Acoustic Analysis of Voice and Electroglottography in Patients With Laryngopharyngeal Reflux

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Summary: Background. Laryngopharyngeal reflux (LPR) refers to the flow of gastric acid content into the laryngopharynx. It has been reported that 10% of the patients consulting an otolaryngologist present with this condition. Signs of LPR can be identified during flexible or rigid laryngoscopy. The Voice Handicap Index (VHI) is a reliable tool for detecting the impact of voice disorders, and acoustic assessment of voice including acoustic analysis of voice (AAV) and electroglottography (EGG) provide objective data of voice production and voice disorders.

Objective. This study aimed to describe changes in AAV, EGG, and VHI in patients who present with LPR compared with a matched control group of healthy subjects.

Materials and Methods. Seventeen patients with LPR were studied. A group of healthy subjects matched by age and gender without any history of voice disorder, LPR, or gastroesophageal reflux disease was assembled. Both groups of patients were studied by VHI, flexible laryngoscopy, AAV, and EGG.

Results. All patients with LPR demonstrated abnormal VHI values. Shimmer, jitter, open quotient, and irregularity were significantly increased in the patients with LPR. Nonsignificant correlations were found between VHI scores and abnormal acoustic parameters in patients with LPR.

Conclusions. Although abnormal acoustic parameters of patients with LPR were not predictive of the overall VHI score, the abnormal acoustic parameters of patients with LPR suggest a decrease in adequate laryngeal control during phonation.

Key Words: Gastroesophageal reflux disease (GERD)–Laryngopharyngeal reflux (LPR)–Acoustics–Voice–Therapy.

INTRODUCTION

Laryngopharyngeal reflux (LPR) refers to the retrograde flow of gastric acid content, including enzymes such as pepsin, into the laryngopharynx.[1,2] LPR was described by Koufman et al in 1988[1] as a pathologic condition associated with gastroesophageal reflux disease (GERD). These authors reported that patients with LPR seemed to have a different pathophysiological mechanism, reflux patterns, symptomatology, and response to treatment compared with patients with GERD.

Patients with LPR present with laryngeal pathology as a consequence of small reflux amounts as they stand in an upright position during most of the day. In contrast, patients with GERD present with reflux in a supine position, preferably during the night and with a longer exposure time.[3] The laryngeal epithelium is more susceptible to be affected by acid gastric content compared with the esophageal epithelium. It has been reported that even only three episodes of LPR with a pH <4 in a week are enough to cause significant damage, whereas GERD requires 50 weekly episodes for producing some degree of damage.[2]

Symptoms of LPR are variable and there is no pathognomonic feature. The most common complaints include hoarseness, vocal fatigue, globus or sensation of a foreign body in the throat, dysphagia, cough, constant throat clearing, and sore throat. All these symptoms are usually chronic and occur intermittently.[2,4]

LPR is an important health problem, and it has been reported that 10% of the patients who are consulting an otolaryngologist present with this condition.[5] Moreover, Koufman et al[6] described that over 50% of patients with dysphonia present with some signs of underlying LPR.

Signs of LPR can be identified during flexible or rigid laryngoscopy. Belafsky et al[7] described the reflux finding score (RFS) which is a scale of severity graded according to laryngoscopy findings, including eight clinical items ranging from 0 (no abnormal findings) to a maximum of 26 (Table 1). A score >7 indicates LPR with a 95% confidence.[7]

The Voice Handicap Index (VHI) is a questionnaire developed by Jacobson et al in 1997[8] to quantify the perceived impact by an individual affected by a voice disorder, addressing aspects such as voice functionality, emotions. and physical capacity in relation to dysphonia. The questionnaire includes 30 items organized in 3 groups, uniformly distributed in 3 domains: functional, physical, and emotional. VHI has been extensively validated as a useful tool for classifying the severity of a voice disorder.[9] The questionnaire was adapted to the Spanish Language by Nuñez-Batalla et al in 2007.[10] The Spanish version of the VHI was validated in 2010.[11]

The acoustic analysis of voice (AAV) provides hard data about voice. The most commonly used acoustic parameters for clinical assessment includes fundamental frequency (f0), shimmer, and jitter. Perceptual pitch is the perceptual correlate of f0 which is determined by the rate of vocal fold vibration, and it is measured in cycles per second or hertz. The frequency of a speaker's voice will vary from one cycle to the next. The random period variability is the frequency perturbation or vocal jitter. Vocal shimmer is similar to the frequency perturbation but it is analogous to amplitude.[11]

The electroglottography (EGG) provides data about the vibratory pattern of the vocal folds. EGG has the advantage of assessing the glottal wave by placing electrodes on the thyroid cartilage, avoiding interference of the supraglottal activity or

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TABLE 1.
Reflux Finding Score by Belafsky et al[7]

Reflux Finding Score		
Subglottic edema	0	Absent
	2	Present
Ventricular obliteration	2	Partial
	4	Complete
Erythema/hyperemia	2	Arytenoids only
	4	Diffuse
Vocal fold edema	1	Mild
	2	Moderate
	3	Severe
	4	Polypoid
Diffuse laryngeal edema	1	Mild
	2	Moderate
	3	Severe
	4	Obstructing
Posterior commissure hypertrophy	1	Mild
	2	Moderate
	3	Severe
	4	Obstructing
Granuloma/granulation tissue	0	Absent
	2	Present
Thick endolaryngeal mucus	0	Absent
	2	Present

background noise because the glottal vibrations are captured directly adjacent to the glottis. EGG analysis focuses on the glottic cycle. The procedure can provide similar acoustic parameters as provided by AAV, including f0, shimmer, and jitter, as well as additional parameters, such as open quotient (OQ), which can be defined as the relation between the duration of the opening phase in a complete glottic cycle, and the contact quotient (CQ), which is an indicator of the closing phase of the vocal folds. A decrease in mean CQ suggests a glottal insufficiency, whereas an increase in this quotient suggests a hyperfunctional glottis.[12,13] An increased CQ can also reflect an increased mass of the vocal fold(s).

The purpose of this paper is to describe changes in AAV, EGG, and VHI in patients presenting with LPR as diagnosed by Belafsky's RFS compared with a matched control group of healthy subjects without any history of voice disorder, GERD, or LPR.

MATERIALS AND METHODS

This study was carried out at the Division of Phoniatrics of the National Institute of Rehabilitation in Mexico City.

Sample size was calculated for one sample study with a confidence interval (CI) of 95% and beta power of 80%, and the prevalence of voice disorders in patients with suspected LPR in 2 previous years at the institute's Division of Phoniatrics was considered. According to the calculations, a minimum of 17 patients should be included in the study group.

All patients with a clinical history of dysphonia and suggestive of LPR from January to October 2016 were studied. Patients with a history of cigarette smoking or chronic contact with irritant inhalant substances were excluded. A routine flexible videonasolaryngoscopy was performed and patients who demonstrated scores >7 of the RFS, without any other additional laryngeal abnormality such as polyps, cysts, or nodules, and with adequate mobility of vocal folds were selected. The study protocol was carefully explained to all selected patients, including the procedures that would be performed, and they were asked to sign an informed consent. Seventeen patients (10 women and 7 men) were recruited in the period of time mentioned herein. They all accepted to participate in the study. The mean age of the patients was 29.06 years; standard deviation = 5.43 and a range of 18–40 years of age.

A control group of 17 volunteer healthy subjects without any history of voice disorder, no history of cigarette smoking, and no history of chronic contact with irritant inhalant substances, GERD, or LPR was assembled. The healthy subjects were matched by age and gender to the patients included in the active group. These subjects were recruited from applicants to a course in Vocal Care offered by a private center for voice care in Mexico City. The applicants were not vocal performers. They were just interested in taking the course for voice care. The research project was carefully and personally explained to each applicant, and a free clinical voice assessment including VHI and a videonasolaryngoscopy was offered. If the results of these diagnostic markers indicated no data of LPR or any voice disorder, then the subject was asked to volunteer for participating in the study. Ten women and seven men were matched with the patients, and they were included in the control group. All subjects signed an informed consent. None of the subjects who were invited to participate as volunteer subjects refused to participate in the study.

VHI scores were obtained for all patients. All 17 healthy subjects showed a VHI of 0.

All patients and subjects underwent AAV in a first recording session. This session was performed immediately after the videonasolaryngoscopy, and these procedures were always scheduled in the morning. A vertical net sound (Layer spacing) microphone (Sound Level Meter Microphone Real SPL, IEC 651, Type II for *Lingwaves voice analyzer software*, WEVOSYS, Forchheim, Germany) was placed in direct alignment with the oral commissure at a 10-cm distance from the lips. The subjects or patients were requested to phonate a sustained /a/ phoneme as steady as possible in their natural pitch. The intensity of the phonation was controlled by directly instructing the patient to phonate without increasing loudness of their voice. The phoneme should be held for at least 4 seconds in a modal registry. Only the most homogeneous samples were selected for further analyses. f0 (Hz), shimmer, and jitter (%) values were used for comparing both groups.

Following the AAV recording session, all patients and subjects underwent EGG. A laryngograph Microprocessor EGG-A-100 (Laryngograph Ltd., London, UK) was used for EGG recordings. Two gold plated electrodes were placed around the neck over the anterior aspect of the thyroid cartilage. A Velcro fastener was used to keep the electrodes in place. As for the AAV recording, subjects and patients were requested to phonate a sustained /a/ phoneme as steady as possible in their natural pitch. The intensity of the phonation was controlled and the phoneme