Clinical Assessment of Glottal Insufficiency in Age-related Dysphonia

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Summary: Objectives. Incomplete glottal closure is one of the key clinical aspects of presbylarynx. The objective of the present study is to determine the diagnostic yield of several tests for the assessment of glottal competence in age-related dysphonia.

Study Design. Cross-sectional prospective.

Methods. One hundred and four healthy patients 65 years and older with a maximum phonation time below 12 seconds for women and 15 seconds for men were included. The glottal closure was assessed with laryngostroboscopy, and this observation was used as gold standard. Continuous light endoscopy, s/z ratio, electroglottography, and aerodynamic analysis of voice were performed, and their accuracy parameters for the diagnosis of the glottal gap in this context were calculated.

Results. A spindle-shaped gap was observed in 47 cases. Sensitivity of vocal fold bowing to predict glottal gap in phonation was 93.6% with a negative likelihood ratio of 0.15. Specificity of s/z ratio was 91.4% with a positive likelihood ratio of 6.17. Electroglottography and aerodynamic measurements of voice resulted to be inaccurate for the diagnosis of glottal insufficiency in phonation.

Conclusions. Conventional endoscopy and s/z ratio are good diagnostic tests for an initial assessment of glottal insufficiency in age-related dysphonia that would allow general otolaryngologists early identification and prompt treatment of this pathology.

Key Words: Presbyphonia–Presbylarynx–Vocal aging–Vocal atrophy–Glottal gap.

INTRODUCTION

Population aging is one of the challenges that worldwide healthcare systems face in the 21st century. As the population older than 65 years gradually increases, a parallel trend in the number of elderly patients seeking medical attention for voice problems has been reported.[1,2]

Several characteristics define an aging voice, such as acoustic changes, reduction in phonation times, or tremor, which are ultimately related to the anatomical and physiological changes that happen in the voice production organs.[3–5] The diagnostic protocol for the age-related dysphonia should assess laryngeal function, as incomplete glottal closure in phonation due to vocal atrophy is thought to be one of its main pathogenic mechanisms,[3,6] but clinicians should also rule out other frequent organic and functional pathologies before establishing the diagnosis of presbyphonia.[4,7]

Among the diagnostic tools for the evaluation of glottal competence in presbylarynx, laryngostroboscopy has become the standard method based on its simplicity and reliability.[8,9] However, stroboscopy is not available at most general otolaryngology offices, and many elderly patients have to be referred to a voice clinic for diagnosis, which could become a problem considering current population trends. Furthermore, the frequent mobility problems and low economic resources of elderly individuals demand the design of more efficient management protocols for their age-related pathologies, relying on their primary or secondary care units whenever possible.[10,11]

The final purpose of the present study is to improve the diagnostic protocol of the aging voice by investigating the accuracy of several tools that are available to both the general otolaryngologist and the voice specialist for the evaluation of the glottal gap. Using laryngostroboscopy as the gold standard, the diagnostic parameters of s/z ratio, continuous light endoscopy, electroglottography, and aerodynamic analysis of the voice were studied, and their clinical applicability for the assessment of this pathology was discussed.

METHODS

The project was approved by the Hospital Ramón y Cajal Ethics Committee. A prospective study was conducted on healthy patients 65 years and older who consulted in our otolaryngology department from 2010 to 2013.

Short maximum phonation time (MPT) was chosen over other clinical manifestations of presbyphonia for the selection of patients, as it is related to the presence of a glottal gap as well as other pathogenic mechanisms,[12,13] thereby providing a proper sample from where to determine the accuracy of the diagnostic tools for glottal insufficiency. Elderly subjects with an MPT ≤15 seconds for men and ≤12 seconds for women were included in the study. These values of MPT are our usual limit for voice therapy referral in presbyphonia, and are well below the normative ranges for elderly men (20–26 seconds) and women (18–24 seconds).[12] To avoid the influence of other comorbidities, patients with a history of any neurological, respiratory, or laryngeal conditions were excluded.

Glottic insufficiency was assessed by using a digital flexible laryngostroboscope Olympus OTV (Olympus Medical

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Systems, Tokyo, Japan) with ATMOS Endo-Stroboscope L light source (ATMOS MedizinTechnik GmbH & Co., Lenzkirch, Germany).Patients were asked to phonate a sustained vowel (/e/) at a comfortable pitch and intensity (below 70 dB). Subjects with a spindle-shaped glottic gap were defined as having glottic insufficiency for the purposes of the study.[3,6,8] The result of this observation was considered as the gold standard for the analysis.

A conventional flexible endoscopy under continuous light was performed to evaluate the morphological aspects of the senile larynx. These are different between sexes, and include vocal bowing, prominence of the vocal processes, and edema of the vocal folds.[3,5,14] Among these anatomical changes, the presence of vocal fold bowing was chosen for analysis as it has been related to a glottal gap in phonation.[3,6,8] The endoscopies were performed by one of the investigators, and a patient was judged to have such a clinical feature when the free edges of his vocal folds assumed a bowed configuration while rest breathing.[14]

To determine s/z ratio, patients were asked to complete at least three maximum phonation trials for both phonemes at a comfortable loudness (below 70 dB), and the best trials were used for calculation.[15] As many Spanish speakers experience trouble when they phonate a sustained /z/, this phoneme was substituted with the vowel /e/, which is a voiced vowel that involves similar production mechanisms in the Spanish language.[16,17] For the analysis, the results of this determination were considered normal if the ratio was smaller or equal to 1.3, and the results were suggestive of a glottal gap if the ratio was greater than 1.3, which is the usual clinical limit for Spanish speakers.[16]

Electroglottography was performed by using a KayPENTAX 6103 electroglottograph (KayPENTAX, Montvale, NJ). Patients were asked to phonate a sustained /e/ at the modal registry. Contact quotient (CQ) was computed by using 30% of the peak amplitude as a baseline,[18] and was considered to be suggestive of glottal insufficiency if it was below 43%. This threshold value is our clinical limit for the interpretation of CQ, and it is based on a preliminary normalization study that we conducted on normal populations.

Aerodynamic analysis of the voice was performed by using the voice efficiency protocol of the KayPENTAX PAS 6600 (KayPENTAX, Montvale, NJ). It is based on the simultaneous record of sound pressure, airflow, and air pressure during phonation.[19,20] The following parameters of interest for the assessment of glottic insufficiency were calculated: mean airflow during voicing, mean peak air pressure, and aerodynamic efficiency. The results were considered suggestive of a glottal gap if peak air pressure or aerodynamic efficiency were below the provided normative values for elderly populations, and if airflow during voicing was above the reference values.[19] Each parameter was studied separately and the results were classified according to the normative range for the patients' gender.

Contingency tables were created for each diagnostic test considering their results for the estimation of the glottal gap in phonation (positive or negative) and the results of the stroboscopy as the gold standard. Afterward, the measures of diagnostic accuracy of each test were calculated using *SPSS Statistics* 17 (SPSS Inc, Chicago, IL). In this particular scenario, sensitivity is an estimate of a test's ability to correctly detect a glottal gap when it is really present, and specificity is a test's ability to correctly detect patients without a glottal gap in phonation. Likelihood ratios provide an estimate of the post-test probability of having a condition. Positive likelihood ratio is calculated by *sensitivity/(1 − specificity)*, and indicates how much the probability of having a glottal gap will increase if a test is positive. Negative likelihood ratio is calculated by *(1 − sensitivity)/specificity*, and indicates how much the probability of having a glottal gap will decrease if a test is negative.[21]

RESULTS

One hundred and four subjects who complied with the selection criteria were included. There were 68 women and 36 men with a mean age of 75 years for both sexes (range from 65 to 93). Mean MPT in the sample was 11 seconds for men and 10 seconds for women.

Laryngostroboscopy was performed on all patients, revealing a spindle-shaped glottal gap during phonation in 47 subjects (17 men and 30 women). As explained above, this observation was considered to be the gold standard for analysis.

In the endoscopic examination under conventional light, vocal fold bowing while rest breathing was found in 74% of the subjects. The accuracy of this observation as a predictor for glottal insufficiency is shown in Table 1.

The s/z ratio had a mean value of 1.13, and the values ranged from 0.7 to 2.56. Based on the established clinical limits for this parameter, 29% of the patients presented a ratio that was suggestive of a glottal gap. The s/z ratio resulted in a highly specific test for the evaluation of the glottal gap, as shown in Table 1.

TABLE 1.
Measures of Diagnostic Accuracy for Each Test and Their 95% Confidence Intervals

	Criteria for Positive Test	SN *(95% CI)*	SP *(95% CI)*	LR+ *(95% CI)*	LR– *(95% CI)*
Vocal bowing	Present	93.6% *(82%–98%)*	41.4% *(30%–54%)*	1.6 *(1.27–2.01)*	0.15 *(0.05–0.48)*
s/z ratio	>1.3	53.2% *(39%–66%)*	91.4% *(81%–97%)*	6.17 *(2.56–14.87)*	0.51 *(0.37–0.7)*
CQ	<43%	67.5% *(52%–80%)*	17.5% *(10%–30%)*	0.82 *(0.64–1.05)*	1.85 *(0.9–3.8)*
PAP (cm H_2O)	♂ < 5.23 ♀ < 4.25	2.1% *(0%–12%)*	94.8% *(85%–99%)*	0.41 *(0.04–3.83)*	1.03 *(0.96–1.11)*
AF (l/s)	♂ > 0.29 ♀ > 0.19	12.8% *(6%–26%)*	93.1% *(83%–98%)*	1.85 *(0.56–6.18)*	0.94 *(0.82–1.07)*
AE (ppm)	♂ < 23.01 ♀ < 35.03	14.9% *(7%–28%)*	96.6% *(87%–99%)*	4.32 *(0.94–19.82)*	0.88 *(0.77–0.99)*

Abbreviations: AE, aerodynamic efficiency; AF, airflow during voicing; CQ, contact quotient; LR+, positive likelihood ratio; LR–, negative likelihood ratio; PAP, peak air pressure; SN, sensitivity; SP, specificity.