Letters to the Editor

Voice Analysis Revisited

To the Editor.—The article on voice analysis by Berke et al[1] in the January 1989 issue of the ARCHIVES emphasizes the use of inexpensive computer systems to aid in clinical applications of assessment of voice quality. I would like the authors to respond to the following points.

First, is the trace depicted as a photoglottogram (PGG) in Fig 4 that of an electroglottogram (EGG) and vice versa, for the text description does not relate to the figure shown. Second, that the opening and closing slopes of a PGG are comparatively symmetric in the computer signal derived from a normal male subject is acceptable. However, this so-called symmetry can also be seen in the trace obtained from a patient with recurrent laryngeal nerve paralysis. Also, the authors have not indicated what symmetry stands for. Is it the rise and fall times of each of the upgoing and downgoing segments of each PGG-derived trace, or is it the length of each segment? How can one derive information from such deductions? Is it better to evolve tangents (angle of slope with reference to the horizontal) for normal and abnormal traces and compute the SD of the tangents for each of these to serve as a reference for comparison? This criterion can also be used to indicate progress made during the recovery process as an objective shift from abnormal to normal. Third, the shift to the left in the PGG peak observed in their Fig 4 with respect to the plateau of the EGG signal could be relative if the duration of the plateau itself is longer than that shown in Fig 2. Are the lengths of the plateaus of the EGG in Fig 4 identical to those in Fig 2? The shift seen in the PGG peak could vary as a result of variations in the time scale of this reference in EGG plateau.

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1. Berke GS, Hagnson DG, Trapp TK, Moore DM, Gerratt BR, Natividad M. Office-based systems for voice analysis. *Arch Otolaryngol Head Neck Surg.* 1989;115:74-77.

In Reply.—The UCLA/Wadsworth Veterans Administration Laryngeal Physiology Laboratory published an article in the January 1989 issue of the ARCHIVES[1] pointing out that relatively inexpensive computer systems could be adapted for the objective assessment of voice. In so doing, we tried to present a general overview of the types of analyses available to users of such a system. Further specific information regarding how our system operates could be found in the references. As such, most of the issues brought forth by Rao's letter have been previously discussed in other publications. However, some readers may lack access to some of the articles listed, therefore we would like to address Dr Rao's concerns.

With regard to his first point, he is quite right that the photoglottographic (PGG) and electroglottographic (EGG) figure legends are reversed. Unfortunately, this occurred when the publisher replaced our original EGG and PGG legends with another set that was of a larger type size and more readable.

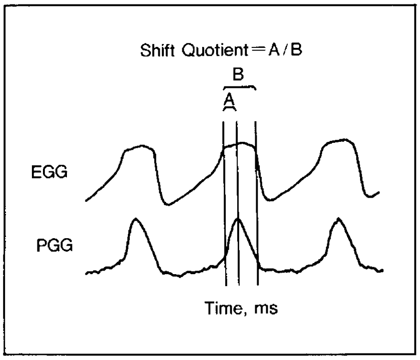
With regard to the second paragraph, we have demonstrated in previous articles that speed quotient can be used to discriminate between normal and pathologic phonation.[2] Speed quotient is defined as the ratio of glottal opening to glottal closing. Symmetric waveforms are thus defined as those in which the time from the moment the glottis opens to peak opening is the same as the time from peak opening to when the glottis finally closes (ie, speed quotient equals 1). Asymmetric waveforms are then designated as those with a speed quotient of less than, or greater than, unity. In order to calculate the speed quotient, it is necessary to identify the moments of vocal fold opening, peak opening, and vocal fold closing. Typically, this has been performed by hand marking based on an interactive examination of PGG and EGG signals. Most recently, our laboratory has compared an automated technique for calculating the speed quotient to the classic by-hand method. The automated technique calculates the speed quotient by using the computer to find the peak amplitude of the PGG signal. From this point, the computer then determines the 80th percentile down both sides of the PGG peak and uses these as the moments of opening and closing. We have additionally evaluated the 90th and 70th percentiles with this method. A Pearson's correlation matrix comparing the automated to the interactive method is shown in the Table. The results demonstrated that not only was there a high correlation among the automated speed quotient indexes but, more importantly, there was a high correlation between the automated indexes and those determined by hand picking of moments of glottal opening, peak opening, and closing. Furthermore, an additional quotient, which we have termed the *slope quotient* (defined as the peak velocity of opening over the peak velocity of closing), had a high correlation to both the automated and the hand-determined speed quotients. These high intercorrelations demonstrate that, in the absence of absolute knowledge of timing of glottal events (eg, high-speed filming), reasonable estimates of glottal opening, closing, and maximal opening using different marking criteria provide highly similar results, providing evidence of concurrent validity. These data indicate that automated or hand picking of points are not arbitrary procedures for determining waveform symmetries or speed quotients.

Our laryngeal physiology laboratory initially considered using tangents as a means to evaluate symmetry, but rejected the idea for the following reasons: (1) Tangents evolved as the angle of slope with reference to the horizontal or baseline have significant variation with signal amplitude. For example, signals with a high amplitude will have tangents with greater slope than signals with low amplitude. Although it is well accepted that relative measures from PGG signals compare quite favorably with high-speed films of glottic area,[3,4] the amplitudes of PGG signals vary greatly not only between subjects, but within the same subject. Amplitude fluctuation may occur due to patient movement, sensor move-

Pearson's Correlation Matrix

	PCT90	PCT80	PCT70	SPQ	SLQ
PCT90	1.000	...	...	...	...
PCT80	0.981	1.000	...	...	...
PCT70	0.948	0.983	1.000	...	...
SPQ	0.854	0.889	0.917	1.000	...
SLQ	−0.832	−0.824	−0.821	0.804	1.000

*Pearson's correlation matrix. PCT90, PCT80, and PCT70 are automated speed quotient indexes. SPQ and SLQ are hand-picked speed quotients.



Electroglottographic (EGG) and photoglottographic (PGG) waveforms from an in vivo canine model with phonation produced in the normal state depicting calculation of the shift quotient (ShQ).

ment, and changes in the intensity of light shining through the glottis. Therefore, measurements of waveform symmetry based on PGG amplitudes (eg, tangents) may be grossly inaccurate. (2) Furthermore, over a 5-second phonation time, baselines may deviate considerably due to laryngeal height movement and patient movement; thus, methods that rely on comparisons to wandering baselines are indeed arbitrary. For these reasons, we have rejected the use of tangents in the evaluation of PGG signals and continue to use methods for determining speed quotient and open quotient, which primarily utilize timing information.

With regard to the third paragraph, Dr Rao is quite correct in stating that the length of the EGG's plateau phase may significantly alter the relationship of the peak of the PGG to the left border of the EGG's plateau phase. It is for exactly this reason that the shift quotient is calculated as the time from the left border of the EGG signal to the peak of the PGG signal divided by the time of the entire plateau phase of the EGG signal. By so doing one removes the effect of the absolute length of the plateau phase, allowing use of the term *quotient*. An example of the shift quotient calculation is shown in the Figure.

Normally, the peak of the PGG lies at approximately the middle of the plateau phase of the EGG signal. This is because during normal vibration, maximal opening (peak of PGG) occurs at about the middle portion of time the vocal folds are not in contact (plateau phase of EGG). The peak of the PGG signal is shifted to the left in comparison with normal phonation in paralyzed states because the paralyzed flaccid fold opens simultaneously in both the horizontal and the vertical planes. Thus peak opening occurs at the time when the vocal folds are at first no longer in contact (left border of EGG plateau phase).

The authors of the "Office-Based System for Voice Analysis" are very pleased to see the widespread attention this topic has generated. In this regard, we appreciate Dr Rao's comments and hope that our discussion has elucidated those areas of concern.

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1. Berke GS, Habnson DG, Trapp TK, Moore DM, Gerratt BR, Natividad M. Office-based systems for voice analysis. *Arch Otolaryngol Head Neck Surg.* 1989;115:74-77.

2. Hanson DG, Gerratt BR, Karin RR, Berke GS. Glottographic measures of vocal fold vibration: an examination of laryngeal paralysis. *Laryngoscope.* 1988;98:541-549.

3. Baer T, Lofqvist A, McGarr N. A comparison between high-speed filming and glottographic techniques. *J Acoust Soc Am.* 1983;73:1304-1307.

4. Harden JR. Comparison of glottal area changes as measured from ultra-high-speed photographs and photoelectric glottographs. *J Speech Hear Res.* 1975;81:728-738.

Clinical Observation Regarding Laser Surgery for Early Glottic Cancer

To the Editor.—A patient, who was recently treated by us, has had a rather disturbing and puzzling course. Because he was found to have an early well-localized glottic cancer, he was treated with the carbon dioxide laser as the treatment of choice. As there is great interest in this method of treatment, I wish to call it to the attention of our readers for their interest, comments, and, in the hope that if there are similar cases, that they may be called to our attention promptly.

Report of a Case.—A 51-year-old man was found on April 6, 1987, to have a superficial lesion on the midpoint of the right membranous vocal cord. The cord was stripped at direct microscopic laryngoscopy under general anesthesia, with the resultant pathologic diagnosis of carcinoma in situ. Endoscopic surgery was advised. Five weeks later, under general anesthesia, the right vocal cord, which was somewhat erythematous but otherwise unremarkable, was decorticated with the carbon dioxide laser. By this, I mean that the mucosa of the entire membranous vocal cord from the anterior commissure back to the vocal process of the arytenoid was vaporized, carrying the resection down to, and well into, the underlying vocalis muscle. No attempt at a complete cordectomy was made, but four selected control biopsy specimens were negative for neoplasm.

Comment.—The patient did well, with a good voice, until 15 months later when some edema appeared in the posterior commissure, with a small ulceration in the interarytenoid area. The cords were reported as "clear." Direct laryngoscopy and biopsy proved the lesion to be infiltrating squamous cell carcinoma. Both membranous cords were smooth and white with full and equal mobility. There was a clinically positive lymph node in each side of his neck. He received full radiation therapy with curative intent, but now has persistent disease in his larynx and in both sides of his neck. Salvage surgery with a total laryngectomy and left-sided neck dissection, to be followed by staged right-sided neck dissection, is planned.

Was this a second primary site? Could viable cancer cells have been implanted in the posterior commissure at the time of laser surgery? Is this a particularly virulent and aggressive neoplasm that would defy all conventional therapy anyway? Have any of our readers experienced a similar case?

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Allergic Rhinitis After Tonsillectomy

To the Editor.—For the past 10 years in our clinical practice, we have come across a few patients who presented with allergic rhinitis earlier and whose symptoms became aggravated following tonsillectomy, and a few patients who had no allergic symptoms earlier but who manifested allergic rhinitis following tonsillectomy. This correlation is not described in the literature, to our knowledge. Currently we are conducting a clinical trial on adult tonsillectomy patients and are reviewing their allergic symptoms.

Due to the hot, humid, dusty weather and its frequent variable nature, there are quite a few cases of adult tonsillitis in our day-to-day practice. Allergic rhinitis is also a leading entity in this part of the world, and involves about 18% of the general population and about 33% of the cases seen in the ear, nose, and throat outpatient clinic.

Although prolonged use of antibiotic therapy for the treatment of recurrent tonsillitis in the adult was described as giving as much as two thirds of the therapeutic results in cases of tonsillitis in some clinical trials,[1] in our clinical practice, recurrent tonsillitis causes much morbidity and frequent visits. Therefore, we advise these patients to undergo tonsillectomy.

As we have mentioned earlier, fol-