Clinical Assessment of Voice

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INTRODUCTION

The focus of this paper is on ways in which computers can enhance the effectiveness and efficiency of the clinical practitioner during voice assessment and therapy. The clinicians have been slow to embrace the routine use of computer software in the delivery of clinical services to patients. The incongruity of this situation is perhaps related to the slow development of user-friendly, easy-to-use software programs that provide truly useful clinical tools for the field. But, as they say, "times are a changing" and today's practitioners can profit from the use of software that has been adapted to the needs of clinicians.

COMPUTER AND CLINICAL SOFTWARE "Dr. Speech"

An affordable and portable clinical office & lab

Computer, together with the clinical software "Dr. Speech", provides valuable assistance to the clinicians during assessment and treatment of voice disorders. Demographic information, such as the names, address, number of visits, types of disorders, progress reports, insurance claim, etc. are easy to display. When such clinical software is installed in a laptop computer, it provides the clinician with a "portable clinical office and laboratory" equipped with powerful clinical tools that easily can be carried from one treatment location to another. Recent advances in computer hardware have made possible the use of new clinical software for voice measure that only a few years ago were considered impossible or impractical due to high cost. As we knew, there are three common clinical measures in the routine voice measures. They are acoustic, Electroglottographic (EGG) and perceptual measures. All of these four measures can be done by the "Dr. Speech" software. No cumbersome boxes are needed.

Acoustic analysis provides quantitative information about the voice quality. EGG measure gives non-invasive information on the contact behavior of vocal fold vibration, especially for the close period of vocal fold vibration. Perceptual tests are more or less useful for voice quality. All or part of these measures considered together can help laryngologists and voice clinicians make a correct diagnosis of voice disorders and/or provide tools for monitoring progress in voice therapy.

The following sections will explain how these voice measures can help you in your routine clinical setting.

VOICE ASSESSMENT FROM ACOUSTIC SIGNALS

Voice Assessment software, one of the module of Dr. Speech, provides quantitative assessment of voice quality from acoustic signals. The capabilities of this software provide measures of pitch, intensity, jitter, shimmer, glottal noise, habitual pitch, histogram, statistics, spectral analysis, and so on. All of the results and graphic displays can be saved, printed and exported pdf.

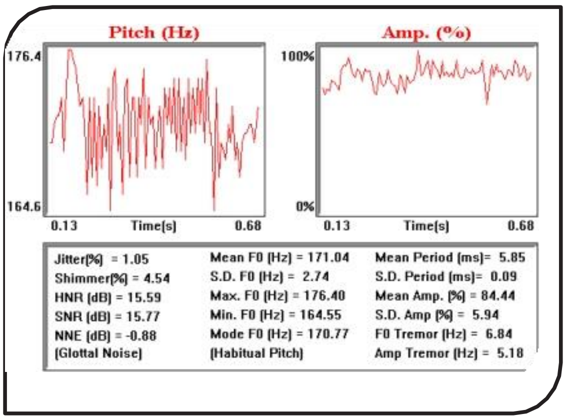
Acoustic Measure of Voice

The voice qualities are usually dependent on the five aspects of the voice signal:

- Fundamental frequency of vocal fold vibration,
- Amplitude of vocal fold vibration,
- Richness of spectral harmonics,
- Amount of glottal noise, and
- Formant frequencies.

There acoustic parameters can be ofconsiderable use to the clinicians in arriving at a diagnosis for evaluating the effects of surgery, or fortracking progress during voice therapy.

Figure 1 provides an example of an acoustic voice profile for a patient with glottic cancer before surgery(male, age 52). The top-left window shows a pitch change over time, and top-right window is an amplitude change over time. The bottom window provides measures of habitual pitch, jitter, shimmer,glottal noise, statistical data, and so on. By comparing this voice profile with a built-in normal and pathological database, a quantitative assessment of voice quality can be provided. Figure 2 provides an example of graphic display of estimated voice quality. The top window shows four acoustic parameters (jitter, shimmer, SD F0, and NNE) which measured from the patient, and the normal range of four acoustic parameters. The bottom window is an estimated voice quality (harsh, breathy and hoarse).



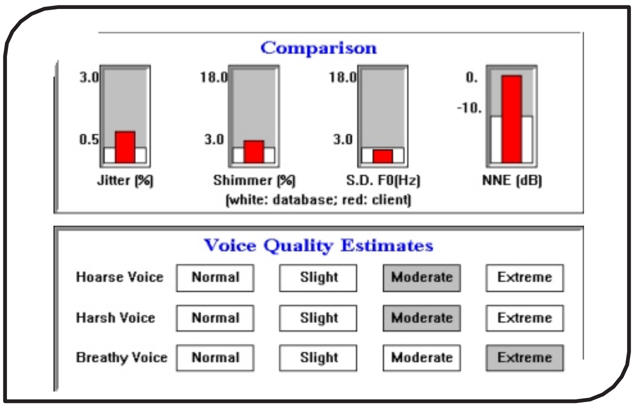


Fig. 1. Voice Profile

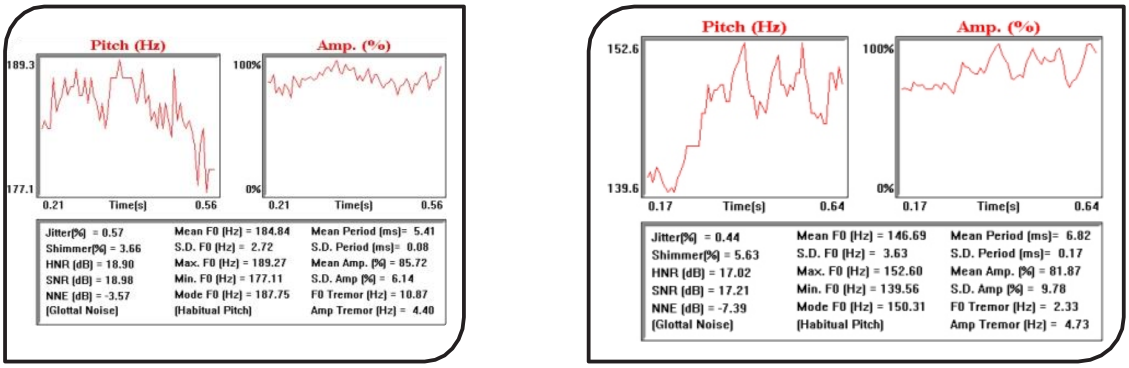
Fig. 2. Voice Quality Indicator

Tracking of Clinical Progress

Another useful application of technology in the clinic is what we might call **Clinical Progress Tracking** program, one of the module of Dr. Speech. This program allow any of the measure obtained during voice assessment to be stored in the computer. The clinical records can be retrieved and trends plotted automatically to show changes in a particular behavior as a function of time in therapy, as the results of surgery, before and after the fitting of a prosthesis, and so on.

As we knew, jitter measure mainly reflects the regularity of vocal fold vibration. NNE measure primarily results from an incomplete closure of the glottis caused by pathological changes of the vocal folds. The pathological voices appear to have higher jitter and NNE values than normal voices. The decrease of jitter and NNE value can provide us an indicator of the improved voice quality

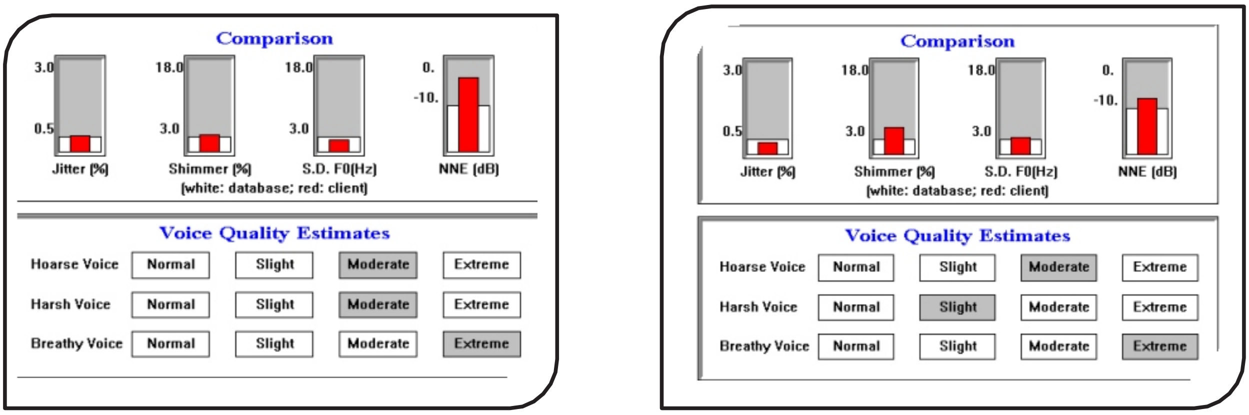
Figure 4 provides an example of an acoustic voice profile for a patient with glottic cancer (male, age 47) before and after surgery.



(a) Pre-operative (b) Post-operative Fig. 4.

Voice Profile for a patient with glottic cancer (male, age 47)

In figure 5, by comparing (a) and (b), we found that jitter and NNE values decreased after surgery. Also, harsh voice quality has been improved after surgery, but hoarse voice quality and breathy voice quality have not been improved.



(a) Pre-operative (b) Post-operative

Fig. 5. Voice Quality Indicator for a patient with glottic cancer (male, age 47)

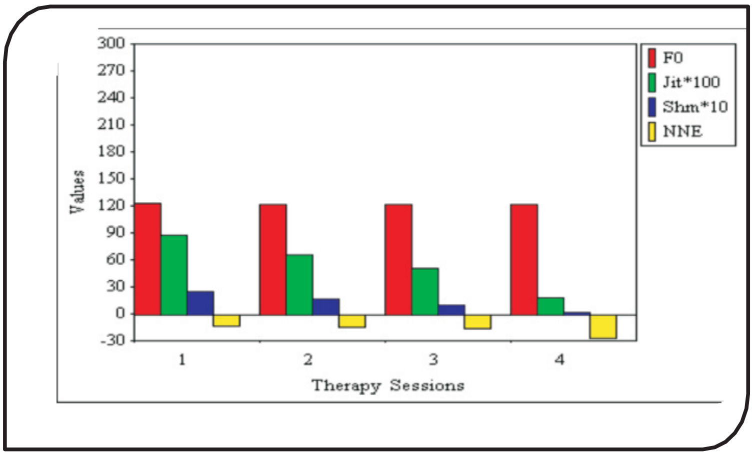


Fig. 6. Monitoring the effect of voice therapy

Figure 6 provides a graphic display of monitoring the effect of voice therapy for a patient with vocal nodules (male, age 35). This figure shows the changes of four acoustic parameter across four voice measures. The first voice measure was made two days before medical surgery, the second measure wasmade a week after medical surgery. The voice therapy started two weeks after medical surgery. The third voice measure was made two weeks after voice therapy, and fourth voice measure was made four weeksafter voice therapy. By looking at the graph, it is easy to observe that the F0 of the voice did not changeduring this time, but jitter, shimmer, and glottal noise are decreased across four therapy sessions. In otherwords, both the surgery and voice therapy for this patient are rather successful and efficient.

Clinical Implications of Acoustic Measures of Voice

Acoustic analyses provide quantitative information about the voice quality. Based on an investigation between perceptual judgments and acoustic parameters, some conclusions are:

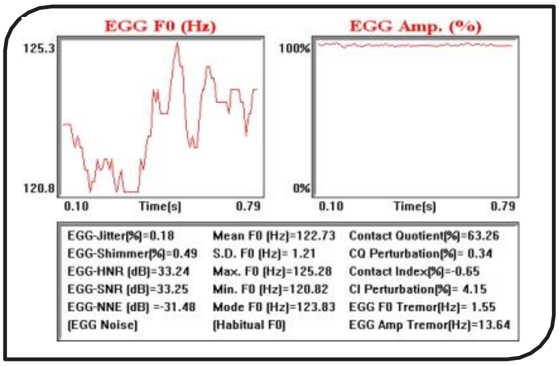
- Hoarse voice quality should be considered as some combination of breathiness and harshness.
- Vocal jitter appears to be related primarily to harsh voice quality.
- The amount of glottal noise (NNE) closely corresponds to the breathy voice quality
- Vocal shimmer appears to be the primary influence on hoarse voice quality.
- The spectral tilt of the glottal source is significantly related to the perceived breathiness.

VOICE ASSESSMENT FROM EGG SIGNALS

EGG Assessment software, one of the module of Dr. Speech, provides quantitative assessment of vocal function from EGG signals, especially for the close period of vocal fold vibration. The capabilities of thissoftware provide measures of EGG-pitch, EGG-intensity, EGG-jitter, EGG-shimmer, EGG noise, Contact Quotient (CQ), CQ perturbation, Contact Index (CI), CI perturbation, histogram, statistics, spectral analysis, and so on.

Electroglottographic Measure of Voice

Figure 7 provides an example of an EGG profile for a patient with papilloma after surgery (male, age 42). The top-left window shows an EGG-F0 change over time, and top-right is an EGG-amplitude change over time. The bottom window provides EGG-jitter, EGG-shimmer, EGG-NNE, CQ, CQP, CI, CIP, and EGG-F0 statistical data.



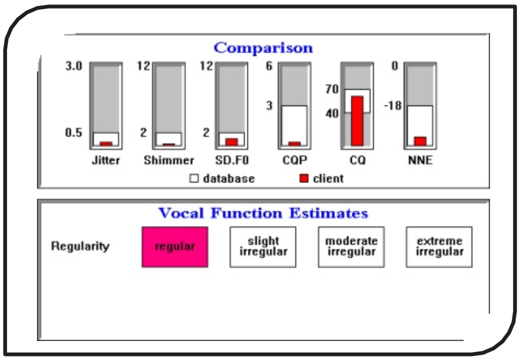


Fig. 7. EGG Profie

Fig. 8. Vocal Function Indicator

By comparing this EGG profile with a built-in normal and pathological database, a quantitative assessment of vocal function can be provided. Figure 8 provides an example of graphic display of estimated vocal function for a patient with papilloma (male, age 40). The top window shows six EGG parameters (EGG-jitter, EGG-shimmer, SD F0, CQ, CQP, and EGG-NNE) which measured from the patient, and the normal range of six EGG parameters. The bottom window is an estimated vocal function(regularity of vocal fold vibration).

Clinical Implications of EGG Measures of Voice

The EGG measure as indicators of vocal function was investigated. Some of the conclusions aresummarized below:

- EGG measures reflect the glottal condition better during the closed phase than during the open phase. EGG measures are chiefly related to laryngeal behavior that occurs during vocal fold contact.
- The presence or absence of glottal vibrations can be determined from the EGG signal.
- CQ reveals information about degree of glottal closure, CI gives information about symmetry of vocalfold vibration.
- CQP and CIP reveals the regularity of vocal fold vibration, the cycle-to-cycle variability of vocal foldcontact phase and vocal fold vibratory symmetry.

VOICE DISORDERS DATABASE:

Learning Resource for Physicians and Clinicians

Sustained phonation taken from 2937 normal and 902 patients with voice disorders were recorded andstored digitally to create the Voice Disorders Database. This database has been built in the **Voice Assessment** program. The database is also oriented for professionals who conduct voice research and provide clinical service for patients with voice disorders, and represents a different approach for improving the assessment and diagnosis of voice disorders.

Table. Discrimination between Normal and Pathological Voices (Source from 2937 normal and 902 pathological samples)

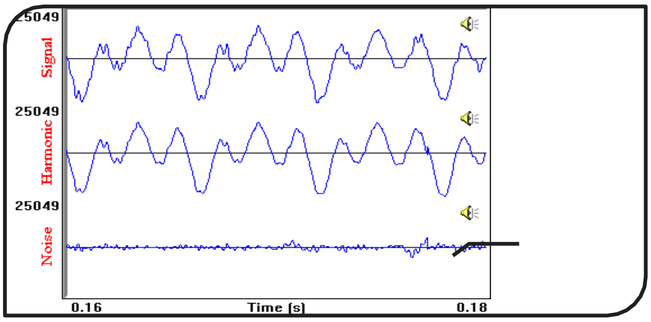
LaryngealPathology	Number of samples detected as Normal	Number of Samples detected as Pathological	Total
Normal	2685	252	2937
Glottic Cancer T1	13	49	62
Glottic Cancer T2	1	23	24
Glottic Cancer T3-4	0	18	18
Vocal fold polyp	26	52	78
Vocal fold polypoid	21	55	76
RLN paralysis	5	30	35

In order to evaluate the performance of acoustic and EGG measures in the distinction between normaland pathological voice status, experiments were made as in Table. A multiple value was obtained from several acoustic and EGG parameters. The voice samples was regarded as normal if the multiplevalue was smaller than a threshold, and as pathological if it was larger than, or equal to, the threshold.

5. GLOTTAL NOISE ASSESSMENT FROM ACOUSTIC SIGNAL

A New Approach in Voice Assessment

Glottal noise (or Normalized Noise Energy: NNE) measure is provided by **Voice Assessment** software, one of the module of Dr. Speech. The capabilities of this software provide measures of glottal noise energy directly. The figure 11 provides an example of a glottal noise measure from acoustic signals for a patient with vocal nodule after surgery (male, age 39). This figure provides an example of noise and Harmonic components from vocal signals. As we knew, glottal noise is useful to explain pathologicalstatus of vocal fold vibration so it is important for us to hear and see glottal noise alone.



See and hear glottal noise directly

Fig. 11. Noise and harmonic components

Further Details
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