps. *J Voice* 2017;31(1):114.
- [15] Busto-Crespo O, Uzcanga-Lacabe M, Abad-Marco A, Berasategui I, García L, Maravi E, et al. Longitudinal voice outcomes after voice therapy in unilateral vocal fold paralysis. *J Voice* 2016;30(6):767.
- [16] Tripathi N, Verma RK, Panda NK, Ghosal S, Sharma A. Early evaluation of voice quality in glottic cancer (T1, T2) following curative radiotherapy. *Rev Laryngol Otol Rhinol* 2014;135(2):91–6.
- [17] Uloza V, Vegiené A, Saferis V. Correlation between the basic video laryngostroboscopic parameters and multidimensional voice measurements. *J Voice* 2013;27(6):744–52.
- [18] Çelik Ö, Çelik A, Ateşpare A, Boyacı Z, Çelebi S, Gündüz T, et al. Voice and speech changes in various phases of menstrual cycle. *J Voice* 2013;27(5):622–6.
- [19] Niebudek-Bogusz E, Strumiłło P, Wiktorowicz J, Sliwińska-Kowalska M. [Comparison of cepstral coefficients to other voice evaluation parameters in patients with occupational dysphonia]. *Med Pr* 2013;64(6):805–16.
- [20] Rodríguez-Parra MJ, Adrián JA, Casado JC. Voice therapy used to test a basic protocol for multidimensional assessment of dysphonia. *J Voice* 2009;23(3):304–18.
- [21] De Bodi MS, Keteislagers K, Peeters T, Wuyts FL, Mertens F, Pattyn J, et al. Evolution of vocal fold nodules from childhood to adolescence. *J Voice* 2007;21(2):151–6.
- [22] Pribuisienė R, Uloza V, Saferis V. Multidimensional voice analysis of reflux laryngitis patients. *Eur Arch Otorhinolaryngol* 2005;262(1):35–40.
- [23] Siupsinskiene N. [Importance of voice quality evaluation in the assessment of treatment outcome after endolaryngeal microsurgery]. *Med Kaunas Lith* 2002;38(12):1183–91.
- [24] Stejadinovic A, Shaha AR, Orlikoff RF, Nissan A, Kornak M-F, Singh B, et al. Prospective functional voice assessment in patients undergoing thyroid surgery. *Ann Surg* 2002;236(6):823–32.
- [25] Crevier-Buchman L, Colomb I, Hans S, Vaissière J, Brasnu D. [Evolution of voice assessment and quality of life after endoscopic laser cordectomy]. *Rev Laryngol Otol Rhinol* 2007;128(5):315–20.
- [26] Chu P-Y, Hsu Y-B, Lee T-L, Fu S, Wang L-M, Kao Y-C. Modified type III cordectomy to improve voice outcomes after transoral laser microsurgery for early glottic cancer. *Head Neck* 2012;34(10):1422–7.
- [27] López JM, Catena A, Montes A, Castillo ME. Effectiveness of a short voice-training program for teachers: a preliminary study. *J Voice* 2017 [Epub ahead of print].
- [28] Behrman A. *Speech and Voice Science*. Plural Publishing Inc; 2012. p. 482 [3rd edition].
- [29] Baken R, Orlikoff RF. *Clinical measurements of speech and voice*. Cengage Learning; 1999. p. 618 [2nd edition].
- [30] Brewer DW, Woo P, Casper JK, Colton RH. Unilateral recurrent laryngeal nerve paralysis: a re-examination. *J Voice* 1991;5(2):178–85.
- [31] Schwarz K, Cielo CA, Steffen N, Becker J, Jötzt GP. Voice and laryngeal configuration of men with unilateral vocal fold paralysis before and after medialization. *J Voice* 2011;25(5):611–8.
- [32] Olthoff A, Steinle J, Asendorf T, Kruse E. Consideration of vocal fold position in unilateral vocal fold paralyses. *Eur Arch Otorhinolaryngol* 2015;272(4):923–8.
- [33] Schwartz SR, Cohen SM, Dailey SH, Rosenfeld RM, Deutsch ES, Gillespie MB, et al. Clinical practice guideline: hoarseness (dysphonia). *Otolaryngol Head Neck Surg* 2009;141:S1–31.
- [34] Giovanni A, Molines V, Nguyen N, Teston B, Robert D, Cannoni M, et al. Une méthode multiparamétrique d'évaluation vocale objective assistée par ordinateur. *Ann Otolaryngol Chir Cervicofac* 1992;109(4):200–6.

