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Parameters and Scales Used to Assess and Report Findings From Stroboscopy: A Systematic Review

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Summary:

Objective.—Laryngeal endoscopy with stroboscopy, a critical component of the assessment of voice disorders, is rarely used as a treatment outcome measure in the scientific literature. We hypothesized that this is because of the lack of a widely used standardized, validated, and reliable method to assess and report laryngeal anatomy and physiology, and undertook a systematic literature review to determine the extent of the inconsistencies of the parameters and scales used in voice treatment outcome studies.

Study Design.—Systematic literature review.

Methods.—We searched PubMed, Ovid, and Cochrane for studies where laryngeal endoscopy with stroboscopy was used as a treatment outcome measure with search terms representing “stroboscopy” and “treatment” guided by Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement standards.

Results.—In the 62 included articles, we identified 141 terms representing 49 different parameters, which were further classified into 20 broad categories. The six most common parameters were magnitude of glottal gap, mucosal wave amplitude, location or shape of glottal gap, regularity of vibration, phase symmetry, and presence and size of specific lesions. Parameters were assessed on scales ranging from binary to 100 points. The number of scales used for each parameter varied from 1 to 24, with an average of four different scales per parameter.

Conclusions.—There is a lack of agreement in the scientific literature regarding which parameters should be assessed to measure voice treatment outcomes and which terms and scales should be used for each parameter. This greatly diminishes comparison and clinical

implementation of the results of treatment outcomes research in voice disorders. We highlight a previously published tool and recommend it for future use in research and clinical settings.

Keywords

Voice; Stroboscopy; Rating; Outcomes; Standardization

INTRODUCTION

Despite being the only direct means of assessing the anatomic and physiological impairments underlying diminished voice quality, laryngeal endoscopy with stroboscopy (LES) is rarely used as a treatment outcome measure in research articles.¹ This is in direct contrast to the use of LES in the clinical care of patients with voice disorders. Voice clinicians frequently rely on LES to determine the underlying pathophysiology of a voice disorder and guide treatment recommendations.² It is well established that type of lesion and specific aspects of vocal fold vibration (eg, mucosal wave amplitude) cannot be determined via other commonly used types of assessment, such as perceptual judgment of voice quality or acoustic analysis, and that LES is imperative for the accurate assessment of voice disorders.

One reason for the rarity of the use of LES as a treatment outcome measure may be the lack of a broadly used standardized, validated, and reliable method to assess laryngeal anatomy and physiology. Thus, in preparation for a clinical trial of voice therapy techniques, one must either determine what is of interest based on the study aims or conduct a time-consuming review of the literature to understand what laryngeal parameters are commonly being assessed and reported. Once the parameters for assessment have been determined, the next decision is what scale to use for the judgment of these features. Once again, the determination is made either with or without the benefit of prior literature. These methods are highly likely to lead to inconsistencies across studies with different features being judged from LES and different scales used to report the features, causing the results of studies to be incomparable and limiting their usefulness for application to clinical practice and progression of the field.

With evidence-based practice, clinicians are instructed to use the scientific evidence as one means of information when determining clinical practice; however, if the scientific literature is not routinely demonstrating the use of LES as a treatment outcome measure, there is a significant disconnect between daily clinical practice and the assessment of voice disorders for research. This disconnect reduces clinicians' ability to determine if they are getting the same effects as those reported in the scientific literature. Furthermore, one cannot expect clinicians in dispersed clinics and hospitals to use common language to report LES results if this does not occur in the literature. The lack of a broadly used clinical protocol to assess laryngeal anatomy and physiology, like the Voice-Vibratory Assessment With Laryngeal Imaging (VALI),³ reduces clinical efficiency and compromises patient care. It is critically important to have standardized commonly used definitions for laryngeal parameters and scales used to judge such parameters, as frequently the clinician conducting and interpreting the LES is different from the treating clinician.

The impetus for this systematic literature review was to assess which parameters and scales are most commonly included, determine the extent of the inconsistencies of the laryngeal parameters studied in voice treatment outcome studies, report on the variety of scales used to rate the parameters, and assess which parameters measured statistically significant improvements. The goal of this review is to call attention to a progress-limiting problem in the field and to provide a summary of the current state of the field with regard to the use of laryngeal parameters from LES as treatment outcome measures.

METHOD

Search strategy

Studies where LES was used as an outcome measure for the treatment of a voice disorder were identified from a search in three computerized journal databases (PubMed, Ovid, and Cochrane). The search terms used were “laryngostroboscopy,” “stroboscopy,” “strobovideolaryngoscopy,” “strobolaryngoscopy,” “videostroboscopy,” and “videolaryngostroboscopy.” Each of the search terms was combined with “treatment.” Specifically, the PubMed search was ((laryngostroboscopy OR stroboscopy OR strobovideolaryngoscopy OR strobolaryngoscopy OR videostroboscopy OR videolaryngostroboscopy) AND treatment). A first search was conducted on November 21, 2013, and a second search was conducted on October 30, 2015. All studies published from database inception (PubMed and Ovid electronic 1946, Cochrane 1993) to our last search on October 30, 2015 were reviewed for eligibility. Authors were not contacted. Unpublished reports were not considered for this review. Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement standards were used to conduct this review.⁴

Inclusion criteria

Articles were considered eligible for the review if they met the following inclusion criteria: English language; original article; human study; reported judgments of identical laryngeal parameters reported both pre and post treatment; and aggregate data reported for five or more participants. Duplicate results were deleted. Studies containing only objective assessment measures or only descriptive (without a scale) assessments were excluded. Articles in the first search were reviewed first by one reviewer (either KG or HB), and then a second reviewer (either KG or HB) assessed each study identified by the first reviewer for inclusion criteria. The articles found through the second search were reviewed by one reviewer (MD) and then validated by a second reviewer (HB) to assess eligibility.

Assessment of evidence

Five data elements were extracted by MD, HB, and KG from each of the eligible articles included in this review: (1) the parameters assessed, (2) the scales used, (3) if a previously published rating protocol was used, (4) whether treatment differences were reported, and (5) which parameters resulted in statistically significant changes.

Data synthesis

A meta-analysis of the results was not possible because of the heterogeneity of the results. Thus, the following analysis of the literature is descriptive in nature.

RESULTS

Search results

Eighty articles were submitted to full-text screening for critical evaluation. Sixty-two (77%) of these studies used rating scales to report attributes of vocal fold anatomy or physiology.^{5–66} Eighteen (23%) articles were eliminated because they provided descriptions of the parameters without using a rating scale or used only objective measurement (eg, glottal gap in millimeters). See Figure 1 for further details.

Study characteristics

The characteristics of the included studies are reported in Table 1, and include sample size, voice disorder(s) of the participants, and intervention(s) received. Sample size ranged from 5 to 474 participants, with an average of 52 participants (standard deviation = 82; median = 27) recruited for the studies.

The voice disorders that were the most frequently studied were vocal fold paralysis (25 articles, 40%) and organic benign lesions (20 articles, 32%). Laryngeal dysplasia or cancer was studied in seven articles (11%), and laryngopharyngeal reflux was studied in six articles (10%). Dysphonia related to food allergies, arytenoid dislocation, post-thyroidectomy dysphonia, and Parkinson disease related dysphonia were each the pathology of interest in a single study.

Three main categories of interventions emerged from the included articles. The most common intervention category was surgery or injection (40 articles, 64%), followed by voice therapy (seven articles, 11%), and pharmaceutical intervention (six articles, 10%). Six articles (10%) included a combination of voice therapy with another intervention method. Three articles (5%) used a different type of intervention: injection of a neutralizing dose of antigen for food allergy,⁹ radiation therapy with or without chemotherapy,¹⁹ and Photofrin-mediated photodynamic therapy.⁵⁰

Parameters

Number of terms and parameters—From the 62 studies that used a rating scale, 20 broad categories of parameters were identified by authors MD and HB: amplitude of vibration, hyperfunction or ventricular folds, arytenoids, edema, erythema, glottal closure or gap, granuloma, regularity or periodicity, phase closure, mucosal wave, phase symmetry, mucus, vibratory behavior, lesions (non-granulomatous), pachydermia, vertical height, vocal fold edge, vocal fold (other), stenosis or web, and recovery. Eleven of these categories were further divided into two to five subcategories, for a total of 49 parameters. For example, the category hyperfunction or ventricular folds was subdivided into four parameters: anteroposterior compression, medial compression, general hyperfunction, and symmetry of ventricular folds. In Table 3, each parameter contains the exact terms used by the authors to describe the parameter assessed, along with the associated scale. In total, 141 different terms were used in the 62 articles.

Terms were classified into the different categories by authors MD and HB. For example, the different terms hyperadduction of false vocal folds, false-fold compression hyperfunction, and ventricular fold movement were judged to refer to the same parameter—medial compression—in the broader category of hyperfunction of the ventricular folds. These judgments were made by the authors to facilitate the interpretation of the results. On average, studies used four terms with a range from 1 to 14. Table 3 provides the full list of terminology and parameters from the included studies.

Frequency of parameters—The parameters most frequently reported were magnitude of glottal gap (31 articles, 50%); mucosal wave presence or amplitude (17 articles, 27%); location or shape of glottal gap (15 articles, 24%); regularity of vibration (12 articles, 19%); phase symmetry (11 articles, 18%); and presence and size of specific lesions (11 articles, 18%).

Use of previously published protocols—Of the articles that used a rating scale, 18 (29%) adapted their rating parameters and scales from a previously published protocol. The protocols used were the Reflux Finding Score from Belafsky et al,⁶⁷ used in three studies^{11,24,42}; adaptations from Hirano and Bless' stroboscopic assessment,^{68–70} used in four studies^{14,18,54,58}; Ott et al scale,⁷¹ used in one study²²; Lee et al scale,⁷² used in one study²⁷; Lorenz et al scale,⁷³ used in two studies^{30,31}; the Stroboscopy Research Instrument (SRI),⁷⁴ used in one study³⁷; Yumoto et al scale,⁷⁵ used in one study⁴⁵; Yun et al scale,⁷⁶ used in one study⁴⁶; and Sodersten and Lindestad scale,⁷⁷ used in two studies.^{47,48} Two studies^{62,63} used a combination of the Lorenz et al scale⁷³ and the SRI⁷⁴ protocol. The articles that used published protocols can be found in Table 2.

Scales

Thirty-six (73%) of the 49 parameters were reported using more than one scale. These scales varied from dichotomous ratings presence or absence to 100-point visual analog scales. The number of scales was, as expected, greatest for the most frequently reported features: magnitude of glottal gap was reported using 24 scales; mucosal wave presence or amplitude was reported using 17 scales; location or shape of glottal gap was reported using 11 scales; regularity of vibration was reported using 11 scales; and phase symmetry was reported using 10 scales. The number of scales used for each parameter varied from 1 to 24, with an average of four different scales per parameter. A list of the parameters, terms, and scales can be found in Table 3.

Treatment differences and statistical significance

Statistical significance of the pre to post-treatment change in LES parameters was assessed and reported in 33 (53%) of the included studies. Of those, 27 articles found a statistically significant improvement following treatment for at least one of the LES parameters investigated, and six articles reported no change. One of those studies also found a negative effect of treatment on one of the assessed parameters (vocal fold edge).⁵⁸ The percentage of times a parameter showed a significant post-intervention change was calculated for parameters on which statistical significance was assessed in at least five articles. Parameters that most commonly revealed statistically significant differences from pre treatment to post

treatment were regularity of vibration (significant change found 88% of the time); phase symmetry (85%); mucosal wave quality (83%); amplitude of vibration (83%); location or shape of glottal gap (80%); mucosal wave presence or amplitude (75%); and magnitude of glottal gap (72%). A significant change for vocal fold edema was found only 40% of the time, and no significant change was found for specific lesions (size and presence) in any of the five articles where that parameter was assessed.

DISCUSSION

The present review provides information on the different LES parameters and scales used across studies to measure laryngeal changes following treatment. The results confirm the lack of a broadly accepted standardized rating form and reveal a wide variety of laryngeal parameters, terms for laryngeal parameters, and scales used to rate those parameters in the literature. The incompatibility of the terms, definitions, and scales used across treatment outcome research has implications for the methodological rigor of any single study and greatly hinders the ability to compare outcomes across studies, with negative impacts on clinical practice as well as research progress. The results of the review are discussed below.

Why do so few articles use LES as a treatment outcome measure?

One key element of information provided through the literature search is that voice treatment studies do not commonly use LES to measure pre to post-intervention changes. Even though an initial stroboscopic evaluation is usually performed on the participants before their inclusion in the study, results from the visual examination of the larynx are rarely included in the outcome measures. A recent literature review⁷⁸ on behavioral voice therapy effectiveness revealed that, of the 15 included randomized controlled trials, only three included data from LES in their outcome measures, making it the least popular assessment. In the present review, LES was also rarely used to measure changes related to behavioral voice therapy. Only 11% of the included articles involved voice therapy by a speech-language pathologist (SLP), whereas almost two-thirds of the articles comprised a surgical or injection intervention. One reason for this unequal distribution could be related to the fact that otolaryngologists often have more access to stroboscopy equipment than SLPs, making it more realistic for them to use LES to measure treatment effects. This difference in use, if due to access, may signify a lack of research collaboration between SLPs and otolaryngologists.

The overall scarcity of LES as a treatment outcome measure in voice research could also be related to the equivocal definitions of the LES parameters and the unclear link between changes in these parameters and clinically meaningful improvements. Even though the clinical value of LES for diagnosing voice disorders and defining therapy goals has previously been demonstrated,^{2,79,80} progress is still needed to gain a better understanding of how specific LES findings translate into vocal symptoms or behaviors and how these can be beneficially modified through treatment. Without a thorough understanding of these relationships, interpreting data obtained with LES is challenging, and this potentially detracts researchers from using it as an outcome measure. Hopefully, the development of a standardized nomenclature for LES will encourage researchers to adopt LES as a treatment

outcome measure to help establish correlations between LES parameters and vocal symptoms and behaviors.

Parameters: What is used?

Parameters most frequently reported were magnitude of glottal gap, location or shape of glottal gap, mucosal wave amplitude, regularity or periodicity of vibration, phase symmetry, and specific lesions—all present in more than 15% of the included studies. Most of these parameters significantly improved at least 70% of the time from pre to post-treatment measures, except for the specific lesions parameter, which did not show a significant improvement in any of the five articles that reported this parameter. Although this could possibly be explained by the lack of validity of the measure and scales used, it may also be that lesions are more difficult to change than other laryngeal parameters.

Parameters: The issue of reliability

Reliability is a factor of primary importance to ensure the value of findings related to LES ratings. Despite their seemingly good ability to detect treatment-related changes, most of the frequently reported parameters have been associated with reliability concerns in previous studies. The reliability issues in LES ratings have been recently described in a literature review by Bonilha et al.¹ Results of the review revealed that reliability analysis results for LES ratings were reported in approximately 10% of the articles, with at least half of these results indicating poor inter- or intra-rater reliability.¹ Results from Bonilha et al.'s review also indicated that, overall, functional (temporally dependent) parameters were less reliable than anatomic (stationary dependent) parameters.¹ Mucosal wave, regularity of vibration, and phase symmetry, identified as some of the most frequently reported parameters, are all temporally dependent because they involve a movement pattern, contrary to static, geometric parameters that merely involve the shape of a structure.^{81,82} The challenge of rating temporally dependent parameters has also been raised by Poburka and Bless⁸² in their work to improve the reliability of stroboscopy ratings. They found that amplitude, mucosal wave, phase closure, and regularity were the features most likely to cause a disagreement between expert raters. When comparing experienced and student raters with expert raters, vocal fold edge and amplitude of excursion measures consistently had the highest correlations, whereas phase closure and regularity—two dynamic parameters—had the lowest correlations. In a later study, Poburka⁸¹ tested an improved Stroboscopy Examination Rating Form (SERF) on the constructs of agreement and reliability using three judges who commonly use stroboscopy clinically. He provided agreement data for exact agreement (three judges agreed) and consensus agreement (two out of three judges agreed). Consensus agreement was above 80% for all features except mucosal wave, edge-straightness left, phase closure, and phase symmetry. The author pointed out that overall, the parameters with the lowest reliability across all trials of inter-rater agreement and intra-rater reliability were phase closure, phase symmetry, and phase regularity. In a study by Rosen,⁷⁴ another stroboscopy rating tool was tested, and four features did not show adequate reliability when assessed by raters with high intra-rater reliability: closure pattern, periodicity (right-side), amplitude (right), and nonvibratory (right). These features also had inadequate interclass correlations, which could be explained, in part, by low variability of some of these parameters. Finally, a recent article by Poburka et al.³ revealed that some parameters were more difficult to rate

than others, leading to a “could not rate” answer from more than one rater. Parameters most associated with this answer were mucosal wave, nonvibratory portion, amplitude, phase closure, symmetry, and regularity. Interestingly, these represent temporally dependent parameters also associated with poor reliability in the previously mentioned studies and are also among the most frequently reported parameters in the studies included in this review.

Terms for parameters and scales

One reason for the abovementioned reliability issues might reside in the general ambiguity that surrounds LES parameters and their definitions. The fact that 49 different parameters were used across the included studies, each associated with up to 15 different terms and 24 different scales, is indicative of a serious lack of agreement in the field regarding (1) which parameters should be assessed to measure voice treatment outcomes and (2) what terms should be used to define the parameters without ambiguity. This lack of agreement is likely to cause confusion among raters and should be compensated for by clear instructions and definitions for each parameter and each level of the scales used. However, the literature review recently conducted by Bonilha et al¹ revealed that out of 80 articles using LES to measure changes following treatment, only two reported attempts to improve rater reliability by either providing a 1-hour training session⁵² or by offering clear anatomic definitions for each parameter and using feature-specific scales.⁵¹ The same problem applies to the majority of the articles included in the present review—there was no mention of instructions offered to the raters, despite the use of ambiguous terms to describe the LES parameters. For instance, the broad category *mucosal wave* contains numerous examples of inexplicit terms, such as *mucosal wave characteristics*, *quality of mucosal wave*, or *mucosal wave*. In these cases, it is not obvious what the rater should be evaluating: is the term referring to mucosal wave amplitude, mucosal wave amplitude symmetry, or mucosal wave presence? In some situations, the associated scale provides supplemental information on what is being assessed, such as in the following example in which it becomes clear that the mucosal wave amplitude is the feature of interest: 1 = absent; 2 = limited to the most medial edge of the vocal folds; 3 = present laterally up to one-fourth of the width of the vocal folds; 4 = present up to but less than one-half the width of the vocal folds; and 5 = present at more than one-half the width of the vocal folds (normal).⁶ Conversely, some scales, such as 1 (normal) to 5 (abnormal), do not clarify the vagueness of the terms employed to label the LES parameters.²¹

Scales

The scales used to judge and report laryngeal anatomy and physiology must consider the number of increments of the feature that a trained clinician can reliably differentiate. For example, phase closure has been rated on a three-level scale (predominately open, equally open and closed, predominately closed) and a 100-level scale (percentage of the cycle that is open). Yet we have no knowledge of whether a trained clinician can differentiate three levels, 100 levels, or somewhere in between. If we ask a clinician to differentiate three levels when they can truly differentiate five levels, we lose available, needed precision of the measure important for detecting treatment effects. Conversely, if we ask a clinician to differentiate 100 levels when they can truly differentiate only five levels, the clinician is not able to be so precise and will be reliable only to ± 10 levels, creating inaccuracy in the measure. Scales not aligned with clinicians' perceptual ability will increase measurement

error. Furthermore, the use of different scales for the same parameter hinders the readers' ability to compare results across studies, which has direct implications for evidence-based practice.

The majority of the scales that were used in the studies were ordinal scales instead of interval scales. This means that the intervals between the levels of the scales may be inconsistent or unknown. In other words, ordinal ranks are discrete categories similar to nominal labels, with the difference that they are ranked on the basis of a specific characteristic.⁸³ This has implications regarding the interpretation and validity of change scores: because ordinal values are not true quantities, they do not have arithmetic properties and are more appropriate for descriptive analyses than other forms of significance testing.⁸³ An appropriate method for interpretation of change based on ordinal values is to analyse the results in terms of frequency counts⁸³; for example, what percentage of participants changed from severe to moderate as a result of the intervention. Nominal values were also frequently used. Most of the nominal scales used in the reviewed studies were dichotomous, for example, improvement or no improvement; present or absent; yes or no; complete or incomplete.

Efforts to improve stroboscopy rating forms

The validity and reliability of LES as a treatment outcome measure is greatly dependent on the clinician's interpretation of the findings. As discussed in the previous sections, reliability issues have been associated with many of the most commonly used LES parameters and this could be related to the unclear terms and definitions associated with the parameters, as well as to limited instructions and training offered to the raters. Efforts have been made in the past to overcome these limitations and to develop, disseminate, and implement a standardized, reliable, and valid protocol for the interpretation of laryngeal features assessed with LES. However, the field of voice, as reflected in the reviewed scientific literature, has mostly ignored those efforts. Only 29% of the reviewed articles reported using a previously published protocol. In most of these cases, the protocol was modified instead of being used as originally published, consequently altering a main purpose of using a protocol—to allow for comparison across different studies using the exact same scales and parameters. Protocols most commonly used were versions of the Bless et al⁶⁸ rating form (n = 4) and the Reflux Finding Score⁶⁷ (n = 3). Other important efforts to improve LES ratings, such as those described below, were not employed in the reviewed studies with the exception of the SRI⁷⁴ used in two studies.

Efforts to improve the reliability of ratings from LES have been reported in four articles. Poburka and Bless⁸² devised and reported on the effectiveness of a multimedia computer-based method for LES rating training. The stated purpose of the project was to overcome known problems in inter- and intra-rater reliability of stroboscopic assessment by providing training involving written definitions, graphics, and video clips of laryngeal parameters. The parameters included were supraglottic activity, vocal fold edge, amplitude, mucosal wave, phase closure, phase symmetry, regularity, and glottal closure. Although training did not significantly improve reliability in experienced raters, it led to improved agreement between students and expert judges. After training, the students' performance was comparable with

that of experienced raters. It was hypothesized by the authors that example-based training helped the students develop an internal conceptualization of normal and abnormal features, a skill that didactic knowledge by itself cannot provide.⁸² Although rating skills seem to improve with experience, offering training to young clinicians could positively impact their reliability and compensate for a lack of experience.

Poburka⁸¹ developed a new LES rating form, the SERF, to resolve known flaws in LES ratings and improve inter- and intra-rater reliability. The features targeted for improvement were supraglottic activity, vocal fold edge, phase closure, phase symmetry, regularity, and glottic closure. The author sought to improve the reliability of the ratings of these features by modifying some of the instructions to enhance clarity and by using a graphical or pictorial type of rating as opposed to the numerical Likert-type scale typically used. However, the features of vocal fold edge smoothness, vocal fold edge straightness, phase closure, phase symmetry, and regularity were still rated on either four- or six-level ordinal scales. Although the author concluded that the rating scale did not completely solve the reliability problems, he did mention several benefits of its use that were acknowledged by the raters: faster rating times, less hesitation in making the ratings, and less confusion over left and right orientations on the form. Moreover, the study helped gather more information for further improvement of the rating form.

Rosen⁷⁴ published a study entitled, “Stroboscopy as a Research Instrument: Development of a Perceptual Evaluation Tool,” with the objective of addressing the need for a LES protocol that provides reproducible and reliable results. He approached the problem of lack of standardization primarily from a research mindset; however, he discussed how this lack of standardization also inhibits education, communication, and advancement of the field as a whole. The first step of the project was to develop the tool based on a literature review and the author’s clinical knowledge, which led to the inclusion of six components: symmetry, amplitude, periodicity, identification of non-vibratory segments, duration of closure during vocal fold vibration, and closure pattern, all of which were rated on a scale ranging from three, four, or six points. Standardized instructions were given to each of the 18 reviewers of varying experience, but no training was employed. An interesting finding from this study is that experienced raters were not found to have higher interclass reliability results than inexperienced raters, and thus, experience in LES does not constitute an advantage when using the SRI. In the analysis of intra-rater reliability, Rosen found that the top 10 raters had a reliability of 0.81–0.99 for all features, and that the lowest intra-rater reliability reported was 0.43. Rosen concludes with acknowledgment of the need for further research and with two main suggestions to enhance reliability of LES ratings in research: (1) to include a variability check for each parameter before proceeding to ratings, and (2) to select judges with an intra-rater reliability of at least 0.80.

Despite the development of these forms and the efforts made to improve their reliability, there is still no standardized form widely used for LES ratings reported as outcomes measures in research. In addition, a new technology, high-speed videoendoscopy (HSV), is being increasingly used both in research and in clinical settings without a widely accepted standardized form for rating laryngeal parameters. Based on these considerations, Poburka et al³ refined a previously published protocol, the SERF, and adapted it for the rating of

laryngeal parameters from both LES and HSV. They named the new rating form VALI.³ To improve the reliability of the ratings, they included four key elements to the forms and associated training: definitions, graphics, and rating instructions for each parameter, as well as video samples for training. Ten parameters were chosen for inclusion: amplitude, mucosal wave, nonvibratory portion, supraglottal activity, phase closure, symmetry, regularity, glottal closure, vertical level, and free-edge contour. In the HSV form, regularity was not included, and two supplemental parameters were added (glottal cycle periodicity and other voice vibratory patterns). The authors compared their reliability results with those of previous studies and noted stronger correlations, particularly for the parameters of phase closure and regularity. They hypothesized that the graphic illustrations and the specific training provided in the VALI helped elucidate the temporal aspect of these features, therefore facilitating the rating process and improving reliability. The VALI form is the result of many years of research pertaining to the development of a valid and reliable instrument for assessing laryngeal features. It contains half of the 20 categories of parameters that were identified in the present review, including the most frequent ones (glottal gap, mucosal wave, regularity of vibration, and phase symmetry). Most of the parameters that are not comprised in the form can be included in the nonvibratory observations section (such as lesions, edema, erythema, granuloma, mucus, pachydermia, and stenosis or web). When possible, the form uses ratio scales (with an absolute 0), which is the most appropriate scale for statistical comparisons and, therefore, for measuring change following treatment. Based on these considerations and on the improved reliability scores as reported by the authors, the VALI is a promising choice as a widely adoptable assessment form for stroboscopy ratings.

Clinical implications

The lack of a widely used, standardized, reliable, and valid rating system for LES impacts clinicians and patients in two main ways. First, one clinician cannot accurately interpret another clinician's LES report if there is no common language (terminology, definitions, defined scales, etc) used. This results in, at best, the clinician accessing the recording of the examination and using valuable clinic time to rate it themselves. More often, a clinician will either repeat the examination because of lack of access to the original recording or, in the most likely scenario, will treat the patient based on their interpretation of the LES report because they do not have access to the LES equipment. Second, even when used by the same clinician, without a standardized, reliable, and valid scoring system, it is not possible to confidently assess treatment effects using LES as one cannot know if the variation in the scores is actually because of the patient improving. All of these situations result in a less than optimally efficient clinic indicating the potential to improve patient care and use of health-care resources if a widely used standardized, reliable, and valid protocol was adopted. Considering results from LES are judged by clinicians to be important for defining therapy goals, educating the patient and evaluating therapy outcomes,² the lack of a widely used, standardized, reliable, and valid rating system has clear clinical implications.

Research implications

The results of this systematic review have implications for research in two ways: (1) methodological rigor of individual studies and (2) research progress in the field. The results of individual studies that do not use a rating system shown to be reliable and valid are

questionable and may not be reproducible by other researchers using different rating systems. On a larger scale, research progress in the field is hindered by the lack of ability to compare research results across treatment studies that use different rating systems (parameters, scales, terms, definitions, etc). The lack of comparability across studies requires each new treatment study to be compared anew with all other viable treatments—an expensive and lengthy process—or to not fully vet the improvements to patient care made by that new treatment.

General comments

The field of voice has made largely unrecognized gains in creating standardized protocols for the assessment of laryngeal parameters from LES. Those gains are not reflected in the current literature. The adoption of one of the recently developed standardized protocol, such as the VALI,³ is likely to have a major impact on the field and positively affect clinicians, patients, and researchers. Other fields have created standardized broadly used protocols for similar clinical assessments. One notable example is in swallowing disorders; the Modified Barium Swallow Impairment Profile⁸⁴ is an assessment protocol, scoring and reporting system, as well as a training method for the judgment of swallowing impairment from modified barium swallow studies. The implementation of this method has allowed the field of swallowing to make noteworthy progress, and a similar method may be the solution to the disparate use and reporting of laryngeal parameters from LES.

Limitations of the review

This review contains limitations that may have influenced our findings. First, it included only articles that were published in English. Moreover, it is possible that the search terms used did not detect all pertinent articles related to the topic. The review did not include a robust statistical analysis combining results of eligible studies, because the wide variety of parameters and scales used did preclude such an analysis. Regarding the interpretation of the results, it is possible that some of the terms related to the stroboscopic parameters were not classified in the categories they were intended to represent: the terms were classified based on the information available in the articles, and when no sufficient information was provided, assumptions were made by the authors of the review.

CONCLUSIONS

An assessment of the voice treatment outcome literature revealed an overwhelming lack of standardization in terminology, operational definitions, parameters, and associated scales. This lack of standardization has clear negative implications for patient management and research progress. There has been much effort devoted to the development of standardized protocols to evaluate laryngeal parameters from LES. To date, these protocols are not used in the treatment outcome literature. The leaders of the field and entities with power, namely journal editors and funding agencies, should rally behind the need for standardization to ultimately improve the efficacy and effectiveness of patient care.

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FIGURE 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart.⁴

TABLE 1.

Study Characteristics

Author and Year	Total Sample Size	Voice Disorder(s)	Intervention Group(s)
(Beaver et al, 2003) ⁵	N=49	G1: Diagnosis of laryngopharyngeal reflux disease (LPDR) (n = 49) G2: No signs of LPDR (n = 10) G1: Unilateral or bilateral vocal fold scarring	G1: High-dose proton pump inhibitor (PPI) therapy G2: No intervention
(Chhetri and Berke, 2011) ⁶	N = 5	G1: Various kinds of organic benign voice pathologies (Reinke edema, polyp, chronic laryngitis, muscle tension dysphonia, intracordal cyst, sulcus, or scar, nodules, unilateral vocal fold paralysis)	G1: Injection of cultured autologous fibroblast in the lamina propria
(DeJonckere et al, 2003) ⁷	N=45	G1: Vocal fold polyps G1: Persistent intermittent dysphonia and positive history for delayed food allergy (n = 10) G2: Non-allergic subjects (controls) (n = 12) G3: Allergic patients with negative skin test (controls) (n = 12)	G1: Phonosurgery (always combined with voice therapy), voice therapy alone, or antireflux medication (with voice therapy when indicated) G1: Quantum molecular resonance-assisted phonomicrosurgery G1-G3: Provocation or neutralization skin testing (injection of a neutralizing dose of antigen)
(Demirhan et al, 2015) ⁸	N=12	G1: Vocal fold polyps	
(Dixon, 1999) ⁹	N=34	G1: Persistent intermittent dysphonia and positive history for delayed food allergy (n = 10) G2: Non-allergic subjects (controls) (n = 12) G3: Allergic patients with negative skin test (controls) (n = 12)	
(Djukic et al, 2014) ¹⁰	N=112	G1: Vocal fold lesion with mild, moderate, or severe dysplasia	Laryngomicrosurgery and different types of endoscopic cordectomy (types I-III)
(Fass et al, 2010) ¹¹	N=41	G1-G2: Diagnosis of laryngopharyngeal reflux disease (LPR)	G1: Esomeprazole 20 mg twice daily G2: Placebo
(Finck and Lefebvre, 2005) ¹²	N=11	G1: Benign vocal fold lesion requiring microsurgery (submucosal fibrosis, intracordal open cyst, intracordal organized hematoma, Reinke edema, localized vergeture, sulcus, mucous cyst) G1-G2: Benign vocal fold lesion requiring microsurgery (edema, mucous cyst, polyp, nodules, sulcus, scar, subepithelial fibrosis, vergetures, open cyst, pseudocyst) G1: Vocal nodules	G1: Microsurgical procedure and implantation of esterified hyaluronic acid (EHA) in Reinke space G2: Microsurgical procedure without implantation of (EHA) in Reinke space
(Finck et al, 2010) ¹³	N=83	G1: Vocal nodules	G1: Microsurgical procedure and implantation of (EHA) in Reinke space G2: Microsurgical procedure without implantation of (EHA) in Reinke space
(Halawa et al, 2014) ¹⁴	N=97	G1: Vocal nodules	G1: Voice therapy
(Halderman et al, 2014) ¹⁵	N=64	G1: Vocal fold paralysis or glottic insufficiency	G1: Injection laryngoplasty with Restylane
(Hallen et al, 2001) ¹⁶	N=14	G1: Insufficient closure of the vocal folds (vocal fold palsy, n = 6; or bowed vocal folds, n = 8) G1: Vocal fold paralysis or hypoadduction G1-G2: Early laryngeal carcinoma	G1: DiHA (dextranomer molecules in a 1% hyaluronan solution) injections G1: Transnasal fiberoptic injection laryngoplasty G1: Type II cordectomy (subligamentous); (n = 13) G2: Type I cordectomy (subepithelial); (n = 4) G1: Radiation, with or without chemotherapy
(Hamdan et al, 2015) ¹⁷	N = 9	G1: Vocal fold paralysis or hypoadduction	
(Hillel et al, 2013) ¹⁸	N=17	G1: Laryngeal cancer (T2 or T3 lesion)	
(Iloabachie et al, 2007) ¹⁹	N=14	G1: Laryngeal cancer (T2 or T3 lesion)	

Author and Year	Total Sample Size	Voice Disorder(s)	Intervention Group(s)
(Jensen and Rasmussen, 2013) ²⁰	N=82	G1: Benign lesions of the vocal folds (polyps, cysts, nodules, edema)	G1: Phonosurgery (with or without postsurgery voice therapy)
(Karpenko et al, 2003) ²¹	N=10	G1: Unilateral vocal fold paralysis	G1: Injection laryngoplasty with Cymetra
(Keilmann et al, 2011) ²²	N=16	G1: T1 or T2 tumor of the vocal cords	G1: Cordectomy-laser excision of the tumor (combined with voice therapy for all patients except one)
(Kodama et al, 2015) ²³	N=33	G1: Unilateral vocal fold paralysis	G1: Refined nerve-muscle pedicle flap implantation combined with arytenoid adduction
(Lam et al, 2010) ²⁴	N=82	G1-G2: LPR	G1: Rabeprazole (20 mg, twice daily) (n = 42) G2: Placebo (n = 40)
(Lan et al, 2010) ²⁵	N=20	G1: Vocal fold polyp	G1: Transoral laryngeal surgery under flexible laryngovideostroboscopy (FLVS)
(Law et al, 2012) ²⁶	N=12	G1: Vocal nodules, vocal edema, hyperfunctional voice disorders	G1: Group voice therapy
(Lee et al, 2014) ²⁷	N=22	G1: Arytenoid dislocation	G1: Direct laryngoscopy and closed reduction of the dislocated arytenoid, with adjunct injection laryngoplasty or botulinum toxin administration in selected cases.
(Lee et al, 2007) ²⁸	N=15	G1: Unilateral vocal fold paralysis	G1: Ansa to recurrent laryngeal nerve reinnervation technique
(Li et al, 2011) ²⁹	N=25	G1-G3: Unilateral vocal fold paralysis	G1: Type I thyroplasty using a Silastic implant, combined with arytenoid adduction (n = 10) G2: Type I thyroplasty only, using Gore-Tex (n = 15) G3: Type I thyroplasty only, using a Silastic implant (n = 20)
(Li et al, 2014) ³⁰	N=349	G1-G4: UVFP By age: G1: <30 years old (n = 26) G2: 30–44 y (n = 165) G3: 45–59 y (n = 133) G4: 60 y (n = 25)	G1-G4: Ansa cervicalis-recurrent laryngeal nerve anastomosis (laryngeal reinnervation)
(Li et al, 2014) ³¹	N=349	G1-G3: UVFP By denervation duration: G1: 6–12 mo (n = 172) G2: 12–24 mo (n = 108) G3: >24 mo (n = 69)	G1-G3: Ansa cervicalis-recurrent laryngeal nerve anastomosis (laryngeal reinnervation)
(Maia et al, 2012) ³²	N=46	G1: Vocal complaint group (presence of larynx lesions-nodules, cyst, polyps) (n = 23) G2: Without vocal complaint control group (n = 23)	G1-G2: Pitched blowing exercise (10 repetitions)
(Malik et al, 2014) ³³	N=40	G1-G2: UVFP	G1: Type I thyroplasty using Silastic implant (n = 20) G2: Type I thyroplasty using titanium vocal fold medializing implant (TVFMI) (n = 20)
(Maronian et al, 2003) ³⁴	N = 9 (7 patients were available for post-	G1: UVFP	G1: Recurrent laryngeal nerve reinnervation

Author and Year	Total Sample Size	Voice Disorder(s)	Intervention Group(s)
(Milstein et al. 2005) ³⁵	treatment N = 20 (data missing for 1 participant)	G1: UVFP	G1: Cymetra injection laryngoplasty
(Monini et al. 2006) ³⁶	N=60	G1: Laryngopharyngeal reflux (LPR)-symptomatic and asymptomatic (n = 49) G2: LPR (symptomatic) (n = 11)	G1: Omeprazole G2: Immunostimulating vaccine (IOTAX lyophilized listatum bacterium 5)
(Morgan et al. 2007) ³⁷	N=19	G1-G2: UVFP	G1: Injection (calcium hydroxylapatite or micronized acellular dermis) (n = 10) G2: Total medialization (with or without arytenoid adduction) (n = 9)
(Mortensen and Woo, 2006) ³⁸	N=34	G1: postoperative scar or polyp, nodule, cyst, fibrovascular lesions or granuloma, or granulation of the larynx	G1: Steroid injections
(Nakagawa et al. 2012) ³⁹	N=132	G1: Vocal fold polyp	G1: Conservative treatment (voice therapy, medication, or both)
(Nam et al. 2013) ⁴⁰	N=50	G1-G2: Lower-pitched voice after thyroidectomy	G1: Vocal function exercise G2: Vocal function exercise and indirect voice therapy
(Paniello et al. 2008) ⁴¹	N=21	G1: Gliding group	G1: Minithyrotomy procedure
(Portnoy et al. 2014) ⁴²	N=35	G2: Non-gliding group	G1: Proton pump inhibitors
(Rihkanen et al. 2004) ⁴³	N = 14 (pre-operative videostroboscopy was available for 12 participants)	G1: Vocal fold scarring	G1: Vocal fold augmentation by injection laryngoplasty (autologous fascia augmentation)
(Rontal and Rontal, 2003) ⁴⁴	N = 18 (post-intervention results available for 10 participants)	G1: LPR	G1: Permanent medialization using injections of botulinum toxin and Gelfoam
(Sanuki et al. 2015) ⁴⁵	N=12	G1: UVFP	G1: Laryngeal reinnervation via refined nerve-muscle pedicle flap implantation combined with arytenoid adduction
(Schindler et al. 2013) ⁴⁶	N=65	G1: Reinke edema (n = 23) G2: Vocal fold cysts (n = 22) G3: Gelatinous polyps (n = 20)	G1-G3: Voice therapy
(Schneider et al. 2003) ⁴⁷	N=14	G1: Recurrent laryngeal nerve paralysis because of cardiothoracic surgery	G1: Medialization thyroplasty using the titanium implant (TVFMI)
(Schneider et al. 2003) ⁴⁸	N=28	G1: UVFP	G1: Medialization thyroplasty using the titanium implant (TVFMI)
(Shoffel-Havakuk et al. 2014) ⁴⁹	N=46	G1: Lesion limited to the posterior glottis (inflammatory granulation tissue, cysts, carcinoma in situ, invasive squamous cell carcinoma)	G1: Conservative management or surgical intervention
(Silbergleit et al. 2013) ⁵⁰	N = 8	G1: Early stage laryngeal cancer (Tis-T1N0M0)	G1: Photofrin-mediated photodynamic therapy

Author and Year	Total Sample Size	Voice Disorder(s)	Intervention Group(s)
(Smith et al, 1995) ⁵¹	N=22	G1-G2: Parkinson disease	G1: Intensive therapy (focused on vocal and respiratory effort) (n = 13) G2: Intensive therapy (focused on respiratory effort only) (n = 9)
(Steward et al, 2004) ⁵²	N=21	G1-G2: Laryngopharyngeal reflux	G1: Proton pump inhibitor (Rabeprazole sodium) and instructions for lifestyle modification (n = 21) G2: Placebo and instructions for lifestyle modification (n = 21)
(Storeck et al, 2007) ⁵³	N=26	G1: UVFP	G1: Medialization thyroplasty using a hydroxyapatite implant
(Storeck et al, 2010) ⁵⁴	N=26	G1-G2: UVFP	G1: Medialization thyroplasty using a hydroxyapatite implant (VoCoM) (n = 11) G2: Medialization thyroplasty using a titanium implant (TVFMI) (n = 15)
(Su et al, 2005) ⁵⁵	N = 15 (2 patients were excluded from analysis)	G1: Early glottis carcinoma-vocal fold deficit caused by previous laser cordectomy	G1: Laryngoplasticity with bipedicle strap muscle transposition
(Su et al, 2005) ⁵⁶	N=30	G1: UVFP	G1: Arytenoid adduction for vocal fold medialization, using a paramedian approach (with or without strap muscle transposition)
(Tsunoda et al, 2005) ⁵⁷	N=10	G1: Sulcus vocalis	G1: Autologous transplant of fascia into the vocal fold (ATFV)
(van Gogh et al, 2006) ⁵⁸	N=23	G1-G2: Have received treatment for early glottic carcinoma	G1: Voice therapy (n = 12) G2: Control group (n = 11)
(Wang et al, 2013) ⁵⁹	N=36	G1-G2: Unilateral hemorrhagic vocal polyp	G1: Potassium titanyl phosphate (KTP) laser-assisted polypectomy (n = 20) G2: KTP laser without endoscopic removal of the polyp (n = 16)
(Wang et al, 2013) ⁶⁰	N=30	G1: Vocal nodules (n = 13) G2: Vocal polyps (n = 17)	G1-G2: transnasal endoscopic steroid injection (TESI) (with voice therapy)
(Wang et al, 2012) ⁶¹	N=20	G1: UVFP	G1: Ansa cervicalis main branch-to-RLN anastomosis
(Wang et al, 2011) ⁶²	N=474	G1: UVFP caused by thyroid surgery (n = 237) G2: Control group of healthy subjects (N = 237)	G1: Ansa cervicalis main branch-to-RLN anastomosis G2: No intervention
(Wang et al, 2011) ⁶³	N=56	G1: UVFP	G1: Contralateral ansa cervicalis-to-RLN anastomosis
(Woo et al, 2013) ⁶⁴	N=64	G1-G2: UVFP	G1: Injection laryngoplasticity through the cricothyroid (n = 30) G2: Injection laryngoplasticity through the thyrohyoid (n = 34)
(Yilmaz, 2012) ⁶⁵	N=44	G1: Sulcus vocalis (unilateral or bilateral)	G1: Excision of sulcus, primary suture of epithelial defect, and medialization laryngoplasticity G2: Microsuture after lesion removal (n = 20) G2: No microsuture after lesion removal (n = 20)
(Yilmaz and Sozen, 2012) ⁶⁶	N=40	G1-G2: Vocal fold polyp, cyst, or Reinke edema	

Abbreviations: G1, group 1; G2, group 2; N, total sample size.

TABLE 2.

Study Results

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Beaver et al, 2003) ⁵	1. Edema of posterior supraglottis 2. Edema of vocal folds 3. Edema of subglottis 4. Erythema of posterior supraglottis 5. Erythema of vocal folds 6. Erythema of subglottis 7. Leukoplakia 8. Nodules or prenodules 9. Polyp(s) 10. Posterior pachydermia 11. Web 12. Contact granuloma	1–6; 0 = not present to 3 = most severe 7–12; present or absent	When comparing index scores of laryngopharyngeal reflux disease patients before and after treatment, there was a significant decrease in scores of parameters 1–6 after 6 weeks of treatment. ** Still digital photographs of the abducted larynx were analyzed.	1–6	No
(Chhetri and Berke, 2011) ⁶	1. Mucosal wave	1: 1 = absent; 2 = limited to the most medial edge of the vocal folds; 3 = present laterally up to one-fourth of the width of the vocal folds; 4 = present up to but less than one-half the width of the vocal folds; 5 = present at more than one-half the width of the vocal folds (normal)	The mucosal wave grade was significantly improved after autologous fibroblast injection treatment.	1	No
(DeJonckere et al, 2003) ⁷	1. Glottal closure 2. Regularity of vibration 3. Symmetry 4. Quality of mucosal wave	1–4: VAS of 100 mm—a score of 0 meaning “normal, no deviance,” and a score of 100 “extremely deviant”	At group level, the overall effects for each parameter showed a significant improvement following treatment (phonosurgery, voice therapy, or antireflux medication).	1–4	No
(Demirhan et al, 2015) ⁸	1. Glottal closure 2. Regularity 3. Mucosal wave 4. Symmetry	1–4: 0 = no deviance to 3 = severe deviance	Results show a decrease in the mean ratings for all four parameters after quantum molecular resonance-assisted phonomicrosurgery.	N/A	No
(Dixon, 1999) ⁹	1. Vascular injection 2. Swelling 3. Glottic edge irregularity 4. Asymmetric localized edema on glottic edge 5. Increased mucus on vocal folds 6. Inability to sustain waveform	1–6: 0 = normal; 1+ = mild; 2+ = moderate; and 3+ = severe	Results show improvement in all parameters after injection of a neutralizing dose of antigen.	N/A	No
(Djukić et al, 2014) ¹⁰	1. Glottic occlusion 2. Symmetry phase 3. Periodicity	1: 1 = sufficient; 2 = insufficient 2: 1 = symmetrical; 2 = asymmetrical	Parameters 2–5 were significantly improved in the mild and moderate groups, and parameters 3–6 were significantly improved in the severe group after surgery	2–5 (groups: mild and moderate)	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
	4. Amplitude 5. Mucosal wave 6. Nonvibratory segment	3: 1 = regular; 2 = irregular successive vibrations 4: 1 = normal; 2 = decreased; 3 = increased 5: 1 = normal with 30%–50% lateral travel; 2 = increased with lateral travel >50%; 3 = decreased with lateral travel <30% 6: 1 = presence; 2 = absence of nonvibratory segment	(laryngomicrosurgery and different types of endoscopic cordectomy).	3–6 (group: severe)	
(Fass et al, 2010) ¹¹	1. Subglottic edema 2. Granuloma or granulation 3. Thick endolaryngeal mucus or other 4. Ventricular obliteration 5. Erythema or hyperemia 6. Vocal cord edema 7. Diffuse laryngeal edema 8. Posterior commissure hypertrophy	1–3: Present or absent 4: Partial or complete 5: Arytenoids only or diffuse 6: Mild; moderate; severe; polypoid 7–8: Mild; moderate; severe; obstructing vibrations	No significant difference between the baseline RFS and the post-treatment scores for the esomeprazole group or the placebo group. **Still-frame images of open and closed vocal fold positions were analyzed.	None	Yes (Belafsky et al, 2001) ⁶⁷ <i>Reflux Finding Score</i>
(Finck and Lefebvre, 2005) ¹²	1. Amplitude of vibration 2. Mucosal wave 3. Glottic closure Descriptions of changes were provided for presence of inflammation and vocal fold appearance (symmetry and presence of deformation)	1: 10 cm scale—normal if noted at 5, increased if above 5, and decreased if below 2: 10 cm scale—normal at the right end, completely absent at the left end 3: 5 cm scale—closure is considered complete at 5 and diminished if noted between 0 and 5	Description of changes, positive for majority, neutral for a couple, and negative for a few, after the microsurgical procedure and the implantation of esterified hyaluronic acid in Reinke space.	N/A	No
(Finck et al, 2010) ¹³	1. Left amplitude 2. Right amplitude 3. Left mucosal wave 4. Right mucosal wave 5. Glottic closure	1–2: VAS—amplitude is considered normal if noted at half the continuum, increased to the right and decreased to the left 3–4: VAS—mucosal wave is normal at the right end and completely absent at the left end. 5: VAS—closure is complete at the right end, absent at the left end	A significant postoperative increase in glottic closure, right amplitude and mucosal wave, and left amplitude and mucosal wave was observed. There was no difference between the two groups regarding the impact of the microsurgery, except for the left mucosal wave, which increased more in the implanted group.	1–5	No
(Halawa et al, 2014) ¹⁴	1. Glottal closure 2. Fold vibration 3. Mucosal wave 4. Phase symmetry	1: Complete or incomplete 2: Present or absent 3: Normal or absent or abnormal 4: Symmetric or asymmetric	According to the overall evaluation of perceptual, laryngostroboscopic, and subjective measures, the patients were classified into two groups: clinical improvement (75 patients, 77.3%) and no considerable clinical improvement (22 patients, 22.7%).	N/A	Yes. Adapted from Hirano and Bless, 1993 ⁷⁰ <i>Stroboscopic Assessment</i>
(Halderman et al, 2014) ¹⁵	1. Reaction or inflammation 2. Scarring 3. Granuloma formation 4. Mucosal wave amplitude	1–3: Present or absent 4: Preserved or not	None of the postinjection examinations revealed foreign body reaction or inflammation at the site of injection. Mucosal wave amplitude appeared preserved without evidence of loss of mucosal pliability. No scarring or granulomatous changes were noted.	N/A	No
(Hallen et al, 2001) ¹⁶	1. Glottic wave movement 2. Closure	1: 0 = no wave; 1 = decreased; 2 = full wave	All patients with unilateral palsy had improved stroboscopic status regarding both the wave and the	N/A	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Hamdan et al, 2015) ¹⁷	1. Glottal gap 2. Size of glottal gap 3. Location of glottal gap	2: 0 = a wide opening; 1 = intermediate closure; 2 = complete closure 1: Present or absent 2: <2 mm or >2 mm 3: Anteroposterior; posterior; anterior; bowing	closure after injection. In patients with spindle-shaped vocal fold closure pattern (n = 8), the glottic wave improved in all but two patients and the glottic closure improved in five patients.	N/A	No
(Hillel et al, 2013) ¹⁸	1. Glottic closure 2. Mucosal wave	1: 1 = complete; 2 = incomplete; 3 = inconsistent 2: 1 = normal; 2 = small reduction; 3 = moderate reduction; 4 = severely reduced or absent	The scores for mucosal wave ratings decreased significantly ($P = 0.008$) from the preoperative time point to the postoperative time point, as did the glottic closure ratings ($P = 0.005$) from the preoperative time point to the postoperative time point.	1,2	Yes: adapted from Bless et al, 1987 ⁶⁸ <i>Videoendoscopic Evaluation of the Larynx</i>
(Iloabachie et al, 2007) ¹⁹	1. Return of vocal cord function	1: Yes or no	Nine patients had return of vocal fold function and five patients did not have return of vocal cord function.	N/A	No
(Jensen and Rasmussen, 2013) ²⁰	1. Lesion presence	1: Present or absent	All vocal fold lesions—except one with a polyp in the anterior commissure requiring a reoperation—were completely removed.	N/A	No
(Karpenko et al, 2003) ²¹	1. Supraglottic activity 2. Mucosal wave characteristics* 3. Glottal competency*	1–3: 1 = normal to 5 = most abnormal *The values for mucosal wave characteristics and glottal competency were combined to give a composite score for which 10 is most abnormal	Combined scores of mucosal wave characteristics and glottal competency improved from pre to post injection. These results proved to be statistically significant ($P < 0.02$). The score of perceived supraglottic activity decreased after the operation but the difference was not statistically significant ($P > 0.30$).	2–3 (values combined)	No
(Keilmann et al, 2011) ²²	1. Morphological changes (tissue hyperplasia or cicatrization) 2. Glottic closure (insufficiency) 3. Mucosal wave pattern reduction (contralateral side) 4. Mucosal wave pattern (operated side) 5. Level of phonation	1: 0 = none; 1 = mild; 3 = moderate; 5 = severe 2: 0 = none; 1 = mild; 3 = moderate; 5 = pronounced 3: 0 = none; 1 = mild; 2 = severe; 3 = complete 4: 0 = present; 2 = not present 5: true vocal cord; false vocal cord; supraglottic phonation	The mean value of the score seemed to demonstrate a slight tendency of gradual improvement, but the time effect could not be proven statistically. Patients with more extended resections demonstrated less favorable results compared to those after limited resections.	None	Yes (Ott et al, 1992) ⁷¹ <i>Clinical assessment of the post treatment changes of the glottis</i>
(Kodama et al, 2015) ²³	1. Regularity 2. Amplitude 3. Glottal gap	1: 0 = periodical and symmetrical; 1 = periodical but asymmetrical; 2 = not periodical 2: 0 = symmetrical; 1 = smaller than the healthy side; 2 = mucosal traveling wave is not discernible 3: 0 = no gap; 1 = small gap between the membranous vocal folds; 2 = glottal gap about one-third of the portion between the membranous v.f.; 3 = glottal gap about two-thirds of the portion between the	Results show significant improvements for all parameters from baseline to 1, 3, 6, 12, and 24 months post surgery ($P < 0.01$). The parameter for regularity 24 months after surgery showed significant improvement compared with those at 1, 3, and 6 months after surgery. Amplitude at 24 months post surgery improved significantly compared with measurements at 3 and 6 months. The glottal gap at 24 months after surgery improved significantly compared with the results at 3 months follow-up.	1–3	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
		membranous v.f.; 4 = gap along the whole glottis			
(Lam et al, 2010) ²⁴	1. Subglottic edema 2. Granuloma or granulation 3. Thick endolaryngeal mucus or other 4. Ventricular obliteration 5. Erythema or hyperemia 6. Vocal cord edema 7. Diffuse laryngeal edema 8. Posterior commissure hypertrophy	1–3: Present or absent 4: Partial or complete 5: Arytenoids only or diffuse 6: Mild; moderate; severe; polypoid 7–8: Mild; moderate; severe; obstructing	Within the rabeprazole group, the total RFS score obtained at week 12 was significantly lower than baseline ($P = 0.002$). The patients had significant improvement in vocal cord edema ($P = 0.001$), diffuse laryngeal edema ($P = 0.006$), and posterior commissure hypertrophy ($P = 0.003$). The total RFS score obtained at week 18 was significantly lower than baseline ($P = 0.0001$). They showed improved vocal cord edema ($P = 0.0001$) and diffuse laryngeal edema ($P = 0.001$). Significant improvements were also found in the placebo group. The total RFS score was not significantly different between the rabeprazole and placebo groups at weeks 6, 12, and 18.	6–8 and RFS total score.	Yes (Belafsky et al, 2001) ⁶⁷ <i>Reflux Finding Score</i>
(Lan et al, 2010) ²⁵	1. Degree of glottic closure 2. Regularity 3. Phase symmetry 4. Mucosal wave	1–4: 0 = no deviance; 1 = slight deviance; 2 = deviance	At 3 months postoperatively, significant improvements in the degree of glottic closure ($P < 0.001$), regularity ($P = 0.046$), phase symmetry ($P = 0.008$), and mucosal wave ($P = 0.008$) were noted when compared with preoperative status.	1–4	No
(Law et al, 2012) ²⁶	1. Vocal fold nodules 2. Vocal edema	1–2: Present or absent	There were no statistically significant changes in laryngeal pathology preand post-voice therapy.	None	No
(Lee et al, 2014) ²⁷	1. Glottal gap 2. Mucosal wave	1: 0 = severe; 1 = moderate; 2 = mild; 3 = absent 2: 0 = absent; 1 = severely reduced; 2 = mildly reduces; 3 = intact	Significant improvements of glottal gap and mucosal wave were found at 1 and 6 months post-surgery when compared to baseline ($P < 0.05$).	1–2	Yes, adapted from Lee et al, 2010 ⁷²
(Lee et al, 2007) ²⁸	1. Glottic closure 2. Supraglottic effort 3. Arytenoid position 4. Vocal fold edge 5. Vertical height difference 6. Vocal fold position	1: 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = fully incomplete 2: 0 = none; 1 = mild; 2 = moderate; 3 = severe 3: 0 = normal; 1 = mildly tilted forward; 2 = moderately tilted forward; 3 = severely tilted forward 4: 0 = straight; 1 = mildly bowed; 2 = moderately bowed; 3 = severely bowed 5: yes or no 6: 0 = midline; 1 = paramedian; 2 = intermediate; 3 = lateral	All investigated data were either the same or improved postoperatively compared with the preoperative values.	N/A	No
(Li et al, 2011) ²⁹	1. Closure at the midmembranous vocal fold 2. Closure just anterior to the vocal processes 3. Closure in the respiratory glottis	1–3: 100-mm VAS—0 = no gap and 100 = large gap 4: 100-mm VAS; 0 = severe and 100 = none	A significant improvement in the postoperative scores was found for all groups for all parameters ($P < 0.05$), with the exception of closure in the respiratory glottis and vertical height difference, which did not significantly improve in G3 (thyroplasty only, with a Silastic implant).	G1: 1–4 G2: 1–4 G3: 1–2 All groups combined: 1–4	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
	4. Vertical height difference between the vocal folds		No significant difference in postoperative scores was found between the groups, for any parameter.		
(Li et al, 2014) ³⁰	1. Glottal closure	1: 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = severely incomplete	The postoperative stroboscopic findings were significantly improved in total sample and within each group compared with the corresponding preoperative findings ($P < 0.01$).	1	Yes, adapted from Lorenz et al, 2008 ⁷³
(Li et al, 2014) ³¹	1. Glottal closure	1: 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = severely incomplete	The postoperative stroboscopic findings were significantly improved in total sample and within each group compared with the corresponding preoperative findings ($P < 0.01$).	1	Yes, adapted from Lorenz et al, 2008 ⁷³
(Maia et al, 2012) ³²	1. Glottic closure 2. Presence of slit 3. Larynx vestibule involvement	1–3: Unchanged, improved or worsened comparing both images	The evaluation revealed improvements in glottic closure and lower larynx vestibule activation in post exercise moment in both groups ($P < 0.001$). There were no changes regarding the presence of a glottic slit.	1,3	No
(Malik et al, 2014) ³³	1. Glottic gap 2. Mucosal wave	1–2: Presence or absence	Closure of the glottic gap was achieved in all cases except for one participant, who underwent medialization with the Silastic implant. Mucosal wave was absent in all cases preoperatively. After the surgery, it was present in 14 of 20 patients in G1 and in 16 of 20 patients in G2.	N/A	No
(Maronian et al, 2003) ³⁴	1. Vocal fold position 2. Degree of compression with phonation 3. Glottic gap 4. Muscle atrophy 5. Muscle bulk asymmetry 6. Arytenoid position during quiet respiration 7. Arytenoid position during speech 8. Arytenoid movement	1: 1 = lateral; 2 = paramedian; 3 = near-midline 2–3: 0 = none; 1 = mild; 2 = moderate; 4–5: Present or absent 6–7: 2 = normal; 1 = mildly abnormal; 0 = moderately abnormal 8: 0 = none; 1 = minimal; 2 = normal	Improvements were found in all parameters for at least 2 of 7 participants. 100% of the participants improved regarding glottic gap and muscle atrophy.	N/A	No
(Milstein et al, 2005) ³⁵	1. Glottic insufficiency 2. Degree of vocal fold bowing	1: 1 = complete closure; 2 = mildly incomplete; 3 = moderately incomplete; 4 = severely incomplete 2: 1 = straight vocal fold edge; 2 = mildly bowed; 3 = moderately bowed; 4 = severely bowed	Mean scores of glottal closure and degree of vocal fold bowing improved from pre to post intervention ($P < 0.0001$).	1–2	No
(Monini et al., 2006) ³⁶	1. Edema of the arytenoid 2. Erythema of the arytenoid 3. Partial or total vocal fold erythema 4. Vocal fold edema 5. Posterior glottic edema	1–5: Present or absent	In G1, laryngeal features were improved in 93% of the participants. In G2, improvements were observed in 54.5% of the participants and pre-post difference was also significant ($P = 0.025$).	N/A	No
(Morgan et al, 2007) ³⁷	1. Symmetry 2. Amplitude	1–4: Normal; mild; moderate; severe	Pre- to post-changes within each intervention group were not assessed for statistical significance. Pre and	N/A	Yes adapted from Rosen, 2005 ⁷⁴

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
	3. Periodicity 4. Closure patterns 5. Location of nonvibratory segments 6. Duration of closure	5: Anterior; middle; posterior third of the true vocal fold 6: Predominately closed; half closed and half open; predominately open; or always open *Ratings were then converted to a 100-point scale (0 = normal; 100 = most abnormal)	post scores for SRI improved in both groups from pre to post treatment, but the statistical significance of these improvements was not assessed.		
(Mortensen and Woo, 2006) ³⁸	1. Vocal fold edge approximation 2. Vertical level of amplitude 3. Amplitude 4. Mucosal wave 5. Vibratory behavior 6. Phase symmetry 7. Closure	1–7: Improved or not improved	Significant improvement was observed for the following parameters: vocal fold edge, amplitude, wave, and vibratory behavior ($P = 0.01$).	1, 3, 4, 5	No
(Nakagawa et al, 2012) ³⁹	1. Polyp size	1: complete remission; shrinkage; no change in size; enlargement	41.7% of the patients showed complete remission of the polyps following conservative treatment. Lesion shrinkage was observed in 29.1% of the patients.	N/A	No
(Nam et al, 2013) ⁴⁰	1. Vocal fold edema 2. Vocal fold tension 3. Subglottic edema 4. Laryngeal mucus 5. Decrease of symmetry of the arytenoids and vocal folds 6. Decrease of regularity 7. Presence of muscle tension dysphonia	1–2: Normal; mild; moderate 3–7: Yes or no	In the non-gliding group, the parameters were not improved following direct voice therapy only. However, an important improvement was observed after indirect voice therapy followed by vocal function exercise (a higher percentage of patients improved).	N/A	No
(Paniello et al, 2008) ⁴¹	1. Mucosal wave 2. Glottal gap	1: NNN—normal or near-normal; IBR—improved but reduced 2: Gap remains or none	Mucosal wave was improved in 18 of the 21 patients, and glottal gap was improved in 19 of the 21 patients.	N/A	No
(Portnoy et al, 2014) ⁴²	1. Subglottic edema 2. Granuloma of granulation 3. Thick endolaryngeal mucus/other 4. Ventricular obliteration 5. Erythema/hyperemia 6. Vocal cord edema 7. Diffuse laryngeal edema 8. Posterior commissure hypertrophy	1–3: Present or absent 4: Partial or complete 5: Arytenoids only or diffuse 6: Mild; moderate; severe; polypoid 7–8: Mild; moderate; severe; obstructing	A small but significant decrease in mean RFS scores was found on the super high dose regimen. The average change in RFS scores (from standard to super high dose) was 1.45 ± 2.9 ($P = 0.0007$).	Yes (average RFS score)	Yes (Belafsky et al, 2001) ⁶⁷ Reflux Finding Score
(Rihkanen et al, 2004) ⁴³	1. Glottic closure of the membranous part of the vocal folds 2. Mucosal wave amplitude 3. Phase synchrony	1: Complete; incomplete (anterior or posterior); totally missing 2: Symmetric or asymmetric 3: Staying in synchrony during all cycles; in most of the cycles; out of synchrony.	The number of patients with complete or partial vocal fold closure, good phase synchrony, and mucosal wave amplitude was increased following injection laryngoplasty. The difference with preintervention	1,3	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Rontal and Rontal, 2003) ⁴⁴	1. Glottic closure	1: Present or absent (as signaled as a return of mucosal wave)	findings was significant for vocal fold closure and phase synchrony ($P < 0.01$). Of the remaining 10 participants, nine had an effective vocal fold approximation after the procedure, allowing glottic closure.	N/A	No
(Sanuki et al, 2015) ⁴⁵	1. Glottal closure 2. Regularity of vocal fold vibration 3. Amplitude	1: 0 = none; 1 = slight; 2 = one-third gap between both vocal folds; 3 = two-thirds gap; 4 = an open glottis during phonation 2: 0 = normal; 1 = mildly abnormal; 2 = moderately abnormal 3: 0 = normal; 1 = reduced; 2 = absent	Glottal closure ($P = 0.0050$), regularity of the vocal fold vibration ($P = 0.0067$), and amplitude of vocal fold vibration ($P = 0.0048$) were significantly improved after laryngeal reinnervation when compared with the preoperative values.	1–3	Yes adapted from Yumoto et al. 2006 ⁷⁵
(Schindler et al, 2013) ⁴⁶	1. Lesion size	1: Improvement or no improvement	Improvement in the lesion size was observed in 11 of the 65 participants after 10 weeks of voice therapy. However, none of the lesions disappeared completely after therapy.	N/A	Yes (Yun et al, 2007) ⁷⁶
(Schneider et al, 2003) ⁴⁷	1. Glottal closure 2. Vibratory patterns	1: 1 = Complete closure all along the vocal folds; 2 = indication of incomplete closure of the cartilaginous part; 3 = triangular incomplete closure reaching anterior to the vocal processes; 4 = triangular incomplete closure of the posterior third of the folds; 5 = incomplete closure of the posterior two-thirds of the folds; 6 = incomplete closure all along the folds; A = spindle-shaped incomplete closure, closure at the vocal processes; B = spindle-shaped incomplete closure at the posterior third of the membranous folds, closure at the vocal processes; C = spindle-shaped incomplete closure at the anterior third of the folds, closure at the vocal processes; D = spindle-shaped incomplete closure at the posterior and the anterior thirds of the folds, closure at the vocal processes and at the middle of the membranous portion ("hourglass") 2: Improved or not improved	Following surgery, a complete closure was noted in six subjects, three had an almost complete closure with a minor gap in the cartilaginous part, four had a triangular incomplete closure reaching anterior to the vocal processes, and one had a triangular incomplete closure of the posterior third of the folds. The vibration patterns of the vocal folds were improved in all participants.	N/A	Yes adapted from Sodersten and Lindestad, 1990 ⁷⁷
(Schneider et al, 2003) ⁴⁸	1. Glottal closure 2. Vibratory patterns	1: See above (Schneider et al, 2003) ⁴⁷ 2: Improved or not improved	Glottal closure during phonation, as well as vibratory patterns, was improved in all patients.	N/A	Yes adapted from Sodersten and Lindestad, 1990 ⁷⁷
(Shoffel-Havakuk et al, 2014) ⁴⁹	1. Posterior glottic lesion	1: Present or absent	Treatment failure occurred in three cases, in which the granuloma reoccurred or persisted during the follow-up period. 91% of the interventions were successful.	N/A	No
(Silbergleit et al, 2013) ⁵⁰	1. Vocal fold edge tumor side 2. Vocal fold edge nontumor side	1–8: 5-point equally appearing interval scale —0 represents normal function and 5 represents the most abnormal finding.	Amplitude of vibration and mucosal wave on the tumor side were significantly improved ($P = 0.004$; $P = 0.003$)	3,5,6,7,8	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
	3. Amplitude of vibration tumor side 4. Amplitude of vibration nontumor side 5. Mucosal wave tumor side 6. Mucosal wave nontumor side 7. Nonvibrating portion of the vocal folds tumor side 8. Nonvibrating portion of the vocal folds nontumor side		at time 5 (20 weeks or more follow-up), when compared with baseline. When compared with the first post-procedure time point, significant improvements were found on the tumor side for amplitude ($P = 0.001$), nonvibrating portion ($P = 0.001$), and mucosal wave ($P = 0.001$) at the end of follow-up. On the nontumor side, significant improvements were found for mucosal wave ($P = 0.013$) and nonvibration portion ($P = 0.008$).		
(Smith et al, 1995) ⁵¹	1. Glottal configuration 2. Degree of glottal incompetence 3. False-fold compression hyperfunction 4. Anterior-posterior hyperfunction	1: Complete; bowing; hourglass; anterior chink; posterior chink; incomplete 2: A 5-point scale was used: 1 = slight, folds just not touching; 3 = moderate, ~50% of the length of the folds not touching with 1- to 2-mm gap; 5 = severe, no vocal fold contact throughout the length of the folds and a large (3–4 mm) glottal gap 3: 1 = no false fold overclosure, laryngeal ventricles easily seen; 2 = one or both false folds obscure laryngeal ventricles; 3 = one or both false folds obscure ventricles and a portion of the true vocal folds; 4 = one or both false folds obscure the entire true vocal folds but are not touching; 5 = false folds touch and cover the entire glottis 4: 1 = no shortening of glottal length compared with resting, nonphonating state; 2 = glottal length shortened by 25%; 3 = glottal length shortened by 50%; 4 = glottal length shortened by 75%; 5 = arytenoids touch laryngeal surface of epiglottis, obscuring glottal view	At a loud phonation effort, there was no significant difference between the pre- and post-treatment outcomes in both groups. The authors reported a trend for improvement to normal glottal configuration after therapy in the vocal and respiratory therapy group, and a significant difference in change between the groups for degree of glottal incompetence ($P < 0.01$).	None	No
(Steward et al, 2004) ⁵²	1. True vocal fold edema 2. True vocal fold erythema 3. Arytenoid edema 4. Arytenoid erythema 5. Pachydermia 6. Granuloma 7. Stenosis 8. Ulceration 9. Nodules	1–5: Scored as none to severe; 0 to 4 on Likert scale 6–9: Noted if present	In both groups, a score reduction was noted at post-treatment when compared to baseline. The change did not reach statistical significance.	None	No
(Storek et al, 2007) ⁵³	1. Glottal closure 2. Mucosal wave	1: No closure; anterior third; anterior two-thirds; complete 2: Improved or not improved	Before surgery, 88% of the patients had a total glottal gap during phonation. After surgery, a complete glottal closure was observed in 77% of patients, and a closure	N/A	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Storck et al, 2010) ⁵⁴	1. Degree of glottal closure 2. Mucosal wave 3. Symmetry of mucosal waves 4. Periodicity of mucosal waves	1: No; anterior one-third; anterior two-thirds, complete 2: Absent or visible 3: Severely asymmetrical or normal 4: Severally aperiodic or normal	Improvements in glottal closure, symmetry of vocal fold vibration, mucosal wave, and presence of periodic vocal fold vibrations improved in most of the patients from both groups. The rate of complete glottal closure was higher in G2 (titanium implant)	N/A	Yes adapted from Hirano, 1981 ⁶⁹
(Su et al, 2005) ⁵⁵	1. Relative size of the glottal gap	1: 0 = no gap during phonation; 1 = minimal gap; 2 = small gap extending up to one-third of the anterior membranous vocal folds; 3 = moderate gap extending up to two-thirds of the posterior membranous vocal folds; 4 = complete glottal incompetence with no observable contact between the vocal folds	Glottal closure improved in 12 of the 13 patients after the intervention. Postoperatively, complete or nearcomplete glottal closure was observed in six patients, and partial closure in six patients. One patient had persistent complete glottal incompetence after surgery.	1	No
(Su et al, 2005) ⁵⁶	1. Relative size of the glottal gap	See above (Su et al, 2005) ⁵⁵	A significant improvement in postoperative glottal closure at the horizontal and vertical planes was found when compared with baseline. After the surgery, complete or nearly complete glottal closure was obtained in 52% of the participants. Incomplete closure was observed in 14 participants, and none of the patients had a persistent complete glottal incompetence.	1	No
(Tsunoda et al, 2005) ⁵⁷	1. Glottal incompetence 2. Mucosal wave 3. Hyperadduction of false vocal folds	1–3: Present or absent	Before the intervention, all patients had glottal incompetence and hyperadduction of the false vocal folds, and none had satisfactory mucosal waves. Six months after the transplantations, satisfactory glottal closure and mucosal wave were obtained in all but the oldest participant. Hyperadduction of the false vocal folds disappeared in seven cases. One year after the ATFV, satisfactory glottal closure, excellent mucosal wave, and no hyperadduction were observed for all subjects.	N/A	No
(van Gogh et al, 2006) ⁵⁸	1. Vocal fold edge R/L 2. Glottic closure 3. Phase closure 4. Vertical level of approximation 5. Amplitude R/L 6. Mucosal wave R/L 7. Vibratory behavior R/L 8. Phase symmetry 9. Periodicity 10. Ventricular folds—symmetry of movement 11. Arytenoid symmetry	1: 1 = smooth; 5 = rough irregular 2: Pictorial 3: 1 = open phase predominates; 5 = closed phase predominates 4: 1 = equal; 2 = right lower; 3 = left lower 5: 1 = normal; 2 = slightly decreased; 3 = moderately decreased; 4 = severely decreased; 5 = no visible movement 6: 1 = normal to 5 = absent 7: 1 = always fully present to 5 = complete absence always 8–9: 1 = regular to 4 = always irregular 10–11: R > L; L > R; equal 12: 1 = normal to 4 = full compress	Following voice therapy, no parameter was significantly changed when compared with baseline, except for the left vocal fold edge, which became more irregular ($P = 0.034$) than before treatment.	None (1 was significantly worsened)	Yes (Hirano and Bless, 1993) ⁷⁰

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Wang et al, 2013) ⁵⁹	12. Ventricular folds movement 13. Arytenoid movement 14. Hyperfunction 1. Recovery	13: 1 = normal to 3 = poor 14: 1 = not present; 2 = sometimes present; 3 = always present 1: 1 = complete recovery (normal mucosal wave propagation with symmetric phase and amplitude); 2 = much improvement (normal mucosal wave propagation with minimal asymmetric phase or amplitude); 3 = some improvement (presence of phase asymmetry or decreased amplitude, but the mucosal wave was improved compared with baseline); 4 = no change or worse	After 6 weeks, examination in the polypectomy group showed complete recovery in 14 patients (70%) and much improvement of vocal fold vibration in 5 (25%). In the KTP laser treatment only, results at 6 weeks showed complete recovery in 6 patients (38%), much improvement in 6 (38%), some improvement in 2 (12%), and no improvement in 2 (12%).	N/A	No
(Wang et al, 2013) ⁶⁰	1. Lesion size	1: 1 = complete resolution of the vocal lesions; 2 = much improvement (>50% of lesion size reduction); 3 = some improvement (<50% of lesion size reduction); 4 = no change	Three months after treatment, vocal fold lesions were completely resolved in 10 subjects and much improved in 19 subjects. There was no significant difference in outcomes between the nodules and the polyps groups.	N/A	No
(Wang et al, 2012) ⁶¹	1. Closure pattern of vocal folds	1: 1 = predominantly closed; 2 = closed or open; 3 = predominantly open; 4 = always open	The pattern of glottic closure was "predominantly open" before the procedure and significantly improved to a "half-open and half-closed" pattern 3 months post intervention ($P < 0.001$).	1	No
(Wang et al, 2011) ⁶²	1. Glottal closure 2. Vocal fold position 3. Vocal fold edge of paralyzed side 4. Phase symmetry 5. Regularity	1: 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = severely incomplete 2: 0 = midline; 1 = paramedian; 2 = intermediate; 3 = lateral 3: 0 = straight; 1 = mildly bowing; 2 = moderately bowing; 3 = severely bowing 4: 0 = normal; 1 = mildly asymmetrical; 2 = moderately asymmetrical; 3 = severely asymmetrical 5: 0 = normal; 1 = mildly irregular; 2 = moderately irregular; 3 = severely irregular See above (Wang et al, 2011) ⁶²	Glottal closure, vocal fold position, vocal fold edge, phase symmetry, and regularity were significantly improved after the surgery when compared with baseline ($P < 0.001$).	1-5	Yes, adapted from Lorenz et al, 2008 ⁷³ ; Rosen, 2005 ⁷⁴
(Wang et al, 2011) ⁶³	1. Glottal closure 2. Vocal fold position 3. Vocal fold edge of paralyzed side 4. Phase symmetry 5. Regularity	See above (Wang et al, 2011) ⁶²	Glottal closure, vocal fold position, vocal fold edge, phase symmetry, and regularity were significantly improved postoperatively ($P < 0.001$).	1-5	Yes, adapted from Lorenz et al, 2008 ⁷³ ; Rosen, 2005 ⁷⁴
(Woo et al, 2013) ⁶⁴	1. Vocal gap size	1: Disappeared; improved; no change	The vocal gap disappeared in all patients at 1 month post-intervention. However, at 3 months, a vocal gap was observed in some of the patients in G1 (cricothyroid group but not in G2 (thyroid)).	N/A	No

Author and Year	Parameters	Scales	Difference Reported (Pre to Post Treatment)	Parameters Significantly Improved (From Pre to Post Treatment)	Use of Previously Published Scale
(Yilmaz, 2012) ⁶⁵	1. Glottal closure 2. Mucosal wave amplitude 3. Mucosal wave symmetry 4. Mucosal wave periodicity	1: 0 = normal; 1 = anterior gap; 2 = posterior gap; 3 = hourglass; 4 = no contact 2: 0 = normal; 1 = mild; 2 = moderate; 3 = severe 3-4: 0 = normal; 1 = mild irregularity; 2 = moderate irregularity; 3 = always irregular	Glottal closure and mucosal wave amplitude improved significantly after the procedure ($P < 0.001$; $P = 0.002$). Mucosal wave symmetry and mucosal wave periodicity did not improve significantly following the surgery.	1-2	No
(Yilmaz and Sozen, 2012) ⁶⁶	1. Mucosal wave amplitude 2. Mucosal wave symmetry 3. Mucosal wave periodicity 4. Glottal closure	1-4: 0 = normal; 1 = mild; 2 = moderate; 3 = severe abnormality	At the end of the 4-week study, all patients had a normal videolaryngostroboscopy (VLS).	N/A	No

Notes: when possible, direct quotes from the articles were used to report the pre to post treatment changes.

Abbreviations: G1, group 1; G2, group 2; G3, group 3; N/A, not available; RFS, Reflux Finding Score; SRI, Stroboscopy Research Instrument; VAS, visual analog scale; v.f., vocal fold.

TABLE 3.

Parameters and Scales

Parameter (Categories)	Parameters (Terms Used)	Scales
Amplitude of vibration	Amplitude	<ul style="list-style-type: none"> ■ 1 = normal; 2 = decreased; 3 = increased ■ Normal; mild; moderate; severe ■ Improved or not improved ■ 0 normal; 1 reduced; 2 absent
	Amplitude of vibration	<ul style="list-style-type: none"> ■ Normal if noted at 5, increased if above 5, and decreased below on a 10 cm scale
	Amplitude left or right	<ul style="list-style-type: none"> ■ 1 = normal; 2 = slightly decreased; 3 = moderately decreased; 4 = severely decreased; 5 = no visible movement ■ VAS-amplitude is considered normal if noted at half the continuum, increased to the right and decreased to the left
	Amplitude of vibration tumor side/nontumor side	<ul style="list-style-type: none"> ■ 5-point equally appearing interval scale-0 = normal function; 5 = most abnormal finding
Hyperfunction or ventricular folds	Anteroposterior hyperfunction	<ul style="list-style-type: none"> ■ 1 = no shortening of glottal length compared with resting, nonphonating state; 2 = glottal length shortened by 25%; 3 = glottal length shortened by 50%; 4 = glottal length shortened by 75%; 5 = arytenoids touch laryngeal surface of epiglottis, obscuring glottal view.
	Hyperadduction of false vocal folds	<ul style="list-style-type: none"> ■ Present or absent
	False-fold compression hyperfunction	<ul style="list-style-type: none"> ■ 1 = no false fold overclosure, laryngeal ventricles easily seen; 2 = one or both false folds obscure laryngeal ventricles; 3 = one or both false folds obscure ventricles and a portion of the true vocal folds; 4 = one or both false folds obscure the entire true vocal folds but are not touching; 5 = false folds touch and cover the entire glottis.
	Ventricular folds movement	<ul style="list-style-type: none"> ■ 1 = normal; 4 = fully compressed
	Presence of muscle tension dysphonia	<ul style="list-style-type: none"> ■ No or yes
	Degree of compression with phonation	<ul style="list-style-type: none"> ■ 0 = none; 1 = mild; 2 = moderate
	Supraglottic activity	<ul style="list-style-type: none"> ■ 1 = normal to 5 = most abnormal
	Hyperfunction	<ul style="list-style-type: none"> ■ 1 = not present; 2 = sometimes present; 3 = always present
	Supraglottic effort	<ul style="list-style-type: none"> ■ 0 = none; 1 = mild; 2 = moderate; 3 = severe
	Larynx vestibule involvement	<ul style="list-style-type: none"> ■ Unchanged; improved or worsened
	Ventricular folds—symmetry of movement	<ul style="list-style-type: none"> ■ R > L; L > R; L = R
Arytenoids	Arytenoid movement	<ul style="list-style-type: none"> ■ 1 = normal; 3 = poor ■ 0 = none; 1 = minimal; 2 = normal
	Arytenoid symmetry	<ul style="list-style-type: none"> ■ R > L; L > R; L = R
	Symmetry of ventricular folds	<ul style="list-style-type: none"> ■ No or yes
	Arytenoid movement	<ul style="list-style-type: none"> ■ 2 = normal; 1 = mildly abnormal; 0 = moderately abnormal
	Symmetry of arytenoid movement	
	Position symmetry (during voicing)	
	Arytenoid position during speech	

Parameter (Categories)	Parameters (Terms Used)	Scales
Edema	Arytenoid position during quiet respiration	■ 2 = normal; 1 = mildly abnormal; 0 = moderately abnormal
	Arytenoid position	■ 0 = normal; 1 = mildly tilted forward; 2 = moderately tilted forward; 3 = severely tilted forward
	Asymmetric localized edema on glottic edge	■ 0 = normal; 1+ = mild; 2+ = moderate; 3+ = severe
	Edema of vocal folds	■ 0 = not present to 3 = most severe
		■ Mild; moderate; severe; polypoid
		■ Normal; mild; moderate
		■ Present or absent
	True vocal cord edema	■ Scored as none to severe; 0 to 4 on Likert scale
	Vocal edema	■ Present or absent
	Diffuse laryngeal edema	■ Mild; moderate; severe; obstructing
Erythema	Swelling	■ 0 = normal; 1+ = mild; 2+ = moderate; 3+ = severe
	Ventricular obliteration	■ Partial or complete
	Edema of posterior supraglottis	■ 0 = not present to 3 = most severe
	Posterior glottic edema	■ Present or absent
	Subglottic edema	■ 0 = not present to 3 = most severe
	Subglottic edema	■ Present or absent
		■ No or yes
	Edema of the arytenoid	■ Present or absent
		■ Scored as none to severe; 0-4 on Likert scale
	Erythema of posterior supraglottis	■ 0 = not present to 3 = most severe
Glottal closure or gap	Erythema of subglottis	■ 0 = not present to 3 = most severe
	Erythema of the arytenoid	■ Present or absent
		■ Scored as none to severe; 0-4 on Likert scale
	Erythema of vocal folds	■ 0 = not present to 3 = most severe
	Partial or total vocal fold erythema	■ Present or absent
	True vocal cord erythema	■ Scored as none to severe; 0-4 on Likert scale
	Erythema or hyperemia	■ Arytenoids only or diffuse
	Reaction or inflammation	■ Presence or absence
	Closure	■ 0 = a wide opening; 1 = intermediate closure; 2 = complete closure
	Degree of glottic closure	■ Improved or not improved
		■ 0 = no deviance; 1 = slight deviance; 2 = deviance

Parameter (Categories)	Parameters (Terms Used)	Scales
	Glottal closure	<ul style="list-style-type: none"> ■ Visual analog scales of 100 mm: a score of 0 meaning “normal, no deviance,” and a score of 100 “extremely deviant” ■ 0 = no deviance to 3 = severe deviance ■ Complete or incomplete ■ 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = severely incomplete ■ 0 = none; 1 = slight; 2 = one-third gap between both vocal folds; 3 = two-thirds gap; 4 = an open glottis during phonation ■ 0 = normal; 1 = mild; 2 = moderate; 3 = severe abnormality Glottic closure ■ Complete at 5 and diminished if noted between 0 and 5, on a 10 cm scale. ■ Complete at the right end, absent at the left end, on a VAS ■ 1 = complete; 2 = incomplete; 3 = inconsistent ■ 0 = complete; 1 = slightly incomplete; 2 = moderately incomplete; 3 = fully incomplete ■ Unchanged; improved; worsened ■ Present or absent ■ Absent or present ■ 0 = severe; 1 = moderate; 2 = mild; 3 = absent ■ GR—gap remains or none ■ Presence or absence ■ <2 mm or >2 mm ■ A 5-point scale was used: 1 = slight, folds just not touching; 3 = moderate, ~50% of the length of the folds not touching with 1- to 2-mm gap; 5 = severe, no vocal fold contact throughout the length of the folds and a large (3- to 4-mm) glottal gap ■ Disappeared; improved or no change ■ Unchanged; improved or worsened ■ Present or absent ■ 1 = normal to 5 = most abnormal ■ 1 = complete closure; 2 = mildly incomplete; 3 = moderately incomplete; 4 = severely incomplete ■ 0 = none; 1 = mild; 3 = moderate; 5 = pronounced ■ 1 = sufficient or 2 = insufficient ■ 100 mm VAS—0 = no gap to 100 = large gap ■ Complete; incomplete (anterior or posterior) or totally missing ■ 100 mm VAS—0 = no gap and 100 = large gap
	Glottal gap	
	Glottic gap	
	Size of glottal gap	
	Degree of glottal incompetence	
	Vocal gap size	
	Presence of slit	
	Glottal incompetence	
	Glottal competency	
	Glottal insufficiency	
Location or shape of glottal gap	Glottic closure (insufficiency)	
	Glottic occlusion	
	Closure at the midmembranous vocal fold	
	Glottic closure of the membranous part of the vocal folds	
	Closure in the respiratory (cartilaginous) glottis	

Parameter (Categories)	Parameters (Terms Used)	Scales
	Closure just anterior to the vocal processes	■ 100 mm VAS—0 = no gap and 100 = large gap
	Glottic gap at the middle and posterior aspects of the vocal folds	■ 0 = none; 1 = mild; 2 = moderate
	Degree of glottal closure	■ None, anterior one-third, anterior two-thirds, and complete
	Glottal closure	■ 1 = complete closure all along the vocal folds; 2 = indication of incomplete closure of the cartilaginous part; 3 = triangular incomplete closure reaching anterior to the vocal processes; 4 = triangular incomplete closure of the posterior third of the folds; 5 = incomplete closure of the posterior two-thirds of the folds; 6 = incomplete closure all along the folds; A = spindle-shaped incomplete closure, closure at the vocal processes; B = spindle-shaped incomplete closure at the posterior third of the membranous folds, closure at the vocal processes; C = spindle-shaped incomplete closure at the anterior third of the folds, closure at the vocal processes; D = spindle-shaped incomplete closure at the posterior and the anterior thirds of the folds, closure at the vocal processes and at the middle of the membranous portion ("hourglass")
		■ No closure; anterior third; anterior two-thirds; complete
		■ 0 = normal; 1 = anterior gap; 2 = posterior gap; 3 = hourglass; 4 = no contact
	Glottic closure	■ Pictorial
	Glottal gap	■ 0 = no gap; 1 = small gap between the membranous vocal folds; 2 = glottal gap about one-third of the portion between the membranous v.f.; 3 = glottal gap about two-thirds of the portion between the membranous v.f.; 4 = gap along the whole glottis
	Location of glottal gap	■ Anteroposterior; posterior; anterior; bowing
	Relative size of glottal gap	■ 0 = no gap during phonation; 1 = minimal gap; 2 = small gap extending up to one third of the anterior membranous vocal folds; 3 = moderate gap extending up to two-thirds of the posterior membranous vocal folds; 4 = complete glottal incompetence with no observable contact between the vocal folds
	Glottal configuration	■ Complete; bowing; hourglass; anterior chink; posterior chink; incomplete
Granuloma	Contact granuloma	■ Present or absent
	Granuloma formation	■ Presence or absent
	Granuloma or granulation	■ Present or absent
		■ Noted if present
	Decrease of regularity	■ No or yes
Regularity/Periodicity	Regularity of vibration	■ 0 = no deviance to 3 = severe deviance
		■ 0 = periodical and symmetrical; 1 = periodical but asymmetrical; 2 = not periodical
		■ 0 = no deviance; 1 = slight deviance; 2 = deviance
		■ 0 = normal; 1 = mildly irregular; 2 = moderately irregular; 3 = severely irregular
		■ Visual analog scales of 100 mm: a score of 0 meaning "normal, no deviance," and a score of 100 "extremely deviant" Periodicity ■ 1 = regular; 2 = irregular successive vibrations
		■ Normal; mild; moderate; severe
		■ 1 = regular to 4 = always irregular
	Regularity of vocal fold vibration	■ 0 = normal; 1 = mildly abnormal; 2 = moderately abnormal

Parameter (Categories)	Parameters (Terms Used)		Scales
Phase closure	Phase closure ratio	Duration of closure	<ul style="list-style-type: none"> ■ Absent or visible ■ Predominately closed; half closed and half open; predominately open; always open
		Phase closure	<ul style="list-style-type: none"> ■ 1 = open phase predominates to 5 = closed phase predominates
		Closure pattern of vocal folds	<ul style="list-style-type: none"> ■ 1 = predominantly closed; 2 = closed or open; 3 = predominantly open; 4 = always open
		Closure patterns	<ul style="list-style-type: none"> ■ Normal; mild; moderate; severe
Mucosal wave	Phase closure (ratio not specified)		<ul style="list-style-type: none"> ■ 1 = absent; 2 = limited to the most medial edge of the vocal folds; 3 = present laterally up to one-fourth of the width of the vocal folds; 4 = present up to but less than one-half the width of the vocal folds; 5 = present at more than one-half the width of the vocal folds (normal)
	Mucosal wave presence or amplitude	Mucosal wave	<ul style="list-style-type: none"> ■ 1 = normal with 30%–50% lateral travel; 2 = increased with lateral travel >50%; 3 = decreased with lateral travel <30%
			<ul style="list-style-type: none"> ■ Normal if noted at 10 on a 10-cm scale. Every value between 10 and 0 is considered a decreased wave. A wave noted 0 is a completely absent wave.
			<ul style="list-style-type: none"> ■ Normal or absent or abnormal
			<ul style="list-style-type: none"> ■ 1 = normal; 2 = small reduction; 3 = moderate reduction; 4 = severely reduced or absent
			<ul style="list-style-type: none"> ■ 0 = absent; 1 = severely reduced; 2 = mildly reduces; 3 = intact
			<ul style="list-style-type: none"> ■ Presence or absence
			<ul style="list-style-type: none"> ■ NNN—normal or near-normal; IBR—improved but reduced
			<ul style="list-style-type: none"> ■ Present to absent; 0–4 on Likert scale
			<ul style="list-style-type: none"> ■ Absent or visible
		Glottic wave movement	<ul style="list-style-type: none"> ■ 0 = no wave; 1 = decreased; 2 = full wave
		Mucosal wave amplitude	<ul style="list-style-type: none"> ■ Preserved or not
			<ul style="list-style-type: none"> ■ 0 = normal; 1 = mild; 2 = moderate; 3 = severe abnormality
			<ul style="list-style-type: none"> ■ 0 = normal; 1 = mild; 2 = moderate; 3 = severe
		Mucosal wave pattern (operated side)	<ul style="list-style-type: none"> ■ 0 = present, 2 = not present
		Mucosal wave left or right	<ul style="list-style-type: none"> ■ 1 = normal to 5 = absent
			<ul style="list-style-type: none"> ■ Scale is unipolar (normal at the right end, completely absent at the left end, VAS)
			<ul style="list-style-type: none"> ■ 0 = no deviance to 3 = severe deviance
		Mucosal wave quality	<ul style="list-style-type: none"> ■ Improved or not improved
			<ul style="list-style-type: none"> ■ 0 = no deviance; 1 = slight deviance; 2 = deviance
		Mucosal wave characteristics	<ul style="list-style-type: none"> ■ 1 = normal to 5 = most abnormal

Parameter (Categories)	Parameters (Terms Used)	Scales
	Quality of mucosal wave	<ul style="list-style-type: none"> ■ Visual analog scales of 100 mm: a score of 0 meaning “normal, no deviance,” and a score of 100 “extremely deviant” ■ 0 = none; 1 = mild; 2 = severe; 3 = complete
	Mucosal wave pattern reduction (contralateral side)	■ A five-point equally appearing interval scale. Zero represented normal function and five represented the most abnormal finding.
	Mucosal wave tumor side or nontumor side	■ Symmetric or asymmetric
	Mucosal wave amplitude	■ 0 = symmetrical; 1 = smaller than the healthy side; 2 = mucosal traveling wave is not discernible
	Mucosal wave symmetry	■ 0 = normal; 1 = mild; 2 = moderate; 3 = severe abnormality
	Mucosal wave symmetry (not specified)	■ 0 normal; 1 mild irregularity; 2 moderate irregularity; 3 always irregular
	Mucosal wave periodicity	■ Severely asymmetrical or normal
		■ 0 = normal; 1 = mild; 2 = moderate; 3 = severe abnormality
		■ 0 = normal; 1 = mild irregularity; 2 = moderate irregularity; 3 = always irregular
		■ Severely aperiodic or normal
Phase symmetry	Phase symmetry	<ul style="list-style-type: none"> ■ 1 = regular to 4 = always irregular ■ 0 = normal; 1 = mildly asymmetrical; 2 = moderately asymmetrical; 3 = severely asymmetrical ■ 1 = symmetrical or 2 = asymmetrical ■ Symmetric or asymmetric ■ 0 = no deviance; 1 = slight deviance; 2 = deviance ■ Improved or not improved
		■ 0 = no deviance to 3 = severe deviance
		■ Normal; mild; moderate; severe
		■ Visual analog scales of 100 mm: a score of 0 meaning “normal, no deviance,” and a score of 100 “extremely deviant”
Mucus	Phase synchrony	■ Stays in synchrony during all cycles, in most of the cycles or is out of synchrony
	Increased mucus on vocal folds	■ 0 = normal; 1+ = mild; 2+ = moderate; 3+ = severe
	Laryngeal mucus	■ No or yes
	Thick endolaryngeal mucus or other	■ Present or absent
Vibratory behavior	Vibratory patterns	■ Improved or not improved
	Vibratory behavior left or right	■ 1 = always fully present to 5 = complete absence always
	Return of vocal fold function	■ Yes or no
	Fold vibration	■ Present or absent
	Vibratory behavior	■ Improved or not improved
Presence and extent of nonvibrating portions	Nonvibrating segments	■ 1 = presence or 2 = absence of nonvibratory segment
	Nonvibrating portion of the vocal folds tumor side or nontumor side	■ A five-point equally appearing interval scale. Zero represented normal function and five represented the most abnormal finding.
	Inability to sustain waveform	■ 0 = normal; 1+ = mild; 2+ = moderate; and 3+ = severe

Parameter (Categories)	Parameters (Terms Used)		Scales
Lesions (non-granulomatous)	Location of nonvibrating portions	Location of nonvibratory segments	■ Anterior; middle; posterior third of the true vocal fold
	Level of phonation	Level of phonation	■ True vocal cord; false vocal cord; supraglottic phonation
	General lesions (presence and size)	Lesion presence Lesion size	■ Presence or absence ■ Improvement or nonimprovement ■ 1 = complete resolution of the vocal lesions; 2 = much improvement (>50% of lesion size reduction); 3 = some improvement (<50% of lesion size reduction); 4 = no change
	Specific lesions (presence and size)	Polyp size Polyps Posterior glottic lesion Ulceration Scarring Morphological changes (tissue hyperplasia or cicatrization)	■ Complete remission; shrinkage; no change in size; enlargement ■ Present or absent ■ Present or absent ■ Noted if present ■ Present or absent ■ 0 = none; 1 = mild; 3 = moderate; 5 = severe
Pachydermia	Pachydermia	Leukoplakia	■ Present or absent
		Nodules or prenodules	■ Present or absent ■ Noted if present
		Vascular injection	■ 0 = normal; 1+ = mild; 2+ = moderate; 3+ = severe
		Pachydermia	■ Scored as none to severe; 0–4 on Likert scale
Vertical height	Vertical height difference	Posterior pachydermia	■ Present or absent
		Posterior commissure hypertrophy	■ Mild; moderate; severe; obstructing
		Vertical height difference	■ Yes or no
		Vertical height difference between the vocal folds	■ 0 = severe and 100 = none (VAS)
Vocal fold edge	Straightness	Vertical level of approximation	■ Improved or not improved ■ 1 = equal; 2 = right lower; 3 = left lower
		Vocal fold edge	■ 0 = straight; 1 = mildly bowed; 2 = moderately bowed; 3 = severely bowed
		Vocal fold edge of paralyzed side	■ 0 = straight; 1 = mildly bowing; 2 = moderately bowing; 3 = severely bowing
		Degree of vocal fold bowing	■ 1 = straight vocal fold edge; 2 = mildly bowed; 3 = moderately bowed; 4 = severely bowed
Not specified	Roughness	Muscle atrophy	■ Present or absent
		Vocal fold edge left or right	■ 1 = smooth to 5 = rough irregular
		Glottic edge irregularity	■ 0 = normal; 1+ = mild; 2+ = moderate; 3+ = severe
		Vocal fold edge	■ Improved or not improved
Vocal fold (other)	Vocal fold position	Vocal fold edge tumor side/nontumor side	■ 5-point equally appearing interval scale (0 = normal function; 5 = most abnormal finding)
		Vocal fold position	■ 0 = midline; 1 = paramedian; 2 = intermediate; 3 = lateral

Parameter (Categories)	Parameters (Terms Used)		Scales
	Vocal fold tension	Vocal fold tension	■ 1 = lateral; 2 = paramedian; 3 = near-midline
	Vocal fold size	Muscle bulk asymmetry	■ Normal; mild; moderate
Stenosis/web	Presence of stenosis or web	Stenosis Web (may be anterior microweb)	■ Present or absent
Recovery	Recovery	Recovery	■ Noted if present ■ Present or absent
			■ 1 = complete recovery (normal mucosal wave propagation with symmetric phase and amplitude); 2 = much improvement (normal mucosal wave propagation with minimal asymmetric phase or amplitude); 3 = some improvement (presence of phase asymmetry or decreased amplitude, but the mucosal wave was improved compared with baseline); 4 = no change or worse

Abbreviations: L, left; R, right; VAS, visual analog scale; v.f., vocal fold.