ORIGINAL ARTICLE

Role of Videostroboscopy and Electroglottography during Therapeutic Intervention in Voice Disorders

Sunita Singh[1], Manaswita Roy[2], NN Mathur[3]

Abstract

Aims and objectives: Videostroboscopy (VSS) and electroglottography (EGG) are widely accepted essential tools in diagnosis and management of dysphonia. Larynx can also be examined by indirect mirror, rigid, or flexible laryngoscopy, but VSS provides superior visualization and recording of the vocal fold mucosal lesions producing dysphonia. The present study was conducted in order to determine the role of VSS and EGG to analyze vocal fold lesions before and 3 months after therapeutic intervention.

Materials and methods: This was a prospective observational study conducted over a period of 1.5 years. Thirty patients were enrolled after fulfilling the inclusion criteria.

Results: This study showed that the most common etiology of benign vocal cord lesions was acute laryngitis (26.7%). Mucosal waves were normalized after intervention for both right ($n = 1$, 3.3%) and left ($n = 2$, 6.7%) true vocal cord (TVC). Complete glottic closure was seen in 93.3% ($n = 28$) cases after intervention as compared to 40% ($n = 12$) cases during initial examination ($p < 0.01$). Mean contact quotient was improved after therapeutic intervention, and the difference was statistically significant ($p = 0.015$).

Discussion and conclusion: Laryngeal lesions causing dysphonia are multifactorial. Early vocal fold lesions causing dysphonia may not be evident by conventional methods of laryngeal assessment including indirect and direct laryngoscopy. This study demonstrated that VSS and EGG provide comprehensive information regarding vocal fold pathology for both diagnosis and follow-up of patients having voice disorders.

Keywords: Contact quotient, Dysphonia, Electroglottography, Videostroboscopy.

Otorhinolaryngology Clinics: An International Journal (2021): 10.5005/jp-journals-10003-1390

Introduction

The assessment of vocal cord pathology has been revolutionized by the introduction of videostroboscopy (VSS).[1,2] It is one of the most practical tools available in ENT practice, providing information about laryngeal structure, arytenoid and vocal fold motion, mucus, vascularity, supraglottic activity, and vocal fold edges.[3] Larynx can be evaluated by indirect laryngoscopy as well as videoendoscopy in office, but VSS can alter the diagnosis in 10–47% of cases.[4] VSS involves the use of xenon light at a frequency a bit lower or higher than the vibratory movement of vocal cord. The brief on and off bursts of xenon light assess the larynx in the time interval of 1/1,000 of a second. Images captured by VSS sampled from various points across many vibratory cycles are then sequenced to provide discernible slow motion of the laryngeal structure. The symmetry, amplitude, periodicity, mucosal wave propagation, and glottal closure are evaluated. VSS provides information about vibratory status of vocal cords which facilitates comparison with previous videos and helps in the follow-up.

Electroglottography (EGG) measures efficiency of glottal closure by graphically recording contact time of vocal folds. A low-voltage, high-frequency current is passed between two electrodes. The variation in electrical impedance between electrodes which is placed on the skin over thyroid cartilage is then measured.[5] It may also provide clinically useful information when combined with laryngeal stroboscopy or other measurements of laryngeal function. The aim of the present study was to assess the videostroboscopic and electroglottographic changes before and after conservative or surgical management in patients with voice disorders.

[1,2]Department of ENT, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India

[3]Department of ENT, Lady Hardinge Medical College and Hospitals, New Delhi, India

Corresponding Author: NN Mathur, Department of ENT, Lady Hardinge Medical College and Hospitals, New Delhi, India, e-mail: drnnmathur@gmail.com

How to cite this article: Singh S, Roy M, Mathur NN. Role of Videostroboscopy and Electroglottography during Therapeutic Intervention in Voice Disorders. Int J Otorhinolaryngol Clin 2021;13(3):106–109.

Source of support: Nil

Conflict of interest: None

Materials and Methods

The present study was conducted at Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, on thirty patients between 11 and 80 years of age presenting with complaints of change in voice over a period of 1.5 years. Patients having laryngeal carcinoma stage T3/T4 or stridor or those exhibiting technical limitations prohibiting VSS were excluded from the study. It was a prospective observational study assessing benign vocal cord lesions via acoustic analysis. VSS was performed after routine ENT examination and under recorded consent. It was performed by using a 70 or 90° rigid endoscope connected to EndoSTROB E (XION GmbH, Berlin, Germany). Ten percent topical lignocaine was used to spray the larynx to eliminate the gag reflex. The patient was made to sit and was asked to protrude the tongue which was held with

a gauze piece outside the mouth. To visualize the vocal cords, the endoscope was introduced into the oropharynx and positioned asking the patient to voice sounds /i/, /a/, and /e/. The stroboscopic images seen on the screen were recorded. Following laryngeal properties during phonation were assessed:

- Mucosal wave: Extent of vocal fold tissue deformation
- Edge: Ratings of smoothness and straightness
- Phase symmetry: Rating of left-right vibratory phase symmetry
- Regularity: Rating of periodicity
- Glottal closure: Category describing shape of glottis at closure

EGG was used in assessment of vocal fold pathology by evaluating the contact quotient (CQ_{EGG}) of the vocal cords using PRAAT voice software. CQ_{EGG} is described as the relative duration of vocal fold contact during the phonatory cycle. EGG transducers (Fig. 1) were positioned on patient neck for detecting variation in electrical impedance produced by changes in the contact area of the vocal fold during vibration. EGG signal varies in response to these fluctuations.[6] Since it is derived from transducers placed at the level of thyroid cartilage, the EGG waveform is virtually unaffected by other activities in the vocal resonance tract or by environmental noise.

Endostrob E System

The EndoSTROB E is a XION device that supports all endoscopic applications in the field of ENT. It can be integrated in DiVAS software environment including network solutions via DICOM and HL7. The DiVAS software's modular structure allows it to be scalable from a single-user solution for recording and editing patient, image, and measurement data, to a complex network solution for recording all relevant examination data produced by an advanced ENT clinic. It also facilitates connection to hospital information system (HIS) or picture archiving and communication system (PACS) or both.

Observations and Results

Thirty patients with complaints of change in voice were assessed under outpatient setting. Most common etiology of benign vocal cord lesions was acute laryngitis (26.7%). Other etiologies included chronic laryngitis (20.0%), cyst (20%), nodule (13.3%), polyp (13.3%, Fig. 2), and growth (6.7%). No difference was observed among males and females with respect to type of benign vocal cord lesions.

Fig. 1: Transducers of electroglottography (EGG)

Conservative management was employed in all the cases of acute and chronic laryngitis, while microscopic laryngeal surgery (MLS) was done in cases with cyst, nodule, polyp, and growth.

Mucosal wave change was assessed before and after intervention for right as well as left true vocal cord (TVC) for all the patients. Reduced mucosal vibration was observed in both right (n = 20, 66.7%) and left (n = 17, 56.7%) TVC before intervention. Mucosal vibration was normalized after intervention for both right (n = 1, 3.3%) and left (n = 2, 6.7%) TVC (Table 1).

Edges of both TVC were assessed whether they were rough or smooth. It was found that in most cases, edges were smooth for both right (n = 19, 63.3%) and left (n = 21, 70%) TVC during diagnosis. After intervention also, the edges remained smooth for most of the cases (Table 1).

Complete glottic closure was seen in 93.3% (n = 28) cases after intervention as compared to 40% (n = 12) cases during initial examination (p <0.01) (Table 2).

Phase symmetry was found to be present in 43.3% (n = 13) cases at presentation, whereas it was found to be present in 86.6% (n = 26) cases after intervention (p <0.01) (Table 2).

It was also analyzed if vocal fold contraction was regular or irregular. It was found to be regular in 66.7% (n = 20) before intervention. After intervention, it was found regular in all patients (n = 30, 100%) (Table 2).

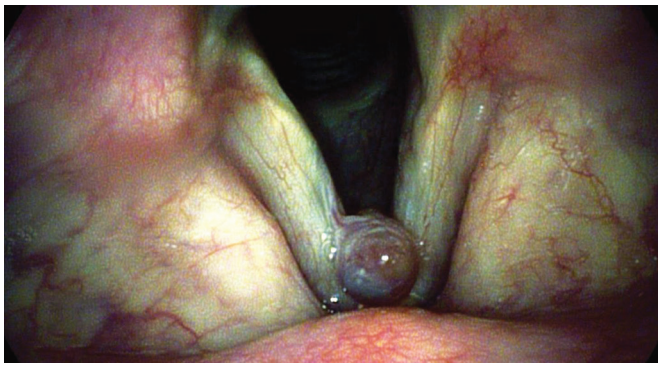

Fig. 2: Vocal cord polyp

Table 1: Mucosal wave and edges of true vocal cord (TVC) before and after intervention

	Right TVC				*Left TVC*			
	Before intervention		*After intervention*		*Before intervention*		*After intervention*	
Mucosal wave of TVC	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Cannot rate	0	0.0	2	6.7	3	10.0	3	10.0
Decreased	20	66.7	1	3.3	17	56.7	2	6.7
Normal	10	33.3	27	90.0	10	33.3	25	83.3
Total	30	100.0	30	100.0	30	100	30	100
		p <0.01				p <0.01		
Edges of TVC								
Cannot rate	0	0	0	0	1	3.3	0	0.0
Rough	11	36.7	1	3.3	8	26.7	2	6.7
Smooth	19	63.3	29	96.7	21	70.0	28	93.3
Total	30	100.0	30	100.0	30	100.0	30	100
		p <0.01				p <0.01		

Table 2: Vocal cord assessment before and after intervention

		Before intervention		*After intervention*		
Assessment of vocal cord		*n*	*%*	*n*	*%*	*p value*
Glottic closure	Cannot rate	6	20.0	0	0.0	**<0.01**
	Complete	12	40.0	28	93.3	
	Incomplete	12	40.0	2	6.7	
Phase symmetry	Cannot rate	2	6.7	2	6.7	**<0.01**
	Cannot rate	13	43.3	26	86.6	
	Asymmetrical	15	50.0	2	6.7	
Regularity	Cannot rate	3	10.0	0	0.0	**<0.01**
	Irregular	7	23.3	0	0	
	Regular	20	66.7	30	100	

Table 3: Pre- and postintervention mean changes in contact quotient

Contact quotient	*N*	*Mean*	*SD*	*p value*
Preintervention	30	0.43	0.09	**0.015**
Postintervention	30	0.47	0.05	

Mean contact quotient at presentation was 0.43 which increased to 0.47 after intervention. The difference was statistically significant ($p = 0.015$) (Table 3).

Discussion

Examination of the larynx is an essential component in the evaluation and management of patients with voice disorder. There are various commonly available approaches which include indirect laryngoscopy using a mirror, flexible, and rigid endoscopy for examination of larynx under outpatient setting.[4] The diagnostic accuracy of history and physical examination, excluding laryngoscopy, in patients with dysphonia is only 5% in comparison to 68.3% accuracy following an initial endoscopic laryngeal evaluation.[4] There are various newly discovered imaging techniques available for assessing mucosal wave patterns of TVC. Videokymography (VKG) gives qualitative and quantitative description of periodic and aperiodic vocal fold vibration and mucosal wave pattern. High-speed digital imaging (HSDI) also describes detailed visualization and quantification of periodic and aperiodic vocal fold vibration and mucosal wave pattern with the help of digital kymography (DKG).[5,6]

VSS is one of the practical techniques available for imaging vibration of normal and benign vocal fold lesions.[7] Stroboscopy was introduced to the modern practice of laryngology by Oertel in 1878 to examine larynx by using pulsatile light generating device with a laryngeal mirror.[8] There is well-documented evidence in literature for recommendation of videostroboscopy in order to evaluate both general hoarseness and organic vocal cord lesions.[9–11]

The prevalence of dysphonia with cardinal symptom of hoarseness is around 1% among patients in general and approximately 30% in a lifetime.[12,13] This study compared vocal cord lesions before and after therapeutic intervention using VSS and EGG as assessment tools. This study showed that maximum cases of dysphonia were suffering from acute laryngitis ($n = 8$; 26.7%) among both males and females. Apart from acute and chronic laryngitis, this study analyzed vocal fold lesions such as cyst ($n = 6$; 47.5%), nodule ($n = 4$; 25.0%), polyp ($n = 4$; 25.0%), and growth ($n = 2$; 12.5%). Patients suffering from acute and chronic laryngitis were managed conservatively, whereas the rest of the patients underwent MLS. Cohen et al. demonstrated that the maximum number of patients suffering from dysphonia was found to have acute laryngitis (42%).[12] A demographic analysis and videostroboscopic assessment was done by Banjara et al. in 112 cases of different vocal pathology. Cases with benign vocal fold pathology constituted 35.71% of all 112 cases. Organic voice disorder in decreasing order of occurrence was vocal nodule, cancer, cyst, palsy, chronic laryngitis, polyp, bowing, sulcus vocalis, abductor palsy, acute laryngitis, leukoplakia, congestion, scarring, papilloma, reflux laryngitis, and rhinosporidiosis.[14] Benign vocal fold lesions, such as vocal nodule, polyp, and cyst, cause significant dysphonia as they disrupt the normal vocal cord vibratory function.[15]

Mucosal wave in stroboscopic analysis is defined as deformation along the lateral plane during the opening phase of vocal fold vibration. The study conducted by Powel et al. found statistically significant differences in the vocal fold mucosal wave before and after surgery by using simulated stroboscopy ($p < 0.001$).[16] This study also demonstrated that after intervention, the cases with normal mucosal wave increased from 33.3 to 90% ($p < 0.01$) for right vocal fold and 33.3–83.3% ($p < 0.01$) for left vocal fold as per images shown by VSS.

The current study also demonstrated vocal fold whether it was smooth or rough for both the cords separately. A regular or smooth vocal fold edge is straight with a sharp superior edge. Irregular vocal fold edge can be categorized as mild, moderate, or severe. Mildly irregular vocal fold edge may be rounded or mildly swollen. There may be complete glottal closure or a small anterior or posterior glottal gap. If a vocal fold edge is clearly nonlinear without impeding the vibratory function of the contralateral fold, it suggests a moderately irregular vocal fold. Glottal closure may form hourglass configuration. The severely irregular vocal fold edge is nonlinear with a large protrusion or multiple areas of irregularity and also impedes the vibratory function of the contralateral fold.[16]

There was significant improvement of vocal fold edges before and after intervention as shown by both VSS and simulated stroboscopy ($p < 0.001$) as per study done by Powel et al.[16] Similarly, the images of VSS in the present study demonstrated increased smoothness of vocal fold edges from 63.3 to 96.7% ($p < 0.01$) for right TVC and 70–93.3% ($p < 0.01$) for left TVC after intervention.

Complete glottic closure was found to be in 93.3% ($n = 28$) of patients after intervention as per the images recorded by VSS in our study though, in 20% cases, it could not be rated before intervention. Similarly, a study done by Banjara et al. showed that glottic closure could not be rated among 19.6% ($n = 22$) of cases, which is comparable to the present study. It is advocated that glottic closure could not be rated due to obstruction of supraglottic structure during phonation.[14]

Vocal fold symmetry is said to be present when maximal amplitude of right and left vocal cord is present when they are at the midline.[16] The asymmetry of the vocal cord can be mild, moderate or severe depending upon differences of amplitude of right and left vocal cord during vocal cord cycle. According to study conducted by Powell et al., right-left phase asymmetry improved after surgery as demonstrated on videostroboscopy ($p < 0.004$). Similarly, according to the present study, there was significant improvement of left-right vibratory phase symmetry which was seen in 43.3% cases at presentation, converted to 86.7% after intervention ($p < 0.01$). Vocal fold asymmetry is found if there is any

mass, tension, elasticity, or neurological involvement. Regularity describes the degree of similarity of time taken to complete each phonatory cycle to the time taken to complete the next cycle.[3] In the current study, regularity of contraction, which was found to be present in 66.67% ($n = 20$) of patients at presentation, improved to 100% after intervention ($p < 0.01$).

EGG is a noninvasive method of monitoring the movement of the vocal folds by measuring the variation of the impedance to a weak alternating current through the tissues of the neck.[17] It provides a relative measure of the contact area between the two vocal cords.[18] Dysphonia due to vocal fold lesions is usually associated with irregularity of EGG signal. It is hypothesized that these irregularities arise from intrinsic nonlinearity of vocal system and have been thoroughly examined by the theories of nonlinear dynamics. It is possible to quantitatively describe the regular and irregular dynamics of the vocal folds, such as asymmetric vocal folds and polyps, using nonlinear dynamic methods.[19] Contact quotient (CQ) is a ratio which illustrates the duration of vocal fold contact during one vocal fold period.[20] In the present study, the preintervention mean CQ, which was 0.43 (SD = 0.09), increased to 0.47 after the treatment (SD = 0.05), and the difference is statistically significant ($p = 0.015$).

Conclusion

The changes of electroglottographic parameters correlate with irregularity of EGG signal. The present study analyzed the role of VSS and EGG to compare vocal fold lesions causing dysphonia before and after intervention. It showed significant improvement in mucosal alterations after intervention as diagnosed by both VSS and EGG. VSS was not limited by bandwidth or memory that restricts recording length. It also showed the simulated slow-motion movement of the vocal fold in real time during capture, offering superior spatial resolution which provided better visualization of mucosal waves.[16] In conclusion, the current study demonstrated that both VSS and EGG are highly significant and essential methods for diagnosing and monitoring vocal fold mucosal abnormality.

Orcid

Manaswita Roy https://orcid.org/0000-0003-1786-7164

References

1. Mehta D, Hillman R. Voice assessment: updates on perceptual, acoustic, aerodynamic, and endoscopic imaging methods. Curr Opin Otolaryngol Head Neck Surg 2008;16(3):211–215. DOI: 10.1097/MOO.0b013e3282fe96ce.
2. Bastian RW, Levine LA. Visual methods for the office diagnosis of voice disorders. Ear Nose Throat J 1988;67(5):363–379. PMID: 3046918.
3. Flint P, Flint P, Cummings C. Cummings otolaryngology head and neck surgery. 7th ed. Canada: Elsevier; 2020. 3126 p.
4. Cohen S, Thomas S, Roy N, et al. Frequency and factors associated with use of videolaryngostroboscopy in voice disorder assessment. Laryngoscope 2014;124(9):2118–2124. DOI: 10.1002/lary.24688.
5. Krausert C, Olszewski A, Taylor L, et al. Mucosal wave measurement and visualization techniques. J Voice 2011;25(4):395–405. DOI: 10.1016/j.jvoice.2010.02.001.
6. Awan S, Krauss A, Herbst C. An examination of the relationship between electroglottographic contact quotient, electroglottographic decontacting phase profile, and acoustical spectral moments. J Voice 2015;29(5):519–529. DOI: 10.1016/j.jvoice.2014.10.016.
7. Popolo P, Titze I. Qualification of a quantitative laryngeal imaging system using videostroboscopy and videokymography. Ann Otol Rhinol Laryngol 2008;117(6):404–412. DOI: 10.1177/000348940811700602.
8. Fried MP, editor. The larynx: a multidisciplinary approach. Mosby Incorporated; 1996.
9. Sulica L. Hoarseness. Arch Otolaryngol Head Neck Surg 2011;137(6):616. DOI: 10.1001/archoto.2011.80.
10. Schwartz S, Cohen S, Dailey S, et al. Clinical practice guideline: hoarseness (dysphonia). Otolaryngol Head Neck Surg 2009;141(1_suppl):1–31. DOI: 10.1016/j.otohns.2009.06.744.
11. Rosen C, Gartner-Schmidt J, Hathaway B, et al. A nomenclature paradigm for benign midmembranous vocal fold lesions. Laryngoscope 2012;122(6):1335–1341. DOI: 10.1002/lary.22421.
12. Cohen S, Kim J, Roy N, et al. Prevalence and causes of dysphonia in a large treatment seeking population. Laryngoscope 2012;122(2):343–348. DOI: 10.1002/lary.22426.
13. Roy N, Merrill R, Gray S, et al. Voice disorders in the general population: prevalence, risk factors, and occupational impact. Laryngoscope 2005;115(11):1988–1995. DOI: 10.1097/01.mlg.0000179174.32345.41.
14. Banjara H, Mungutwar V, Singh D, et al. Demographic and videostroboscopic assessment of vocal pathologies. Indian J Otolaryngol Head Neck Surg 2012;64(2):150–157. DOI: 10.1007/s12070-011-0451-z.
15. Thomas G, Mathews S, Chrysolyte S, et al. Outcome analysis of benign vocal cord lesions by videostroboscopy, acoustic analysis and voice handicap index. Indian J Otolaryngol Head Neck Surg 2007;59(4):336–340. DOI: 10.1007/s12070-007-0096-0.
16. Powell M, Deliyski D, Hillman R, et al. Comparison of videostroboscopy to stroboscopy derived from high-speed videoendoscopy for evaluating patients with vocal fold mass lesions. Am J Speech Lang Pathol 2016;25(4):576–589. DOI: 10.1044/2016_AJSLP-15-0050.
17. Nieto A, Cobeta I, Kitzing P. La electroglotografía en la investigación y la clínica laríngea [Electroglottography in the research and physiology of larynx]. Acta Otorrinolaringol Esp 1993;44(4):257–263 [Spanish]. PMID: 8217266.
18. Selamtzis A. Electroglottographic analysis of phonatory dynamics and states [Licentiate dissertation] [Stockholm]; 2014. (TRITA-CSC-A). Available from: http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-145692.
19. Nacci A, Romeo SO, Cavaliere MD, et al. Comparison of electroglottographic variability index in euphonic and pathological voice. Acta Otorhinolaryngol Ital 2019;39(6):381–388. DOI: 10.14639/0392-100X-2127.
20. Kankare E, Laukkanen A-M, Ilomäki I, et al. Electroglottographic contact quotient in different phonation types using different amplitude threshold levels. Logoped Phoniatr Vocol 2012;37(3):127–132. DOI: 10.3109/14015439.2012.664656.